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UNIVERSITY

William E. Gibson

# Aircraft Investment Planning and Uncertainty

COLLEGE OF AERONAUTICS

Ph.D THESIS

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Supervisor: Dr. Peter S. Morrell

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# Abstract

This research sets out to determine whether there is a best way to perform aircraft investment analysis. The question of best practice is found to be linked to corporate ownership: world airline shareholding patterns are identified and linked to investment analysis practices, and to airline financial performance over the last aviation cycle.

A key weakness identified by surveying airline practice concerns the treatment of uncertainty in the financial analysis. This research critically examines the state of practice regarding treatment of uncertainties embedded investment valuation assumptions, in airline fleet planning around the world, and proposes structured application of advanced analytical techniques to valuation in today's world of volatile and diverse aviation markets.

The assumptions underlying valuation are embedded in modern financial theory, which has been developed and tested over the last century. The validity and usefulness of financial valuation models is examined from both theoretical and practical perspectives, and the state of practice regarding these models in the airline industry is established, both quantitatively through survey research, and qualitatively through aviation executive interviews in the field. This combined approach has allowed the establishment of 'paradigms' characterizing the concrete application of financial theory to the question of aircraft investment.

Regional patterns of airline shareholding are identified in a detailed analysis of ownership structure and business models. The resulting governance typology is analyzed in aggregate, and associated with production, and profitability by region. The tendency of each airline ownership type to use modern financial valuation techniques has to some extent been established by applying survey results to the different regions.

The fleet planning process and the positioning of investment valuation within it is discussed, and key uncertainties underlying fleet planning assumptions are identified and mapped in a risk map framework. A method for strategic analysis of fleet financing alternatives is derived from classical theory, and applied to the specifics of the aircraft market.

The uncertainties surrounding several key modelling assumptions are found to be substantial in the minds of today's fleet planners, and the assessments of uncertainty vary substantially between airline fleet planners and third-party advisors. The identified practices in applying classical financial theory are found to be strikingly inadequate in treatment of these uncertainties.

A model is developed for valuing the acquisition of aircraft under uncertainty, using extensions of the classical financial framework entailing more advanced quantitative techniques. The model's application to a specific analytical situation analysis show that investment valuations under deterministic models are contradicted when applying uncertainty to key uncertainties present in today's markets, and a process that yields insights beyond classical finance is proposed.

# Acknowledgments

This thesis research has been a part-time labour of love since 2003. In that year, Professor Paul Clark, Managing Director of AirBusiness Academy, provided the strong encouragement necessary to embark on this research, which has a natural synergy with my work as a lecturer and advisor on fleet finance and evaluation. ABA's current M.D., Michèle Oberto, has also been very supportive of this research, as was our interim M.D., David Bradley.

Over the years, Dr. Peter Morrell has consistently encouraged and supported the research process by graciously accepting to co-author papers, and by providing rigorous, precise and critical commentary and editorial suggestions on the evolving thesis. Professors Clark and Morrell have written the definitive texts in their respective fields, and their support to this research has been a great honour to receive.

Among the many contributors of ideas and perspectives to this research, the most illuminating and inspiring have been Stéphane Daillencourt, Ignacio de Torres Zabalá, Nils Hallerström, Jorge Otero Rodriguez, and Claude Pluzanski.

The critical reviews and comments provided by the referees of the Journal of Air Transport Management and its editor Professor Kenneth Button, have been both encouraging and edifying. The publication and conference presentation opportunities offered by the Air Transport Research Society (ATRS), which accepted four papers fundamental to this research, have provided important perspective, in its unique forum of academics and practitioners. Jacques Tournut's continued confidence in my abilities as a lecturer in Finance at the Toulouse Business School has been equally important, giving me the opportunity to test these ideas

Identifying company practice in the strategic areas of fleet planning and investment valuation was made possible by the enthusiastic co-operation of a large number of executives from airlines, financial institutions in Europe, who must remain anonymous due to the promise of confidentiality.

The time away from family necessary to complete this thesis is a gift from my wife Mireille and sons Luke and Emerick, and I could never sufficiently thank them for this.

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# 1. Introduction and objectives

## 1.1. Airline fleet planning and investment analysis

The investment in aircraft is a long-term proposition for airlines around the world, involving choices which strongly impact the company's economic performance over the years the aircraft is in operation and at the time of disposal, in the form of aircraft residual value. The capital cost of aircraft can represent over 15% of airline costs, and represents 37% capital and labour inputs, as observed in 2000/2001 (Morrell, 2001). These costs are incurred with limited flexibility over the medium term, based on decisions made in a complex fleet planning activity within the airline.

According to a definitive work on the subject, "fleet planning is a process by which an airline acquires and manages appropriate aircraft capacity in order to serve anticipated markets over a variety of defined periods of time with a view to maximising corporate wealth" (Clark, 2007). This definition goes beyond the decision to acquire or dispose of aircraft, requiring that fleet planners effectively manage capacity over time (and economic cycles), to suit the needs of anticipated, uncertain, market demand.

It is a complex and ongoing organizational process involving many functions and analytical processes:

- Strategic, Network and/or Commercial planning for the market potential
- Marketing to define the cabin product and evaluate revenue potential
- Flight Operations for aircraft performance
- Engineering for maintenance capacity planning and costs
- Finance for the economic assessment

The investment appraisal[1] is typically performed when a final decision is required from an airline's board of directors. All of the inputs are summarized in economic terms (amounts invested, revenue, cost and cash flow projections), and the expected profitability of the investment is measured and defended to secure a favourable decision. Various profitability metrics can be observed in regular airline use, with their sophistication reflecting both the governance and the size and sophistication of the airlines concerned. These decisions, once taken, tend to lock airlines into fixed transport capacity and

[1] The terms investment *appraisal* and *analysis* will be used interchangeably in this research. Both refer to the process of valuing investment plans, often referred to as *capital budgeting* in U.S.

attendant costs over the medium term. This research will show that risk assessments range from "gut feel" to simple sensitivity analysis, and rarely to application of more sophisticated techniques to judge the likelihood of potential outcomes and suggest alternative investment paths.

In addition to the duration of the investment, the complexity of the equipment analysed and attendant corporate processes, airline fleet planning is characterized by complex relations with the airframe and engine manufacturers during the lead-up to the aircraft selection and board approval. After a strategic decision has been made to change the airline's capacity by replacing and/or adding capacity, a Request for Proposal (RFP) is usually issued to alternative suppliers of equipment. These documents and the resulting commercial proposals from manufacturers contain many details about the performance, cabin layout, hold baggage and cargo capacity and cost characteristics of various airframe/engine combinations, which serve as inputs to the airline's investment appraisal.

The valuation of the investment is often conducted hand-in-hand with the process of selecting among competing aircraft types, and the intermediate financial results are frequently used as a negotiating tool with suppliers of airframes and engines. The base of the economic analysis is a careful comparison of cash operating costs between alternatives. Cost per seat-kilometre (seat cost) is balanced against the cost of a flight (trip cost), and guarantees are sought for key items such as range, weight, fuel burn and maintenance cost.

Recent examples of the interaction between investment planning and negotiations with manufacturers were the protracted and difficult 2002 campaigns led by Boeing and Airbus to place single-aisle aircraft with Ryanair and easyJet in the midst of the 9/11 chill on new orders. The discussions led to repeated "best and final offers" by the manufacturers and leasing companies before Ryanair selected the 737-800, while easyJet agreed to move from a 737 fleet to highly customized A319s.

Along with the U.S.' Southwest Airlines, these companies pioneered the low-cost carrier mega-order that has been popular since. Both chose to publish certain non-confidential terms of Airbus and Boeing's commercial offers in prospectuses on their web sites, which have contributed to increased transparency in aircraft pricing. The 2002 Ryanair prospectus stated that the deal was proposed at pricing “significantly below” list prices, while easyJet (2003) cited “very substantial price concessions,” offering pricing “one third per seat below… the 737-700 aircraft already delivered" by Boeing in a previous deal[2].

A third party to the process, operating leasing companies can also play an important role in the fleet planning process, most obviously by providing available aircraft in contrast to the lead time imposed by the aircraft programme development and manufacturing processes. The major leasing companies have significant portfolios of used aircraft, and the strongest among them place "speculative" orders allowing them to offer near-term delivery positions in the event of strong demand.

In terms of the investment appraisal, aircraft acquired on operating lease are a hybrid between investment and financing, offering the right to "quiet enjoyment" of the aircraft during the lease period in exchange for a monthly lease payment composed of the aircraft depreciation, and interest charge and the equity return required by the operating lessor. The airline has no risk or reward regarding the asset's value at the end of the lease term, leading to questions regarding the analytical classification of a lease as an investment or financing vehicle. The second feature of operating leasing relevant to this research, much touted by the lessors, is the flexibility to abandon an individual aircraft, or even the aircraft type, at the end of the lease period. This thesis will review and propose methodologies for calculating the price of the risk transfer to lessors.

More generally, aircraft financiers in both the private and public sectors can play an important role in fleet development, because of the high leverage and hunger for capital of airlines around the world, making the bankers a fourth potential player in the investment planning process. This research explores the interactions between investment and financing decisions, given the often severe funding constraints faced by many airlines seeking to add or renew capacity.

Finally, fleet planning in many airlines is a highly political process, reflecting the various airline governance structures and political agendas in the broader economy. A recent a striking example of political interference in the process was the September 2007 rejection of Kuwait Airways' proposed $3billion fleet renewal plan and order of Boeing 787 and Airbus A320 aircraft by the government of Kuwait. This political imbroglio, deriving ostensibly from a lack of legal provisions for financing the deal which involved a local leasing company, brought about the resignation of the airline's management team and

[2] Extracts from the Ryanair and easyJet prospectuses are reproduced in Appendix 1

board of directors, which had completed a network and fleet study of many months' duration in preparation of the proposed aircraft order[3].

### 1.1.1. Aircraft investment, airline profitability and uncertainty

The world's airlines are continually challenged to deal effectively with uncertainty in the transport sector and the inevitable downturns faced by any business. In the 12 months ending August 2008, at least six airlines operating large aircraft (Aloha, Skybus, eos, maxJet, Silverjet, Oasis Hong Kong) went bankrupt in the wake of dramatically higher fuel costs driven by oil prices over $100/bbl. A new business model (low-fare business-class only service) was called into question, due to the incipient recession's impact on premium travel and the unprecedented, and unpredicted, price of jet fuel. At its 2008 Annual General Meeting, IATA changed its industry profit forecast for 2008 from its previous +$5billion forecast to -$2.3billion "at least" prior to its June AGM, and further reduced it to -$5bn by September, stark evidence of the rapidity with which the airline cycle can move.

These cyclical swings can be exacerbated by the periodic need to replace older equipment with more modern aircraft. There is, historically, a distinct relationship between the profits of the airline sector, and orders for jet aircraft.

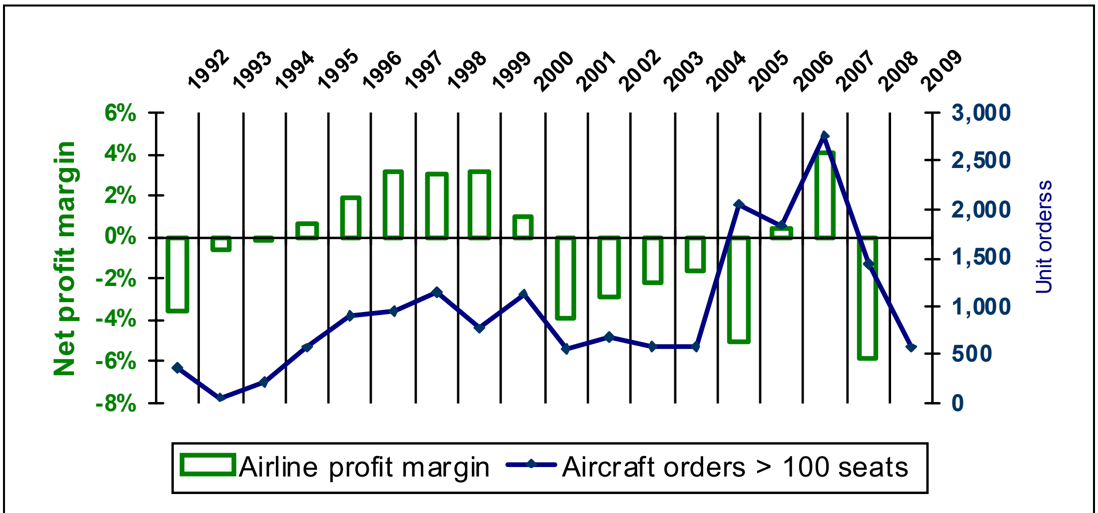



Figure 1.1: Airline profits and aircraft orders. Source: Airline Business[4], Airbus

Recent research testing more narrowly defined parameters has revealed closer relationships than airline operating profits and orders. Hallerström

[3] These events were reported in Air Transport Intelligence, 29 August 2007, 9 and 12 September, 2007

[4] Included in the 2005 industry net loss is the restructuring charge resulting in a net loss of $27.7bn by United Airlines, which emerged from Chapter 11 bankruptcy proceedings in that year

(2000) modelled jet aircraft demand and value as "pent-up relative capacity shortage/surplus (PURCS)", a function of the difference between traffic and seat growth offered, adjusted for the overall growth trend of air transport. Analysing previous forecasts of this relationship, he found that short-term swings in PURCS are "basically unpredictable." Otero (2006, p. 57) found a close relationship between airline operating profits (EBITDAR) per seat and orders of aircraft in the 1990s. Figure 1.1 reveals that in the most recent cycle, the profit-order relationship is far less pronounced, as the commercial success of the Boeing 787 and the continued popularity of single-aisle aircraft worldwide fattened manufacturer order books during three successive years 2005-2007, where orders averages 2,220 aircraft per year, while the Top 150 airlines achieved significant profits only in 2007.

Due to the manufacturing lead time needed to produce aircraft once ordered, the cycle of aircraft deliveries is often out of sync with airline profits. Aircraft ordered during times of strong growth (at the peak of the PURCS and profit cycle) are often delivered when profits are low or negative. In 2000 as the "new economy" began to wind down, the dollar strengthened, fuel prices rose, and U.S. pilot wage concessions negotiated in the early-90s downturn expired, airline profits fell below 1% of revenue, while nearly 800 jets over 100 seats, worth many tens of billions of dollars, were delivered. As losses mounted to total 4% of revenue in 2001, an even greater number of aircraft were delivered to operators by Airbus and Boeing. The precipitating event for the 2001-2004 downturn, the WTC attacks on 11 September, only exacerbated what was already starting as another "basically unpredictable" downward swing in airline performance, while manufacturer productions rates slowed only after the airline profits declined for two straight years.

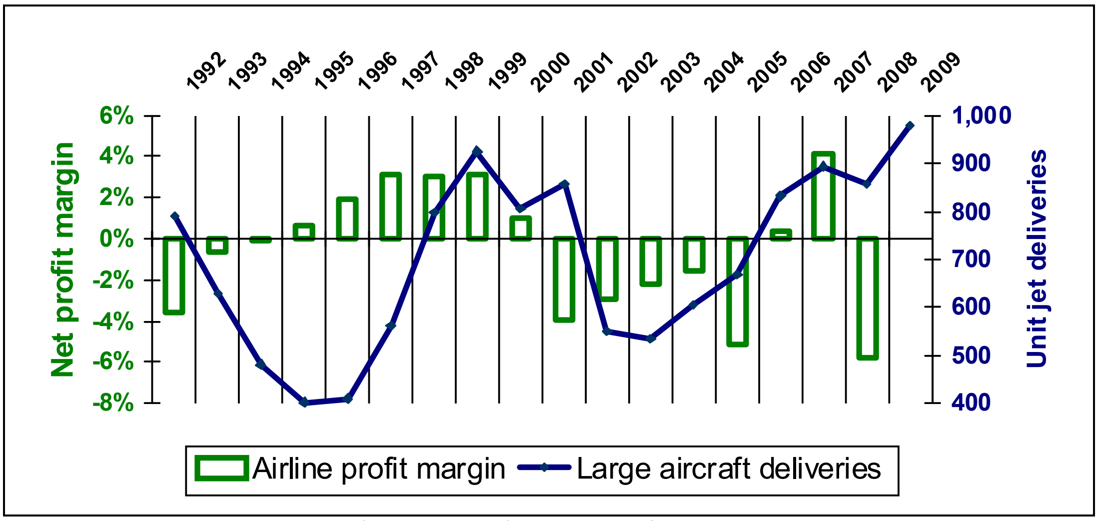



Figure 1.2: Airline profits and aircraft deliveries. Source: Airline Business, Airbus

Similarly, the financial crisis begun in 2008, coupled with high fuel prices and some unwise hedging practices, led to the deepest losses experienced yet by the world's largest airlines. These losses will certainly be repeated or deepened when 2009 results are finalized, and continue into 2010 in most regions: meanwhile, Boeing and Airbus delivered 979 large jets between them in 2009, and forecast similar deliveries for 2010. For this research it is important to note the fundamentally unpredicted nature of the WTC attacks and the present financial crisis (and the first Gulf War before them), which can wreak havoc with the best-laid plans of airline planners.

Added to the cyclicality is the well-known chronic problem of low profitability. The operating profits of the world's top 150 airlines occupy a consistently low place, when compared to other companies in the aviation supply chain.

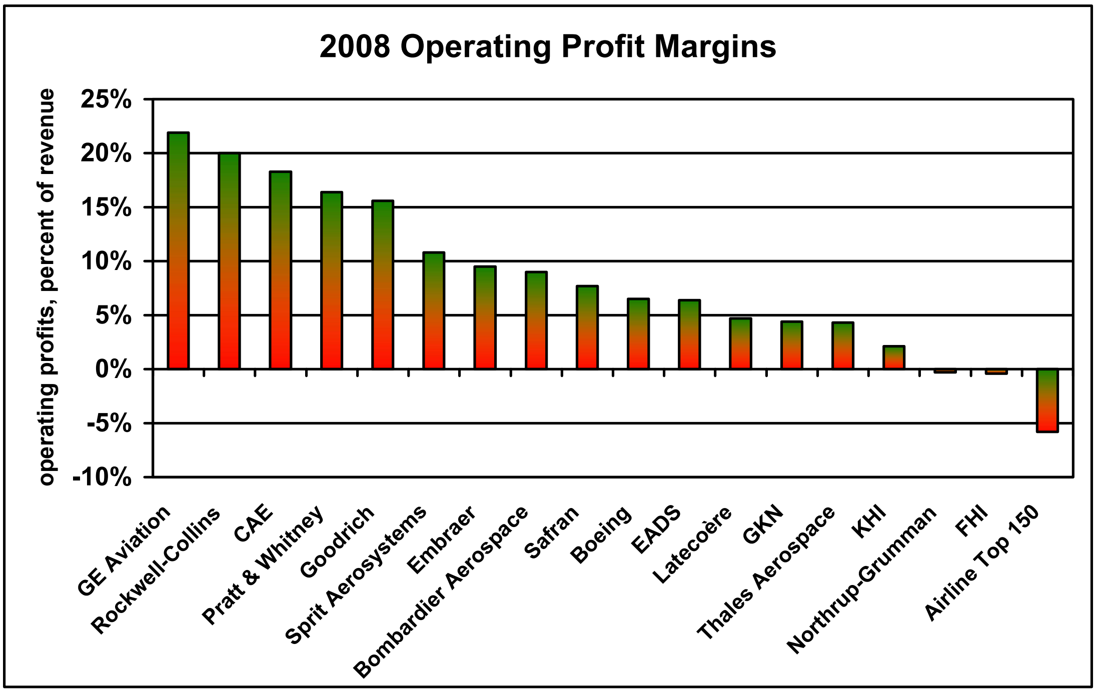



Figure 1.3: Aviation Supply chain profitability in 2008. Source: Flight International, Airline Business

The combination of cyclicality and fundamental difficulty producing profits means that the world's airlines have consistent and massive recourse to debt markets in order to finance investment in aircraft and other equipment. This financing gap leads to high financial leverage and interest charges, exacerbating the profitability problem and putting off private providers of long-term equity capital. In addition to its high fixed costs and operating leverage, airlines frequently have high financial leverage, with a wide range of capital structure in evidence across the business, as shown in Table 1.1.

| Airline | Debt to Total Assets ratio | Airline | Debt to Total Assets ratio |
|---|---|---|---|
| Singapore Airlines | -27% | Air Berlin | 72% |
| Vueling | 41% | TAM | 72% |
| GOL | 49% | Thai | 74% |
| Southwest | 52% | ANA | 75% |
| easyJet | 54% | Lufthansa | 75% |
| Ryanair | 55% | Alitalia | 78% |
| Cathay Pacific | 56% | LAN Airlines | 78% |
| Air Asia | 56% | British Airways | 79% |
| Aer Lingus | 58% | Frontier | 79% |
| Air China | 62% | JetBlue | 80% |
| Finnair | 64% | Air Canada | 80% |
| Turkish Airlines | 65% | JAL | 81% |
| Emirates | 65% | America West | 87% |
| Air New Zealand | 67% | United | 84% |
| Aeroflot | 67% | China Eastern | 92% |
| SAS | 68% | Continental | 97% |
| Qantas | 68% | China Southern | 100% |
| Air France | 69% | American | 102% |
| Iberia | 70% | Northwest | 161% |
| Westjet | 70% | Delta | 169% |

Table 1.1: Debt-Equity ratios of selected airlines. Source: Jacobs Consultancy (2006)

The variability of capital structure cuts across all of the world's regions and airlines business models. Some, like Singapore Airlines, had negative debt, while at the other end of the spectrum, three U.S. majors (of which two in Chapter 11, Delta and Northwest) had debts exceeding the total value of assets. The average debt to total assets ratio across the Jacobs (2006) sample was 74%.

Aircraft financing & investment interactions

The first and vital source of capital for any business is risk capital or shareholders' equity. In many countries, airlines were historically viewed as an infrastructure investment, required to promote economic development and growth, with the state providing the equity. This implies that for governments of these countries, the debt portion of airline financing could be viewed as part of the state's overall infrastructure financing. Further, because of the strategic and military background of aviation, many of the world's airlines were initially financed using state funds. This research will reveal that the state remains the largest shareholder in nearly half of the world's major airlines, and will explore the consequences of this fact for investment valuation.

Since the progressive deregulation of airline price and route structures began in the U.S. in 1978, many of the world's flag carriers have been privatised. This trend is most pronounced in Western Europe, so much so that among western European network carriers, the state held an absolute majority share only in Finnair, Olympic and TAP in 2009.

The wide range of governance structures that characterizes the airline business inevitably has a powerful impact on the investment appraisal process within the airlines. Private airline managers should be expected by their shareholders to perform rigorous economic and financial analysis to test and demonstrate the rationality and viability of investment projects in order to obtain board approval. British Airways and Lufthansa demonstrate valuation methods with great transparency in annual reports and other financial communications available on their web sites.

At the other extreme, an airline such as Kuwait Airways which is a department of the government shows a very high degree of state interference in decision-making process. That said, state ownership is no "guarantee" of non-economically rational behaviour on the part of airlines: Singapore Airlines and Emirates are both held (indirectly in SIA's case) by their respective governments, and both are industry-leading players in growth (Emirates) and profitability (Singapore). Between the extremes lie closely-held companies such as Virgin Atlantic and Hainan Airways, which may be expected to perform economic analysis very carefully, but are highly secretive about the extent and nature of such analysis.

A final group is airlines majority owned by other airlines. Often these are regional feeder carriers such as Air France's Regional Airlines, and American's American Airlines' American Eagle. In these cases the economic rigour of the parent should extend to the subsidiary. However, in other cases such as Brazil's Varig (owned by the low-cost start-up GOL) and China's Dragonair (an airline which has changed ownership from Cathay Pacific's parent Swire Group and Air China and back in the last few years, may have more strategic motives in their planning, rather than strict economic analysis of the airline's plans as a stand-alone entity.

The cyclicality and requirement for fresh capital creates major business opportunities for operating lessors and other aircraft financiers. Airbus reports the following sources of finance for the years from 2003 – 2008.

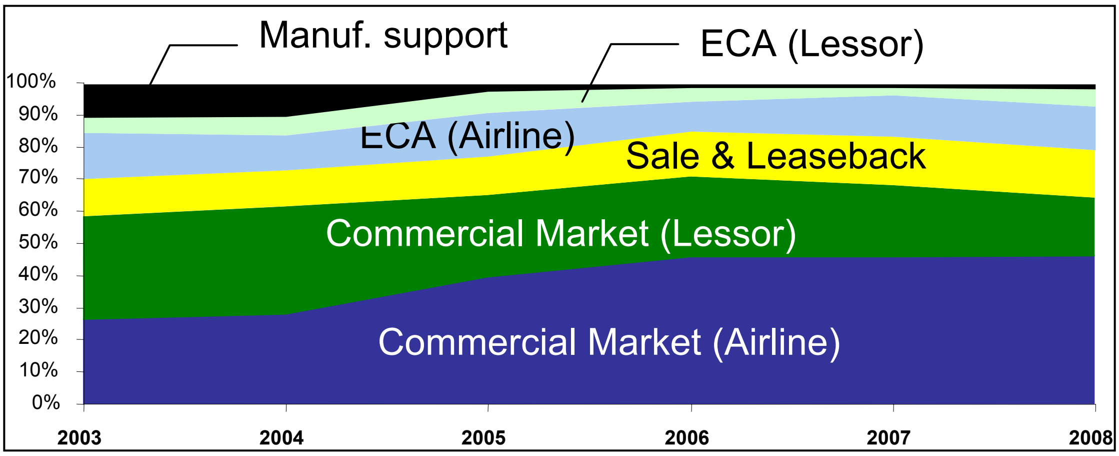


Figure 1.4: Sources of financing of Airbus aircraft, 2002-2008. Source: Airbus

More evidence of the impact of the airline profitability cycle on financing opportunities is clearly evident in Figure 1.4. In 2003 less than 30% of financing came from airline cash and market finance, a figure which rose to nearly 50% by 2006, near the peak of the most recent cycle. Regarding operating leasing, we can see from 2004 on a new trend away from "pure" operating leases and underlying speculative aircraft orders from manufacturers, toward increasing Sale and Leaseback operations where the airline orders and specifies the aircraft, cedes the title at delivery, and simultaneously signs an operating lease. Of longer duration than traditional operating leases, these vehicles demonstrate a very high level of investment-financing interaction and again raise the question of the analytical nature of an operating lease. Tactically the airline can realise a paper profit on the sale to the lessor, while eliminating the residual value risk, at a price which is embedded in the lease payment.

Lastly, the variability of the Export Credit Agency (ECA) proportion in the financing mix reflects the airline cycle. These agencies in industrialized countries provide loan guarantees to banks, in order to facilitate the export of capital equipment. The ECAs can be seen providing a financing "cushion" during the downturn years of 2003-2004, while their role is reduced when commercial financing becomes available during recovery and up-cycle periods such as 2005-2007. The rules governing ECA financing have recently been updated to be more inclusive, and to more effectively evaluate and price the default risk of such financing. The former Large Aircraft Sector Understanding (LASU), which specified the conditions for government loan guarantees available to finance exports of Boeing and Airbus equipment has been supplanted by the Aircraft Sector Understanding (ASU). The new agreement covers smaller and shorter-range regional fixed-wing aircraft as well as the larger jets. It also implements an airline credit rating scheme which is to be used, on all sides, to establish the appropriate premium to charge for the financing guarantee. These changes are intended to reduce the financing market distortion effect that ECA financing has been accused of in the past[5].

The picture on the other side of the Atlantic is similar, as Figure 1.5, from a Boeing FAA briefing presentation. Boeing clearly anticipated that the financial crisis would create an even greater need for ECA financing in 2008 than was the case for Airbus.

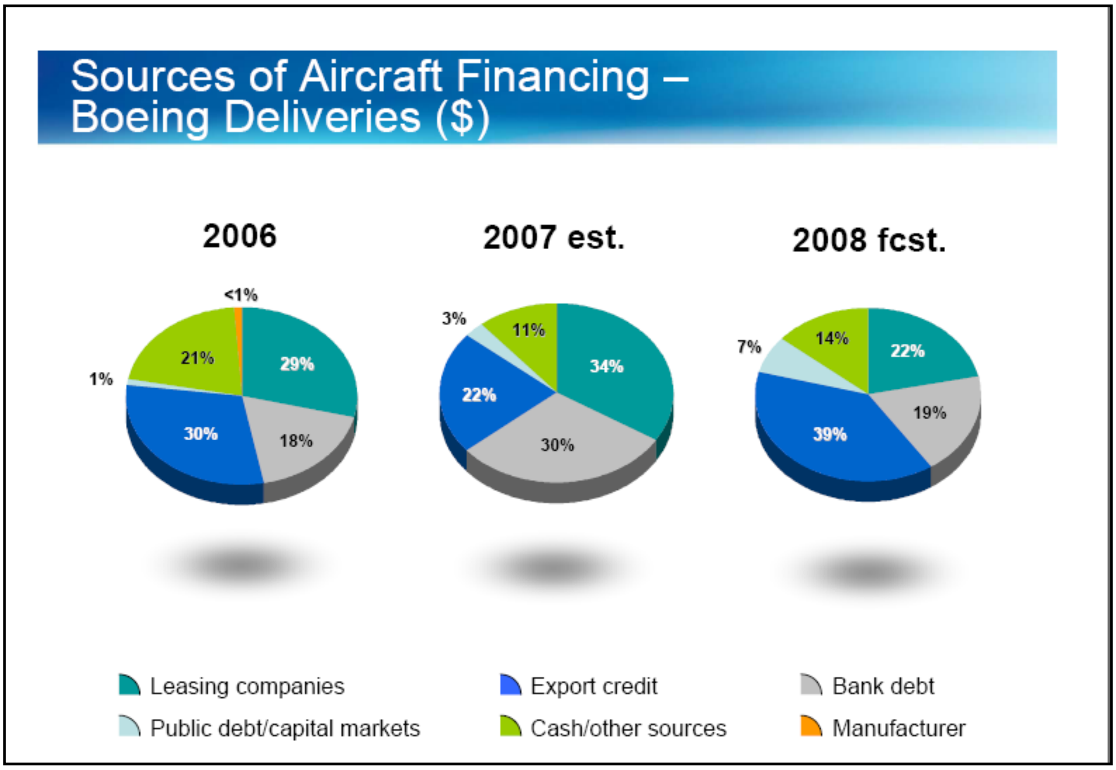



Figure 1.5 Sources of Finance for Boeing aircraft. Source: Boeing

The ECAs are not the only public-sector financiers of airlines and aircraft. The European Investment Bank (EIB) financed €5,370 million of airline projects between 1990 and 2001 (EIB, 2004). The bank's evaluation report for the period noted the volatility of the air transport market, the medium-term nature of fleet capacity decisions, and the very wide range of airline management and governance impacting decision-making. While generally positive regarding the EIB's performance, the report does point up a certain lack of methodology in project selection, and problems with project follow-up during the operational phase. The 10 EIB aviation financing projects analysed show a wide range of profitability projections, suggesting that the origination of the deals and the motives for the projects, and the loans, are not strictly economic.

[5] see, for example, AirFinance Journal (2007)

## 1.2. Thesis aims and objectives

The world's airlines thus often suffer from low profitability, high financial and operating leverage, high market uncertainty, and dependence on debt finance, ECA guarantees, and operating leases to support their growth and development.

Airline fleet planning processes are in turn characterized by:

- Long-term commitment to investments with limited flexibility to exit
- Complex, ongoing fleet planning processes involving many functional areas of the airline
- Involvement of equipment manufacturers and leasing companies
- Political interference, both in governance and financing

The basic research question is derived from these characteristics: given these challenges and complex interactions of many players, what is the role of the financial valuation, and is it done properly (and indeed, *can* it be done properly) given the theoretical framework and tools at hand? Beyond the question of proper application of theory, the research aims to identify best practice in valuation, given different airlines' geographical reqion, size, governanance, and previous aviation track record, establishing a set of guidelines for the proper use of financial theory depending on these parameters,

With this central question, there are three research aims of this thesis. The first is to investigate the coherence, clarity and usability of financial valuation theory for evaluating aircraft investments, including questions of data availability around the world, and to establish the state of airline practice regarding financial valuation. A second aim is to establish an airline ownership typology capturing and synthesizing the wide variety of airline equity ownership patterns, and to examine the relationship between equity ownership and valuation methods used. The research then attempts to establish a link between governance, profitability, and aircraft investment valuation. The final aim is to discover if and how application of the most recent financial and investment theory to fleet planning processes can contribute to an improvement of aircraft investment financial evaluation, which could in turn enhance profitability and access to cost-effective private sector sources of long-term capital. The research establishes the state of current practice across the world's regions and airline ownership patterns, identifies new approaches beyond simple application of classical finance theory, and provides a methodological framework for applying these extensions to investment appraisal in a systematic way.

Starting with the recognized methods of investment analysis widely used within and outside aviation, the research establishes a baseline of valuation practice in the general business community and in the airline industry, investigating both *which* techniques are used, and *how they fit* in planning processes. Given these baseline techniques, the research seeks to identify paradigms of practice, given the most recent extensions and variations used by the most financially advanced airlines in Europe.

Finally, the research identifies the key uncertainties facing fleet planners today, and proposes methods for most effectively assessing risk over the investment horizon, including measuring and modelling the impact of economic cycles and demand uncertainty on investment projects. Methods for reliably and transparently pricing the potential risk-transfer inherent (for example) in manufacturer options are proposed.

### 1.2.1. Research methodology

The objectives of this thesis require investigation of financial analysis techniques used within companies. The primary difficulty of the present topic is that decision processes surrounding fleet acquisition are considered highly strategic, and are held confidential in the vast majority of cases. The goal of establishing best practice further requires research into *which* financial analysis techniques are used: additionally, inquiries into the even more sensitive topic *how* they are used to evaluate investments are necessary. In order to surmount these challenges, a broad mix of field research and analysis of publicly available data was necessary.

To determine which techniques are in use, this research uses, compares and contrasts three field research items:

- Executive survey of 249 airlines, to identify and compare airline investment valuation practice with the general business community. The comparison with the general business community is intended to identify, any unique strengths and weaknesses in the airline business
- Structured interviews with senior managers of airlines, financial institutions, and aircraft manufacturer, to clarify the question of the positioning of the investment appraisal within the overall fleet planning process

- Finally, an expert panel of fleet planning professionals, which was queried specifically on the degree and impact of uncertainties underlying both fleet planning processes and financial valuations

To deal with the particularly abstruse nature of some current financial theory (such as Real Options), this research developed a stylized illustrative example using an aircraft investment valuation model developed by the author - and used actively with clients in the field - to the problem of capturing, and valuing, uncertainties in investment projects.

Three cross-sectional analyses of the airline industry worldwide were performed for this research: the executive survey mentioned above, analysis of airline equity ownership worldwide, and analysis of airline financial performance over the 2004 – 2008 period. In selecting the airlines for survey and analysis, the primary principle was to identify a single airline population where it was possible to obtain reliable published information for the ownership and profitability analyses.

A second guiding principle in sampling was pragmatism, in the face of many firms' reluctance to disclose their methods of strategic decision-making to company outsiders. The most willing respondents throughout this research come from the European region, for at least two reasons.

The first is the stature of Cranfield University in the European aviation sector, cited by several interviewees as encouraging them to co-operate with this research. The second is the fact that since the privatizations beginning with British Airways in the 1980s, and led by the practices of British Airways, Lufthansa and others, European airlines have developed a management culture of financial transparency, as evidenced by the extensive financial communication available on the airline web sites.

This pragmatic approach has clearly produced sample bias into this research, which is skewed toward representation of European best practice. The research is thus most relevant for those airlines that choose to adopt highly transparent communication of investment analysis, whether they be in Europe or other regions of the world.

The specific method used to establish specific samples for each phase of the research is described in the relevant chapter.

The secondary research methods used in this thesis are:

- Review of the usefulness of the relevant financial theory literature and investment analysis techniques available, and the numerous recent theoretical advances in the field

- Identification of the state of investment appraisal practice in the business and communities through literature surveys
- A stylized "case study" approach to identify and synthesize the state of practice. Three valuation paradigms are proposed, and practices combining traditional and advanced valuation techniques are analysed and compared.

### 1.2.2. Thesis structure

This thesis first reviews the relevant financial theory, its evolution through today. One of the central debates in modern financial theory is the separation of the investment and financing decisions, around the notion that the way a firm is financed does not affect its overall market value. Chapter 2 of this thesis surveys the evolution of the relevant investment theory underlying such decisions.

Company and project investment valuation techniques evolved from classical economic evaluation pioneered in the 1960s and updated since are discussed in Chapter 3. Application of the techniques in the general business community and in aviation is then surveyed, with a specific discussion of the treatment of risk in the analysis.

Classical investment theory was developed primarily with publicly-traded shares in mind. Chapter 4 explores the relevance of valuation theory for the airline business today, given the wide range of airline equity ownership patterns found in the world's companies and airlines. The potential and pitfalls of classical valuation techniques worldwide are examined in detail. Governance patterns are identified for each region, valuation techniques are matched with region and governance patterns, and are compared with the practice in publicly traded firms. Growth and profitability by region and by ownership pattern from 2004-2008 are analyzed.

The positioning of the investment appraisal within the airlines' fleet planning process is the first subject of Chapter 5, using various European airlines to identify and illustrate different approaches. The influence of manufacturer forecasts on fleet planning is discussed, and the ‘neo-classical’ investment valuation paradigm is described in detail. The chapter concludes with the expert panel on fleet planning uncertainties, bringing to light the varying degree of uncertainties underlying certain fundamental assumptions, and suggesting the need to adopt valuation techniques beyond the neo-classical approach.

Chapter 6 identifies and analyzes two new valuation paradigms in today's airlines, and examines the potential benefits of each in valuing projects, negotiating with aircraft suppliers, and managing fleet planning uncertainties. The problematic valuation of the residual value risk transfer inherent in operating leases is examined, and classical financial theory is extended and adapted to this specific valuation question.

Chapter 7 seeks to advance the usefulness and viability of the most recent strategic and investment theories for fleet planners, focusing on options pricing and its underlying tool Monte Carlo analysis, with a secondary emphasis on recent applications of Game Theory and environmental cost modelling to the fleet planning problem.

Chapter 8 of this research intends to both summarize the research and facilitate the adoption of the more advanced techniques. Profit performance of practitioners of financial theory is compared with overall industry performance, concrete applications of the advanced techniques are recommended, and areas for further research are identified.

# 2. Financial theory and the cost of investment

The theory of planning and costing investments grew over the twentieth century with the rise of publicly held companies issuing equity and debt securities on organised security markets; the practices derived from these theories are still with us today. A body of theory and practice regarding security analysis by arms-length investors (that is, investors who were not necessarily managers or board members of the company concerned) was developed and codified in works like Graham and Dodd's comprehensive Security Analysis, originally published in 1934 and still in print and widely used today in its 5th Edition (updated by three additional authors in 1988, 12 years after Benjamin Graham's death). In the late 1950s and 1960s, theory took a major turn from valuing securities using financial statements to more statistical and approaches to estimating investment returns and company values. This chapter outlines the evolution of relevant investment theory and its implications for airline investment planning.

## 2.1. Traditional views of investment costs and returns

The question of the cost of corporations' investments in real assets – or, equivalently, the return to investors and lenders to such corporations - was extensively developed in the context early in the last century in articles and books such as Graham and Dodd (1934). This body of practice will be called the "traditional view" in this research, and its tenets have been widely debated since the second half of the century. They are still the subject of contention among academics and practitioners today. Graham and Dodd's Security Analysis is still in print in its Fifth edition updated by three additional authors and published in 1988: it is this edition, referred to as Graham and Dodd (1988), which is used to illustrate the concepts in this research.

Several fundamental constructs underlie this body of practice, which its advocates call "value investing". The first and most important is that a firm's *intrinsic value*, defined by Graham and Dodd as "the value which is justified by the firm's assets, earnings, dividends, definite [growth] prospects, and the factor of management." This intrinsic value can be estimated, and it bears an uncertain relationship to the market price of the firm's shares at any given time. Share values are held to fluctuate around a *central tendency*, a concept very similar to the economist's notion of an equilibrium value between supply and demand for the securities.

This intrinsic value of the firm is best estimated by *sound valuation* based on careful analysis of the company's financial statements. Discrepancies between market value and intrinsic value give rise to the activity of contrarian investing, acquiring shares of firms whose intrinsic values are substantially above their current market values. This gap between these values is known as the *margin of safety*: risk-averse investors will seek deeply discounted market valuations in order to “insure” themselves against continued market misperception, while the more adventurous will be willing to accept smaller value gaps when justified by knowledge of the business or the company's management skills.

Because the relationship between market and intrinsic values is uncertain, investors cannot be sure when (or indeed, if) the market will perceive the value gap and bid up the shares. The solution proposed to this conundrum is holding a diverse portfolio of such shares, some of which will be re-valued by the market earlier than others, an intuition presaging the Markowitz’ more formal theory of diversification as a tool to maximize the ratio of return to uncertainty. The notion that shares can be durably under- or overvalued is contradictory to the more recent theory of efficient financial markets, where all relevant information about a company's condition and prospects is at all times embedded in a firm's share price. The margin-of-safety concept is less elegant and amenable to broad theorization than efficient markets theory, but Warren Buffet, certainly the world's most successful security analyst, made his fortune based on these concepts, and Mr. Buffet frequently cites the teaching of Benjamin Graham as the main inspiration for his investing approach. This research will make extensive use of the remaining constructs in the traditional view, discussed below.

These other constructs are consistent with subsequent investment valuation theory and practice, and underlie its development. The first of these is the existence of a capitalization factor which allows the analyst to relate the firm's current and expected profit performance to its share price. The most common and simplest capitalization ratio is the Price-Earnings Ratio (PER), a factor relating today's share price $P_0$ to the firm's expected Earnings per share (EPS):

$$PER_0 = \frac{P_0}{EPS_1} \quad \text{2.1}$$

Easy to measure for both the market as a whole and for individual firms, this single-period ratio allows comparison of the optimism of investor's expectations among firms and markets. It is often interpreted as a measure of expected growth prospects in a fuzzy way, as it represents the number of years' *current* earnings paid for a share. Numerous variants of this basic equation are in common use, including in the numerator Enterprise Value (EV, the market value of bonds and shares outstanding less cash), and cash flow in the denominator: in all the variants, the underlying valuation concept is the same.

Firms' growth prospects are better accounted for in a multi-period dividend discounting valuation framework, which in its simplest form calculates today's value as a perpetuity function of the next year's expected dividend ($DIV_1$), the investor's required annual return (r) and the anticipated growth rate of the dividend (g):

$$P_0 = \frac{DIV_1}{r-g} \quad \text{2.2}$$

Since value investing is heavily dependent on estimating the expected future earnings of the company, dividends must be derived through an assumed percentage of profits paid out as dividends, known as the dividend payout ratio. As Brealey and Myers (1984) pointed out, the relationship with the growth expectations implicit in PER can be derived by dividing Equation 2.2 through by EPS:

$$\frac{P_0}{EPS_1} = \frac{DIV_1}{EPS_1} x \frac{1}{r-g} \quad \text{2.3}$$

The price earnings ratio can thus be high for any or all of three reasons: the payout ratio and/or dividend growth is expected to be high, or investors' required returns are low.

For value investors, projections of earnings necessarily underlying dividend forecasts should be based on macro-economic forecasts, broad analysis of listed share earnings expectations, sector and finally company analysis. Individual company forecasts are held to be highly dependent on the quality of management, and easier to perform for companies with a long track record to base the forecast on, and/or a dominant position in their industries. Examples of ideal companies for value analysis given by Graham and Dodd (1988) are then-dominant firms like McDonald's and General Motors, and Dayton Hudson, a remarkably stable retailer of consumer goods.

To better reflect future prospects, precise dividend forecasts are recommended by proponents of value investing, leading to the familiar valuation equation in common use today, for both company and real asset investment valuation.

$$P_0 = \frac{DIV_1}{(1+r)^1} + \frac{DIV_2}{(1+r)^2} ... \frac{DIV_n}{(1+r)^n} \quad \text{2.4}$$

In this approach, each year's dividend is estimated and discounted over the number of years in the investor's horizon (*n*). Clearly, the projected future dividend estimates are subject to a broad range of uncertainties

There are two basic analytical approaches to using these dividend discount models, which again find echoes in real asset investment analysis: either the analyst chooses a discount rate reflecting expected risks of the company and solves the equation for the "true value" (today known as target price) of the shares, or today's price is used to calculate the implied annual rate of return (the internal rate of return, or IRR) in an iterative "trial and error" method.

Both approaches beg the question of the investment horizon, an issue which is avoided in the simpler PER approach and for which there is no absolute prescription, and neither deals with companies which do not issue dividends. Graham and Dodd, while admitting the choice of investment horizon is arbitrary, argue forcefully for a five-ten year investment horizon, in order to cover the company's prospects over a complete business cycle (Graham and Dodd (1988, p. 514-515)). This research will return to the critical question of cyclicality in later chapters of this research. The dividend question remained unsolved until portfolio pricing techniques were brought into play. These are discussed in section 2.3.

The final construct used in the traditional view is the intuition of a *risk premium* to be estimated on share markets, raising the cost of share finance over and above the cost of debt. This final construct relates the expected return of company shares to overall economic conditions and the returns available for alternative, lower-risk investments. Summarizing the traditional view, the expected return on share markets is a function of current and future earnings and dividends as discussed above, but also of inflation, interest rates on relatively low-risk AAA corporate bonds, and an equity risk premium. In the 1988 edition, a numeric example of these elements is given (earnings growth prospects 7.5%, expected inflation 5.2%, AAA bonds 8.5%, and equity risk premium 2.75%), giving an 11.25% expected share return of which 7.5% comes from price appreciation, and implicitly, 3.75% from dividend yield.

To estimate the required rate of returns, the equity risk premium (presumably over the market return) is presented by Graham and Dodd as the "variability of expected returns [in individual years] around the trend line returns," based on three broad categories of causes:

1) industry factors, operating and financial leverage, creditworthiness and non-financial elements;

2) potential growth over and above the trend line from new products and markets, as well as economic and social developments;

3) informed and experienced based appraisal of management ability to cope with uncertainty and unpredictable events.

For traditionalists, the variability of company performance over the economic cycle is highly dependent on the quality of the company's management, a subjective appreciation which defies quantification.

To best manage the risk of investments, value investing proponents such as Graham and Dodd are starkly conservative. In this view the ideal securities come from companies with a long track record and relatively consistent growth and profit performance (and which, ideally, dominate their markets), within sectors of "inherently stable character," with analysis to be performed in "normal" economic conditions. Finally, the ideal securities should be relatively senior issues protected from earnings variability, such as preferred shares. This view, along with the margin of safety concept, essentially means that value investors should avoid the combination of risky industries (a category which certainly includes the world's airlines), start-up and volatile companies, and securities such as common shares. In short, this traditional investing approach seeks to deal with risk by avoiding it, surely very good advice in itself but not terribly helpful for research into the airline industry, in which earnings are highly volatile.

The contribution of the traditional approach to this research is the clear definition of the fundamental valuation concepts and constructs used in security and investment analysis ever since. The traditional view posited valuation constructs such as the risk premium of shares over bonds in an intuitive way, but stopped short of providing an explicit method for estimating the appropriate discount rate to be used in valuing individual companies and their projects, a problem which is still subject of much theoretical and practical debate today. Much of the valuation theory developed in the second part of the twentieth century seeks to scientifically estimate the proper discount rates for valuation purposes. The emphasis in the traditional view is on profits, and its foundation is a careful examination of a company’s reported financial statements: in its quantitative aspect this approach is backward-looking, and based on reported profits rather than cash flow. This is in contrast to the valuation methods identified in this research, which use cash flow forecasts to more transparently reflect the large up-front investments and long-term forecasts required of airline fleet plans.

## 2.2. Capital structure and investment costs

Traditional valuation theory says little of any precision about the relative benefits of debt or equity financing. The emphasis on earnings per share and the price-earnings ratio for company valuation inevitably raised a problem which has been central to corporate finance theory and practice ever since, the question of capital structure (debt and equity mix). The so-called financial leverage benefits of debt to the company's shareholders are easy to demonstrate: for a given level of operating profits, a firm with a higher level of debt will generate larger net income per share than a firm fully financed by equity, because a greater amount of the capital needed to finance investment and growth is provided by the lenders to the company, and because the corporate income tax bill is reduced by the deductibility of interest.

A much-reproduced and dissected numerical example follows:

| | Firm A | Firm B | Firm C |
|---|---|---|---|
| **Capital structure** | | | |
| Debt financing | | 50m | 75m |
| Equity financing | 100m | 50m | 25m |
| Total book value | 100m | 100m | 100m |
| **Profit and loss** | | | |
| Operating profit | 200m | 200m | 200m |
| Interest expense (at 5%) | 0.0m | 2.5m | 3.8m |
| Pre-tax profit | 200.0m | 197.5m | 196.3m |
| Income tax (40%) | 80.0m | 79.0m | 78.5m |
| Net income | 120.0m | 118.5m | 117.8m |
| Number of shares | 50000 | 25000 | 12500 |
| **Earnings per share** | **2.40** | **4.74** | **9.42** |
| **Traditional valuation** | | | |
| **Price earnings ratio (PER)** | **11.6** | **12.0** | **6.0** |
| Value of shares | 1392m | 1422m | 707m |
| Value of debt | 0m | 50m | 75m |
| Total value of company | **1392m** | **1472m** | **782m** |

Table 2.1: Effect of financial leverage on profits and returns to shareholders, author example

As debt is added to the capital structure of Firms "B" and "C", absolute earnings decrease, while both per-share earnings and return on shareholders equity increase. Of course, losses attributable to shareholders are equally magnified by higher levels of debt, making earnings more volatile for leveraged companies. In the traditional view, share markets will reward firm B for having a "reasonable" amount of debt, bidding up the PER to 12.0 because this firm can "grow faster than A at a given dividend payout ratio [that is, by reinvesting higher amounts through additional borrowing], or can pay higher dividends at the same growth rate."

On the other hand, traditionalists and lenders use the debt-equity ratio as a key indicator of the company's ability to repay debts as they come due, and hence, a potential lender will only advance funds to firms with a "reasonable" amount of debt. Firm C in our example has entered the value investors' category of "speculative" firms, and the PER accorded to the firm, reflecting the increased riskiness of the firm, is illustrated by Graham and Dodd as "about half that of Company A."

No reliable or quantitative method of estimating the PER as a function of debt level is provided, and value investing proponents are also silent about what constitutes a reasonable amount of debt, opening the door to decades of debate about the existence of an "optimal" capital structure, where the PER and share price would be maximised without doing damage to the company's credibility with investors or increasing the cost of borrowed funds. If such an optimum does exist, company managers can increase the total value of the company (debt + equity) simply by borrowing up to the "reasonable" amount of debt, as in the case of Firm B in our example. They could, indeed, decrease the overall cost of investments by judicious use of debt.

The most important theoretical challenge to the fuzzy traditional concept of optimal capital structure was The Cost of Capital, Corporation Finance and the Theory of Investment (Modigliani and Miller, 1958), in which the authors pointed out that the question of "cost of capital" (the new term for investment cost) is of interest to both "managerial economists" in charge of investment planning (capital budgeting) and corporate finance specialists who seek the best financing alternatives. This article singularly pushed the cost of capital debate into the world of probabilistic calculations, while turning the idea of a "reasonable" amount of borrowing with little impact on shareholders' expected returns on its head. The article posits and demonstrates that under the stylized conditions used, the value of any company derives from the productivity and the value of its assets, rather than the way it is financed, a proposition today known as the "law of preservation of value"[6]. Secondly, the authors show that to maximise the value of the firm for investors firms' managers should only invest in (real) projects that produce returns higher than the cost of capital. These normative rules have guided the practice of investment analysis since its publication. Its implications for both financial economics and normative management practice are tremendous.

The succeeding pages of the article presented an elegant and highly stylized set of answers to the cost of capital question, answers which have fuelled both strong debate among the highest level economists ever since - for example Durand (1959 and 1989), Stiglitz (1969), and Tirole (2006) - and find strong echoes in recommended practices in virtually all college textbooks on corporate finance. The two propositions and derivative theories won the Sveriges Riksbank Prize in Economic Sciences (or so-called "Nobel Prize in Economics") for Franco Modigliani in 1985. The concepts and tools introduced in this article are fully as relevant today as they were in 1958, and are essential to an understanding of investment valuation in any publicly held company.

The highly provocative 1958 article starts by criticizing earlier economic theories for assuming that physical investments yield known, certain streams of returns similar to those on interest-bearing bonds. In this "certainty case,"

[6] See for example, Brealey and Myers (2000), pp. 476-477

the conclusion had been that the cost of capital to the owners of a firm is precisely equal to the rate of interest on bonds, leading to the conclusion that, in a world of sure returns, "the distinction between debt and equity funds reduces largely to one of terminology," that is, that the cost of investments are equal to the borrowing costs, and any additional profit or cash generated will simply accrue to the shareholders. While this view may be appropriate for closely held firms, managers of publicly traded companies cannot limit themselves to such an analysis.

The authors then described economists' attempts to take uncertainty into account by superimposition of a vaguely defined "risk premium" on the cost of debt financing, just as in Graham and Dodd's seminal work. Striking at the heart of the traditional approach's weakness, the authors state that "no satisfactory explanation has yet been provided as to what determines the size of the risk [premium]." According to the authors, this tendency in valuation is derived from Keynesian macroeconomic analysis, in which "aggregate investment is written as a function of the (riskless) rate of interest." The adaptation of Keynes' macroeconomic theory to microeconomics is not helpful to the financial practitioner analysing and financing risky investments.

They then moved on to describe more recent theories, the first of which postulates profits as a set of mutually exclusive outcomes which "can at best be described by a subjective probability distribution", or, "a random variable" which defies the notion of "maximizing" these profits at the firm level. For the shareholders, investment and financing decisions can only be ranked based on a *subjective* "utility function" (italics theirs) which weighs the expected yield against the probability of success. In this scenario, the desirability of a given investment will be wholly dependent on the taste for risk of the current owners of the firm, making theoretical generalization impossible, particularly for widely held firms.

The second theory discussed relies on the notion of market value maximization, which is today at the centre of most approaches to value-based management discussed in this research. This approach finesses the above-mentioned problem by exchanging the closely-held corporation for those with widely-held shares, where the "market prices will reflect not only their [the current owners'] preferences but those of all potential owners as well." This approach was used to both introduce the concept of cost of financial capital to a firm's managers, and to build the postulate that financing decisions (stock vs. bond financing) are irrelevant in maximizing the overall value of the firm, including both shares and bonds.

In order to generalize the concepts, Modigliani and Miller (referred to as Modigliani and Miller in the literature and in this research) postulated the existence of risk classes of shares: in each individual class, the ratio of expected return ($\overline{X}$, the expected value of the random profit distribution) to the price paid for the share – in conventional terminology, the expected *yield* on the shares - is the same. This ratio of earnings to share price is defined as $\rho_k$, and is the same concept of the capitalization factor (e.g. PER) used by Graham and Dodd), but in this case generalized to a class of risk-equivalent shares.

Based on the assumption that all bonds, regardless of the issuer, are perceived by traders as having certain returns in a market where all equivalent securities are priced identically (a so-called perfect market), the authors postulated in Proposition I that the overall market value of the firm $V_j$ is not impacted by the relative quantities of shares ($S_j$) and Bonds ($D_j$) in its capital structure, but is rather entirely described by expected profits and the discount factor for its risk class:

$$V_j \equiv (S_j + D_j) \equiv \frac{\overline{X_j}}{\rho_k} \quad \text{.......} \quad 2.5$$

In this view, managers are unable to create any value for shareholders by levering up the firm with debt, because the investors can freely issue bonds to create leverage benefits for themselves, while arbitraging away any artificial overvaluation or undervaluation of shares with the proceeds of the bonds.

Many authors have picked away at the unrealistic assumptions of perfectly-priced financial markets and the unlimited ability of investors to issue risk-free debt for themselves. The value of Modigliani and Miller I for this research is not its theoretical impact (which was considerable), but rather its conceptual and normative impacts on management practice, including today's airlines.

Conceptually, Proposition I introduced the notion of an overall average cost of capital to managers of a firm who were previously focussed on the cost of debt to estimate financial costs of investments. The authors state this cost of capital as:

$$\frac{\overline{X_j}}{(S_j + D_j)} \equiv \frac{\overline{X_j}}{V_j} \equiv \rho_k \quad \text{.......} \quad 2.6$$

This formulation had the (perhaps unintended) effect of putting the question of the "cost" of shares and debt on a similar footing as sources of financing to managers who did not own the company's shares, each having its own cost (albeit identical according to Modigliani and Miller I). In a singular way, the *formulation* of Modigliani and Miller I clarified managers' paradigm of investment costing as much as its *content* created debate among academics and practitioners.

Normatively, the Modigliani and Miller propositions (particularly Proposition I) had a huge impact on business education and corporate finance practice: the implication of Proposition I for managers is that focus should be exclusively on analyzing the overall profitability and returns of investments in real, productive assets, rather than trying to optimize shareholder returns through debt financing vehicles. In the decades following its publication, the practice of investment analysis has focused on the investment side of the equation, and questions of financing have largely been dealt with separately. Modigliani and Miller I "solve" the riddle of optimal capital structure by stating that such an optimum did not exist: the determinant of cost of capital is the company's "risk class," which is determined by its operating characteristics rather than financing.

Proposition II, derived directly from Modigliani and Miller I, states that the cost of equity (or from investors' viewpoint, the expected yield on a share), denoted $i_j$, is a linear function of the capitalization rate of the risk class $\rho_k$, to which is added a financial risk premium calculated as the Debt/Equity ratio times the difference between unlevered yield and cost of debt).

$$i_j = \rho_k + (\rho_k - r) D_j / S_j \qquad 2.7$$

Under this proposition, investors require an increased return on the firm's shares in the form of the risk premium $\rho_k - r$ directly proportional to the Debt/Equity ratio, from the first dollar of debt added to the balance sheet. Due to the arbitrage mechanism at the heart of the Modigliani and Miller proposition, this premium exactly offsets the potential decrease in overall cost of capital from the use of lower-cost debt financing.

The authors pointed out the contrast to what they call the "conventional view", in which share valuations will be minimally affected by "moderate" amounts of debt in the capital structure. Their formulation is clearly in contradiction to Graham and Dodd, who assert that investors will bid up the shares (i.e., require a lower yield for a given earnings stream) in companies who offer leverage benefits within a "reasonable" range of debt.

One specific development of these basic propositions in Modigliani and Miller (1958 and 1963) concern this research. Taking into account the tax-deductibility or interest, Modigliani and Miller postulated an adjusted capitalization factor $\rho_k^\tau$ in the presence of deductible income taxes, and state at the end of the article that "gains can accrue to stockholders from having debt in the capital structure, even when capital markets are perfect." The valuation in the original 1958 article was later corrected by themselves in Modigliani and Miller (1963), stating the value of a Levered firm $V_L$ with a permanent debt (such as a perpetuity or refunded bond) on its balance sheet:

$$V_L = \frac{(1-\tau_c)\overline{X}}{\rho^{\tau}} + \frac{\tau_c R}{r} \qquad 2.8$$

The first term is the valuation of the profits of an unlevered firm as in Modigliani and Miller I (equation 2.5), on an after-tax basis. The second term increases this valuation by the present value of the tax savings (the corporate tax rate $\tau_c$ multiplied by the total interest expense R), capitalized at the borrowing rate *r*.

This extension of the Modigliani and Miller propositions to include income taxes has profound implications for the practice of airline investment management (as it has for any capital-intensive business). At a theoretical level, it leads to the conclusion that companies can in fact maximise shareholder value by borrowing as much as possible, allowing the firm's shareholders to benefit by what is in effect a subsidy on debt, known in the jargon as the "tax shield".

For airlines in particular, a primary requirement to benefit from the tax shield is that the firm be generating sufficient operating profits to be shielded from income tax. As has been demonstrated, sustainable profits over the cycle – and hence the life of an aircraft financing deal - are far from ensured in the low-margin airline sector. In addition, the airline industry is of course global, and the world's airlines are subject to a plethora of tax regimes. To cite two extreme examples, the average Japanese corporate tax rate stood at 39.5% in 2006, while there is no corporate income tax in the United Arab Emirates. These differences have led to the creation of an segment of the financial services industry dedicated to finding profitable companies or individuals having "tax capacity" (profits to shield), which they then "lend" to the acquirers of aircraft in complex loan and leasing arrangements typical of the aircraft market today.

This impact of taxes was further refined by Miller (1977), to include the effect of personal income taxes, stating that in aggregate, higher corporate tax rates will encourage firms to increase indebtedness (as in Modigliani and Miller 1958 and 1963), while higher *personal* income tax rates will do the opposite, as investors look for higher equity returns to compensate. This "migration" between equity and debt financing stops when the two rates of tax are precisely equal. The study of the corporate-individual income tax rate effects on investment is beyond the scope of this research.

The effect of taxes on capital structure and cost of capital leads to the contradictory conclusion that a firm's managers should increase debt as much as possible, while maintaining sufficient pre-tax profits to benefit from the tax shield.

The second extension includes the effect of increasing interest rates as leverage increases. Again in contrast to the "conventional view" c.f. Graham and Dodd, Modigliani and Miller maintain that the expected yield on the shares will increase (and hence their value decrease) as debt is added to the balance sheet - although not at a linear rate as in Proposition II – until such a point where the higher yield on bonds offsets lower expectations for the firm under financial duress, when the expected share yield will begin to fall. This extension of the propositions, we find that because of taxation and the risk of bankruptcy (but NOT because of the so-called leverage effect espoused by value investors), there is a maximum value to the firm achieved by adding debt, as pictured below and taught to thousands of finance students worldwide each year.

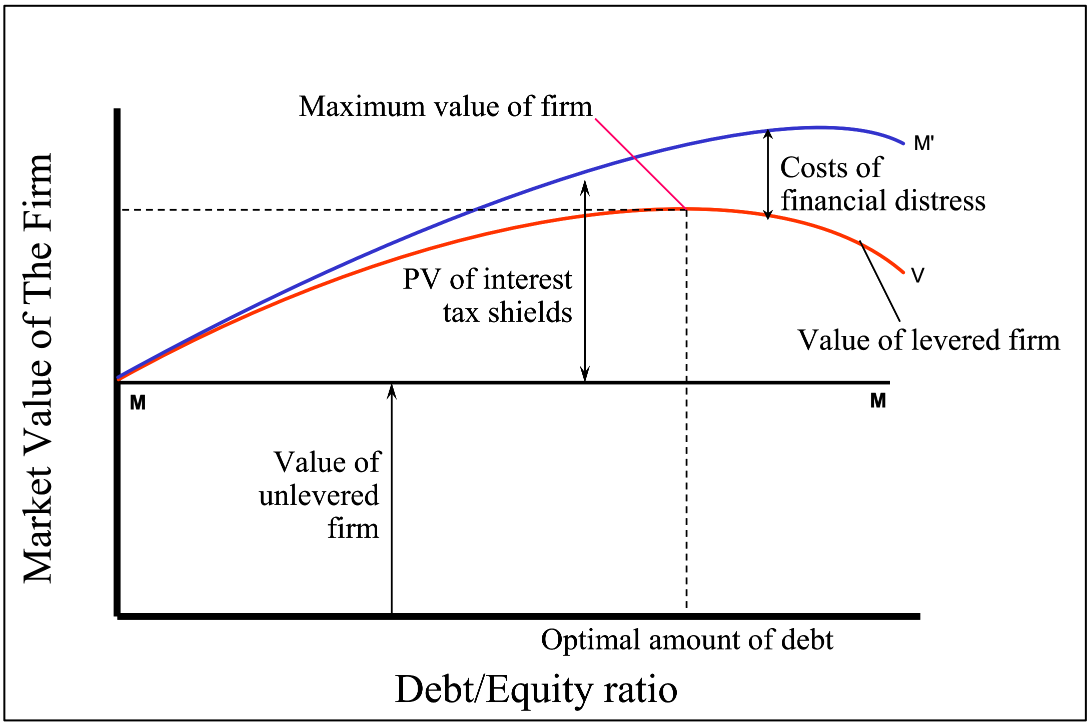



Figure 2.1: Value maximisation through use of debt   Source: Brealey & Myers (2000)

The Modigliani and Miller I constant value of the firm regardless of capital structure (line Modigliani and Miller in figure 2.1, above) gives way to Modigliani and Miller' as tax-deductible debt is added to the capital structure.

Modigliani and Miller's intuition that eventually shareholder expected returns will decline as the firm nears bankruptcy, and that the benefits of debt will disappear as profits approach 0 (line Modigliani and Miller'), has been formalized in subsequent work, most notably in the "trade-off theory" balancing optimal capital cost against "costs of financial distress," a balance which will vary for different industries. These difficult to quantify costs give rise to the generally accepted form of the curve MV in figure 2.1. Through the continuing debate, the existence of a non-quantified "optimal" or "target" capital structure remains the accepted view in practice. This is view comes full circle, harking back to the traditionalist recommendation to add “reasonable” amounts of debt to the capital structure to maximize shareholder returns.

The most normative and least-debated conclusion of Modigliani and Miller's article begins with the statement of Proposition III, that "the cut-off point for investments in the firm will in all cases be $\rho_k$ and will be completely unaffected by the type of security used to finance the investment." This proposition is tested in the case of debt, common stock and earnings and found to hold true under the same market assumptions as Proposition I.

The conclusion of the 1958 article broadened the discussion and opens the financing debate to issues of forecasting heuristics and bias, information asymmetries and agency issues, which have come to the fore in financial economics today. The article is thus very forward-looking and suggestive of current theoretical trends.

A subsequent major body of theory covering the question of capital structure and investment financing choices is "pecking order" theory introduced in Myers (1984) and further discussed in (for example) Berens and Cuny (1995). The relevance of this theory for airline managers is discussed and surveyed in Chapter 7 of this research.

Today, financial economists are increasingly focused on the governance structures, contractual arrangements and management incentives to motivate and ensure behaviour consistent with value maximization. The most comprehensive example of this is Tirole (2006). Governance and incentive structures, and their relevance for airline owners and managers, are discussed through a detailed analysis of global airline ownership structures in Chapter 4.

The Modigliani and Miller articles are full of assumptions (e.g. capital markets with no transaction or bankruptcy costs, uniform risk-free interest rates for corporations and investors) that are clearly not applicable in the real world, and yet the postulates are widely taught and practiced as the "right" way to estimate cost of capital.

Similar to the traditional view, one key issue the Modigliani and Miller articles do not deal with explicitly is a method for estimating the cost of investment capital. Modigliani and Miller simply postulate the irrelevance of the choice between debt and equity financing within the vaguely defined notion of a risk class, with only the most basic discussion of debt or equity capitalization rates themselves.

While debt costs are readily available to practitioners working in the financial markets or in banks, the work of estimating expected equity returns for widely-traded firms was left to portfolio theory, discussed in the next section.

## 2.3. Portfolio theory and the cost of equity capital

### 2.3.1. The foundation: Modigliani and Miller

Modigliani and Miller posited the capitalization factor for a firm's shares (aka, discount rate or cost of equity) as identical for all firms in a given risk class. However, they made no claim as to how to estimate this capitalisation factor. A second and parallel body of theory, consistent with the Modigliani and Miller postulates, completes the picture.

In Modigliani and Miller (1958), the cost of equity $i_j$ is directly proportional to the content of debt in the firm's capital structure and the market risk premium of company returns over the interest cost *r*, as in formula 2.7. Taking corporate income taxes into account, the authors specified a capitalization rate for after-tax returns $\rho_k^\tau$ and restate the cost of equity in much the same terms as before:

$$i_j = \rho_k^\tau + (\rho_k^\tau - r) D_j / S_j \qquad 2.9$$

The existence of an equity capitalization rate specific to after-tax profits means that taxes will "prevent the arbitrage process from making the value of all firms in a given class proportional to the expected returns generated by their physical assets," bringing the distortion of tax-deductible interest to the fore, and not incidentally opening the door to a wide variety of aircraft financing structures aimed at exploiting this distortion.

This formulation was corrected by the authors in Modigliani and Miller (1963) in a non-trivial adjustment taking into account the deductibility of interest charges, an advantage that accrues to the shareholders:

$$i_j = \rho_k^\tau + (1-\tau)\left[\rho_k^\tau - r\right] D_j / S_j \qquad 2.11$$

This correction reduced the risk premium for addition of debt to the capital structure (by a factor of 1-$\tau$, the value of the interest deduction to shareholders), but did not in any way change the principle of such a risk premium, in contrast to the traditional view asserting that "reasonable" amounts of debt do not impact shareholder expected returns.

These formulations still beg the question of concretely estimating the proper capitalization rate to value risky investments in company securities. Indeed, the authors clearly state that the propositions bear no relation to investors' risk preferences.

### 2.3.2. Quantifying the risk-return trade-off: Markowitz

Shareholders' equity (and equity portfolio) valuation theory has been called "a microeconomics of capital markets" by its primary originator, Harry Markowitz (1991). Less monolithic than the Modigliani and Miller's theory of capital structure, the theory of optimal selection of security portfolios can be found in Markowitz (1952). This work was later generalized into the Capital Asset Pricing Model (CAPM) by Treynor (1961, unpublished), Sharpe (1964) and Lintner (1965). Like the Modigliani and Miller propositions and extensions, these theories remain prevalent in practice as a way to estimate shareholder expectations from the company's shares, in wide use by firms that seek to maximise shareholder returns.

This 'microeconomics of capital markets' has its basis in utility theory developed over the 18$^{th}$ and 19$^{th}$ centuries, completed by the development of *expected* utility theory – the theory of rational decision-making under uncertainty – best-known in its formulation by John von Neumann and Oscar Morgenstern (1944 and subsequent editions).

Expected utility is founded on the notions of preference, and subjective probabilities. As codified into von Neumann and Morgenstern's axioms of cardinal utility, preferences must be rigorously consistent in order to be considered rational: all individuals are able to determine and express clear and logically consistent preferences among (potentially) thousands of choices, for example, shares of companies available on the market. In developing portfolio theory a further assumption is added: that individuals will always prefer more wealth to less, that is, wealth is considered as invariably producing utility.

When combined with rationally expressed preferences (and an absolute preference for wealth), subjective probabilities allow us to express the expected utility of wealth, (*E[U(W*)].

$$E\left[U(W)\right] = \sum_i p_i U(W_i) \quad \text{.......} \quad 2.12$$

Rational investors will seek to maximize their expected total wealth by weighing all potential wealth outcomes in the set *i* of opportunities (*$U(W_i)$*) by the a priori probability of each outcome $p_i$, and selecting those which produce the greatest product. Many useful economic theories have questionable simplifying assumptions at their base, and the notion of a priori knowable probabilities is the weakness in expected utility theory. Discussing his theory in 1991, Markowitz said that he was convinced that "a rational agent acting under uncertainty would act according to 'probability beliefs' where no objective probabilities were known."

The theory has the practical advantage that individuals' stated utility functions can readily be identified through an interviewing approach. Interviewers propose a series of gambles and asking the subjects their preferences between a certain sum for sure, versus taking the gamble at a given payoff and probability. A risk-averse investor is one who requires that the actuarial (or expected) payoff of a gamble exceed the certain payoff in order to accept the risk. In all subsequent formulations, investors are assumed to be risk-averse utility maximizers.

To develop this theory and its derivatives, the preferred measure of risk is dispersion around a mean of normally distributed security returns, quantified as the standard deviation of returns, commonly denoted $\sigma$. While theoreticians point out that using $\sigma$ as a measure of risk gives equal weight to both high and low returns as undesirable, and suggest that other measures such as semi-variance are more useful for these investors and for skewed return distributions, the computational convenience of the normal distribution, with all points on the distribution calculable using the mean and standard deviation, pushed strongly in the direction of the normal distribution and $\sigma$ as the appropriate measures of risk and return.

Markowitz' work concerned itself with the choice among combinations of risky assets. His work sought to establish (or confirm) maxims or rules for the rational investor. His seminal 1952 article asserted that such an investor will not simply seek to maximize return (as is implicit in Graham and Dodds' Security Analysis and other authors' work), but will instead seek a balance between risk and return by combining different shares in "efficient portfolios." Markowitz' initial intuition was to apply statistical correlation to measure the distribution of pairs of share returns, which are then double-summed to estimate overall portfolio variance, his preferred measure of risk.

$$Variance = \sum_{i=1}^{N} \sum_{j=1}^{N} X_i X_j \sigma_{i,j} \quad \text{.......... 2.13}$$

The $X$ terms are the relative proportion of the two shares analysed, while $\sigma_{I,j}$ is the covariance, itself the product of each share's standard deviation and the correlation coefficient between the returns of the two shares. As increasing number of shares are added to the portfolio, the correlation terms between the pairs of shares become increasingly important in the calculations. Because most shares are at least modestly positively correlated with others, the risk that can be "diversified away" by adding shares is asymptotic, reaching a minimum value which is the risk of the market itself.

Correspondingly, the indicator of return will be the weighted sum of average expected returns $\mu$:

$$Return = \sum_{j=1}^{N} X_i \mu_i \quad \text{.......... 2.13}$$

Applications of these formulae to share returns lead to a set of possible portfolios depicted in two-dimensional space with variance and expected return as the Y and X axes respectively. Markowitz' second major contribution is defining the "efficient frontier" of portfolios, whose risk-return characteristics are at the "southeast" boundary of these potential return-variance combinations.

Markowitz' work was highly normative, asserting that investors not seeking a balance or trade-off between return and risk are speculators rather than investors. It is also quite practical, adopting both the convenience of the normal distribution, and the pragmatic suggestion that that any calculated returns and covariance among shares should be adjusted "on the basis of factors or nuances not taken into account by the formal computations."

The graphical demonstrations of the concept in the 1952 article are somewhat laborious and abstruse, as are his subsequent calculations of the efficient frontier, which involve parametric quadratic programming, but Markowitz' work set the scene for portfolio valuation in use today. He codified the notion that the "rational" investor is one who seeks to balance risk and reward, which we will refer to as a mean-variance investor in this section.

### 2.3.3. Firm-specific risk and return in a diversified portfolio: CAPM

A decade after the original Markowitz article, Jack Treynor, William Sharpe and John Lintner separately hit on a way to generalize portfolio selection into a general theory of equilibrium for share returns. This theory opened the door to a pragmatic methodology for estimating company cost of equity capital, in wide use today.

Of the three authors, William F. Sharpe provided the clearest exposition and most simply packaged version of what is now know as the Capital Asset Pricing Model (CAPM) in the prestigious Journal of Finance (1964). The theory owes its existence not just to Markowitz but also to James Tobin (1958).

Markowitz' theory concerned itself solely with holdings of one or more risky assets (equity investments), leaving out the alternatives of holding cash and lending risk-free in the form of government securities. Tobin's paper dissected mean-variance investor preference for these two categories of "investment", thus substantially broadening the scope of the discussion. The paper takes as its starting point the Keynesian liquidity preference schedule, which posited an inverse relationship between an investor's willingness to hold (or hoard) cash, and the interest rate he is offered to invest the cash. Tobin questioned the assumptions underlying Keynes' postulate, asking himself why an investor should hold "non-interest-bearing obligations of the government" (cash) instead of its interest-bearing obligations (treasury bills). Clearly, there are "transaction" needs for cash; any other holding of cash must be as a compensation for "expectations or fear of loss in other assets." The paper then analysed investors' potential expectations of risk in both the interest rate and the potential capital gain or loss on the treasury bill held.

Considering interest rates first, the investor may expect an upward move in interest rates, creating an opportunity cost inherent in any investment at the current offered rate. For the capital gain or loss, since the market value of traded debt securities such as treasury bills moves inversely to interest rates, the hypothetical investor would experience a loss in the trading value of his investment if, for example, the market were flooded with such assets, or if interest rates rise according to his expectation, above. The investor will take both risks into account, and will hold cash only if the sum of these expectations is less than 0 (in other words, if the capital loss exceeds the increased revenue from interest).

The rest of Tobin (1958) applies Markowitz' concepts of the efficient diversification and the efficient portfolio to various classes of debt securities. For this research, the key insight of Tobin was to increase the scope of portfolio valuation to include risk-free assets. This set the scene for the dramatic simplification of the CAPM, which is often called the "Revolutionary Idea in Finance" (e.g., French (2008).

Sharpe's 1964 paper formulating CAPM combined Markowitz' and Tobin's concepts, stating that the choice of investments can be seen as combining a risk-free investment in debt securities and a portfolio of equity securities. Following Markowitz (and Treynor (1961)), Sharpe was looking for a means of estimating the "price of risk" for a mean-variance investor. Sharpe's paper attempted to establish a model of equilibrium for the prices of risky assets, consistent with classical economic doctrine of a balance between supply and demand for securities. To do this, he used a single-period investment model with normally-distributed returns, very much along Markowitz lines. Along the way, Sharpe mentioned in a footnote the appropriateness of using semi-variance to capture only the downside of investment variation, but cited the "formidable computational problems" standing in the way of this analysis. From this point on, upside and downside risk has been considered equally desirable in securities and derivatives valuation. Sharpe's article can be seen as a means of simplifying the analysis proposed by Markowitz in 1952. One of the striking features of this article is its agile use of two-dimensional geometry to demonstrate concepts and relationships.

The discussion begins with the Markowitz investment space, where an efficient frontier of portfolios dominates all other potential portfolios for mean-variance investors. He then demonstrates in a simple two-security example the effect covariance has on risk, creating the familiar efficient frontier curve reproduced in Figure 2.2.

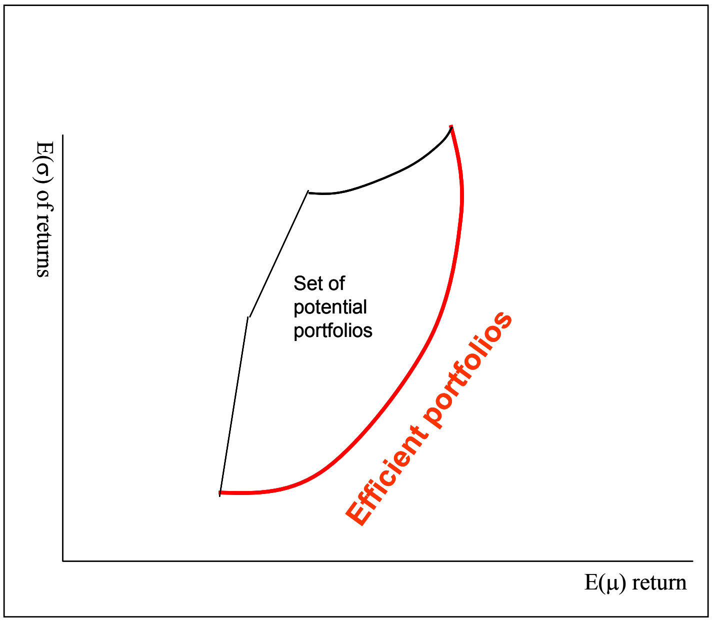


Figure 2.2: the efficient frontier of portfolios, following Markowitz (1952)

Sharpe pointed out that while the efficient portfolio set is simple conceptually, the computation solution which yields the highest potential return per unit of risk is challenging. This difficulty itself facilitated the solution, since this point on the curve must "either linear or increasing at an increasing rate." (that is, the square of the derivative with respect to the square of the expected return must be positive). By combining a combined risk-free asset and risky portfolio investment, and by postulating a general equilibrium of risky asset prices, Sharpe allows practitioners and subsequent theoreticians to adopt the former, linear, approach to solving the problem.

By suggesting (without substantiating) that an investor may hold a combination of fixed interest-bearing and risky assets which have a fixed return, Sharpe noted that using the standard covariance formulation, the y-axis coordinate E(σ) reduces to a linear function of the proportion of investment in the risky portfolio and its standard deviation. Given this convenient fact, the utility of all such portfolios of risk-free and risky assets will be dominated by that described by a line tangent to the efficient frontier, with the risk-free rate as its x co-ordinate, as in figure 2.3.

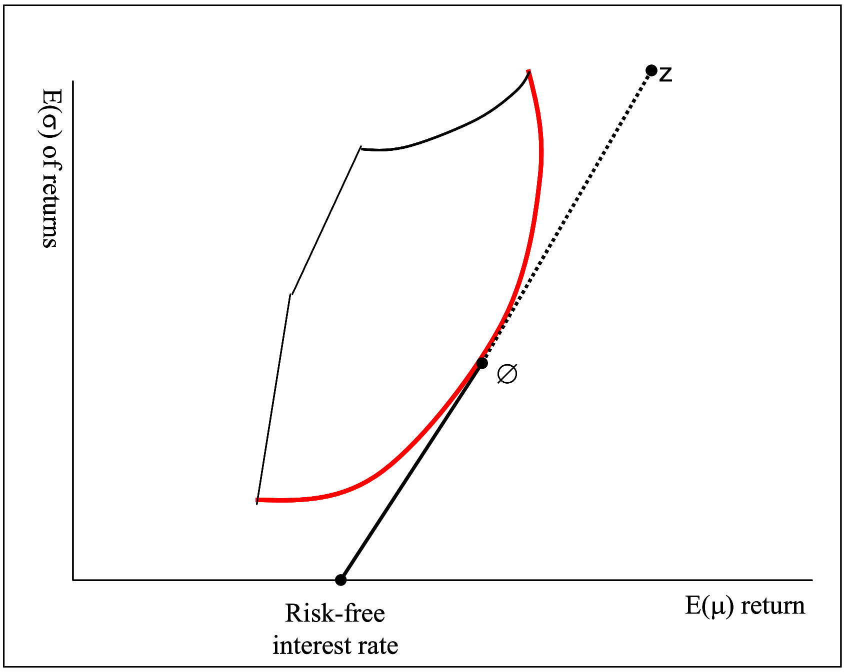



Figure 2.3: The dominant combination of risk-free and risky assets, from Sharpe (1964)

As can readily be observed here, given a partial investment in the risk-free asset, there is no potential combination with the efficient risky portfolio further "southeast" on the efficient frontier than the tangent. Sharpe assumed that investors can freely borrow as well as lend at the risk free rate, which takes the relationship even further: for the portfolios along the solid portion of the line the investor lends at the risk-free rate and invests the remainder in the efficient portfolio found at point ∅, while on the dotted portion from ∅ to *z*, the investor borrowed funds at the same rate to increase her holdings of the same risky portfolio. This ingenious discovery, theoretically valid while highly pragmatic from a computation and validation standpoint, was made and used by all three originators of the CAPM (Sharpe, Treynor and Lintner).

Sharpe alone among the three, however, went on to assert that in equilibrium, *all* investors will seek portfolios along this line from the risk-free rate to z. He achieved this by making the assumption that investors have uniform expectations about the returns and variances of investment opportunities. He defends this highly improbable assumption by stating that "the proper test of a theory is not the realism of its assumptions but the acceptability of its implications." Sharpe's assumption of homogeneous investor expectations will later be relaxed in Lintner (1969).

Under these conditions, investors with portfolios "west" of this line will increase the share of the risky portfolio ∅ until the line is reached. This will cause the price of this portfolio to increase and its yield to decrease, while the opposite will happen to alternative risky portfolios "east" of the line. This classical supply-demand adjustment of prices leads in equilibrium to an efficient frontier that has "flattened" along the line, as in Figure 2.4. Portfolios A, B and C are each composed of different risky portfolios and risk-free investment proportions, but due to the market mechanism, they will all end up priced along a single risk-return line, characterised by the risk-free rate, the proportions invested in the risk-free and risky portfolios, and the risk-return characteristics of each risky portfolio.

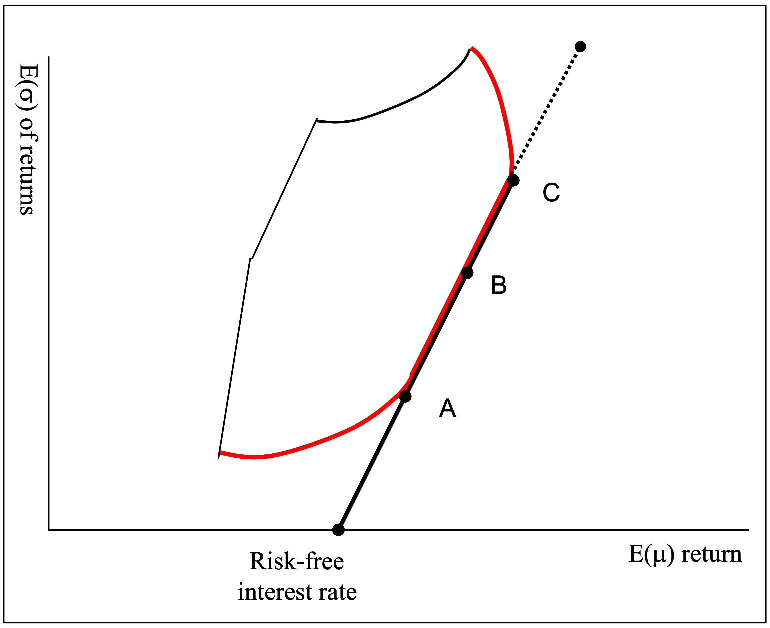


Figure 2.4: Efficient portfolios in equilibrium, from Sharpe (1964)

The existence of such a straight line in equilibrium implies that the returns of these efficient portfolios are perfectly correlated with each other. Turning to the returns of individual securities, Sharpe proved in a half-page footnote that a portfolio containing any individual risky security must be tangent to the efficient market line, implying a relationship between its individual characteristics and the efficient portfolio itself. From this he postulated the notion of systematic risk, which cannot be diversified away. In another elegant explanatory graphic, he demonstrates this relationship in terms of expected returns of the portfolio and the individual security.

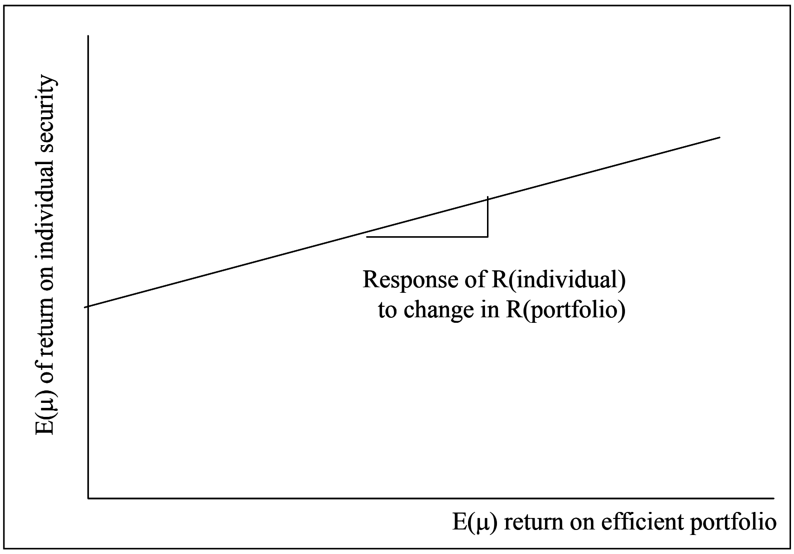



Figure 2.5: Relationship of individual security returns to portfolio return, from Sharpe (1964)

The slope of this line is the systematic element, which cannot be diversified away. The observed returns for the individual security will not lie on this line, with the resulting "error terms" being the result of the risk of the individual security. Sharpe concluded his article by suggesting that this framework has two advantages. In terms of methodology, the theory of systematic risk and the linear relationship in Figure 2.5 can readily be tested through regression analysis, while intuitively and practically, the notion of systematic risk implies that there is a bedrock market risk which no amount of diversification can eliminate. Both conclusions will serve a generation of later theoreticians and practitioners seeking to estimate expected returns on shares of publicly traded companies.

In a follow-up article, Sharpe (1965) provided evidence for a linear relationship between ex post returns of portfolios of shares, while stating that "the implications of the theory cannot be tested practically, since […] clearly, actual results may diverge considerably from the predictions made by investors at the time they purchase assets." Performing regression analysis on a group of 34 open-ended mutual funds over the ten-year period 1954 – 1963, he found a positive correlation, with $R^2$ of +0.836, demonstrating the relationship between return and risk in these funds suggested in Sharpe (1964). He noted that the sample data does show a certain non-linear tendency toward increased risk as higher levels of return are reached. In spite of this, Sharpe asserted that it is "reasonable to assert that for purposes of characterizing the general nature of the capital market the relationship between risk and return can be assumed to be linear." He further tested the linearity of the efficient portfolio line by measuring the correlation of 34 mutual funds with the Dow Jones Industrial average, and finds correlations of 29 of the funds to be between +0.9 and +0.999, "results [which] certainly appear to be in substantial agreement with the theory." This evidence is reminiscent of the sketchy empirical support for their propositions presented in Modigliani and Miller (1958). The CAPM and this article has created what French (2008) called "a cottage industry of attempting to substantiate or refute the validity of CAPM as a positive economic model." The theory underlies options pricing, probably its most significant extension. Options pricing and its application to aircraft investment is discussed later in this research.

More rigorous tests have been made since, looking at the evidence for the empirical form of CAPM. In its theoretical form, the expected return on an individual share $E(Rj)$ is expressed as:

$$E(R_j) = r_f + \beta_j \left[E(r_m) - r_f)\right] \quad \text{2.14}$$

In this formulation, $r_f$ is the risk-free interest rate on government borrowings, $E(r_m)$ is the expected future return on shares in the market (and therefore $E(r_m)$- $r_f$ is a share market risk premium over the risk-free rate), and beta ($\beta$) is the covariance of the firm's shares with the market divided by the variance of market returns.

In order to test the model, CAPM is usually restated in its "empirical form", as an explicitly single-period model, where the portfolio and market returns are expressed as the excess over the risk-free rate:

$$R'_{jt} = \gamma_0 + \gamma_1\beta_j + \varepsilon_{jt} \quad \text{2.15}$$

In this formulation, the $R'$ term is the excess return of the individual share over the risk-free rate, while $\gamma_1$ is the excess return on a broad range of shares. The excess return of a share should be entirely explained by the $\beta$ term and random error (the $\varepsilon$ term).

In order to get round the expectations vs. observed value conundrum, the notion of a "fair game" is invoked: in such a game, the observed return over time is equal to the expected return. A coin toss is an example: most people expect that over time, there will be an equal number of heads as tails, and hence, their expectation is consistent with the long-term average outcome. As one might expect, there is an extensive literature regarding CAPM, efficient markets and fair games.

If CAPM is valid, the $\gamma_0$ term should be equal to 0, the resulting equation should be linear in $\beta$, and $\gamma_1$ should equal the difference between the market portfolio return over the risk-free rate.

The earliest and still definitive tests of the CAPM were performed in the 1970s, at the same time as the development of options pricing model derived from it. These tests are found in Blume and Friend (1970, 1973), Black, Jensen and Scholes (1972), Miller and Scholes (1972), Blume and Husick (1973), Fama and Macbeth (1973), Basu (1977), Reinganum (1981a), Litzenberger and Ramaswamy (1979) and Banz (1981).

The results of these 10 studies are summarized in Copeland and Weston (1983 and subsequent editions), as stated below:

- The $\gamma_0$ and $\gamma_1$ terms are *significantly different* from those predicted, suggesting that low-beta shares earn more than CAPM predicts, and high-beta shares earn less.
- The relationship is found to be *significantly linear in $\beta$:* the best fit is found using $\beta$ as the primary measure of risk.
- Other factors can be found that explain the residual risk (i.e., *the error term $\varepsilon$ is not random*).

This last finding gave rise to a more general Arbitrage Pricing Theory (APT) developed in Ross (1976), which postulates a curvilinear model with various factors explaining risk. APT is more open and flexible than the single-factor CAPM, and it in turn can and has been tested, using multiple regression, over the years.

In contrast to Sharpe's very careful and explanatory articles, Jack Treynor, primarily a practitioner never bothered to publish his 1961 article, which remains in draft form. Treynor found before Sharpe the key link from Markowitz to Tobin (1958), and formulated the CAPM three years before. In addition to deriving the capital market line described entirely by the risk-free rate and the covariance of a security with a well-diversified "market portfolio." He also provided a proof that this model is consistent with Modigliani and Miller I, bringing the analysis full circle.

Like many financial theories, CAPM has been found to be quite imperfect in the predicting market performance, and yet, it remains fundamental to the practice of investment analysis, with profound applications for practitioners of capital budgeting within and without the airline industry. Many extensions have enhanced the descriptive power, realism and (especially) the mathematical sophistication of the model. And yet, to quote French (2008): "the single-period, discrete-time CAPM has become popular and endured, as all great models do, precisely *because* it is simple and unrealistic. It is realistic enough, apparently, to be coincident with the utility functions of a great many agents."

## 2.4. Capital structure and Weighted Average Cost of Capital

The seminal Modigliani and Miller & CAPM theories are both consistent with one another and complementary. CAPM says little about capital structure, while the Modigliani and Miller propositions do not claim to estimate cost of shareholders' equity to managers of a firm. The two fit together as two pieces of a complex puzzle.

The final Modigliani and Miller formulation of what is now known as the weighted average cost of capital (WACC) from their 1963 "correction" of the after-tax Proposition II is:

$$WACC = r_e \frac{E}{V} + r_d(1 - T_c)\frac{D}{V} \qquad 2.16$$

where $r_e$ is the shareholders' expected annual return, $r_d$ is the annual interest rate on borrowing, $E$ is the market value of the firm's shares, D is the market value of the firm's debt, and $V$ is the total market value of debt and equity. That is, the expected returns on equity and the after-tax cost of debt are weighted by the market values of equity, and debt in the company's long-range target capital structure. Since any new investment will potentially cause the firm to change its capital structure, Modigliani and Miller hold that the proper mix of debt and equity to use in the capital structure to be used is this target capital structure.

As French said of CAPM, the Modigliani and Miller WACC construct has been and remains useful *because* it is simple. In many ways less rigorous than CAPM, it has a certain intuitive logic: investors can duplicate any financing arrangements for themselves, and will bid up the expected share returns in the presence of corporate debt, removing the advantage of specific capital structures set up by corporate managers. This normative theory provides a rule for managers to separate the investment and financing questions in capital budgeting... except for the key role of taxation, which remains central to aircraft financing. This research will explore the extent to which investment and financing decisions are intermingled in the airline industry.

The Modigliani and Miller WACC construct and CAPM can be demonstrated to be mathematically consistent, as in Copeland & Weston (1982), *under the idealised assumption* that there is only one interest rate, the risk-free rate, at which investors and corporations can borrow (and investors can lend). This consistency is important because Modigliani and Miller make no claim to identify corporate "risk classes" in their paper: estimating shareholder systematic risk for individual shares is performed by the covariance (β) term.

The result is a highly cohesive set of tools and maxims which guide investment valuation for many firms having shares listed on public exchanges. For example, this β term from CAPM can be adjusted to estimate the additional risk from adding debt, using the Modigliani and Miller methodology:

$$\beta_L = \beta_u \left[1 + (1 - T_c) D / S\right] \quad \text{2.17}$$

This simple formulation is used to adjust historic betas in the prospect of adding debt to the capital structure. As it is a prospective adjustment occurring over period of time where many other firm-specific risk variables may change as well, empirical tests have been relatively rare in the literature. As with CAPM and WACC, it is used because it is practical and simple to explain, notwithstanding a lack of firm scientific validation.

## 2.5. Conclusions

The various research threads discussed in this chapter result in a theoretically justified – if not fully empirically validated - and above all practical methodology for firms to estimate the cost of investments in financial assets, which is extended to investments in real assets such as aircraft in the next chapter.

The work of Graham and Dodd, Modigliani and Miller, and Markowitz, Sharpe et al. is essentially normative rather than positive economics. Graham and Dodd is not economics at all, being rather a practitioner’s manual, very much in current use and cited by successful investors as the basis for their investment practice. The other building blocks are more theoretical in nature, but are based on sound precepts of rational behaviour on the part of investors in financial assets.

The traditional and classical emphases and views are summarized in Table 2.2.

| Aspect of the theory | Traditional view | Classical view |
|---|---|---|
| Primary intended user | Outside investors | Company managers |
| Primary objective | Calculate investor returns for security selection | Calculate company cost of capital for investment |

| | | |
|---|---|---|
| | | valuation |
| Source of data for analysis | Profits and dividends | Share price and dividends |
| Source of estimates and expectations about the future | Expectations based on current profit performance and growth prospects, macroeconomic and industry analysis | Expectations based on a priori probability estimates, usually estimated using historical data |
| Impact of leverage | Increases return on equity | Increases firm value through tax savings |
| View of capital structure | Reasonable amount of debt does not impact share price negatively | Optimal capital structure balances tax benefits against risk of default |
| Treatment of uncertainty | Uncertainty not quantified, “margin of safety” sought | Uncertainty central, normal distribution used to quantify |
| Valuation frequency and adjustment cycle | Static, bound to firms’ financial statement cycles | Dynamic, statistical adjustments made based on market movements |
| View of market behaviour | Inefficient: substantial under/overvaluations can persist over time | Efficient: investors optimize risk-reward through diversification |

Table 2.2: comparison of traditional and classical valuation approaches

The classical approach can be viewed as an alternative to the traditional earnings-based valuation but also as an extension of it. The classical view is more statistical, but not more quantitative (financial statements can be quite complex in themselves). This research argues that while the underlying maths of the classical view are more sophisticated and the theoretical reach greater, company managers have adopted classical valuation methods for investment largely because it is intended for their use, because it is prospective rather than retrospective in nature, and because it has been simplified sufficiently, making “heroic assumptions” along the way, to make it both theoretically defensible and usable by practitioners with a modicum of statistical skills.

The most fundamental problems in application arise for firms trading in markets with smaller or less-liquid capital markets, certainly the case in many of the world’s airline regions. A second concern with classical theory concerns the application of classical valuation to the investment-financing interactions clearly present in aircraft markets. The implications of broad diversity in the world’s capital markets and airline equity ownership patterns, and the consequent implications for airline investment planners in both developed and emerging markets, are central to this research.

# 3. Classical theory and aircraft investment analysis

This chapter establishes the link between purely financial theory – whether traditional or classical – and the practice of establishing and approving investments for assets such as aircraft in today's airlines. The link between the CAPM theory of financial asset prices and real asset valuation is first established. Second, a survey of practices in the general business community from the 1960s to the present day is provided, to establish whether the classical approach of Modigliani and Miller/WACC (late 1950s) and CAPM (early 1960s) have been adopted. The final step is to compare the most current practices in the general business community with those practiced by financial managers in the airline business.

This chapter, then, sets a baseline of practice, used in later chapters to shed light on the applicability of more recent theoretical advances. From this point on in the research, the term "traditional" will refer to the earnings/PER approach of Graham and Dodd, while "classical" will refer to the Modigliani and Miller/CAPM approach, with its emphasis on cash returns to creditors and investors and statistical risk pricing.

## 3.1. From portfolio theory to corporate capital budgeting

Of the three seminal articles postulating the CAPM method for estimating the cost of investment capital, Lintner (1965) went furthest toward extending the model's principles to the practice of corporate capital budgeting, with a set of normative rules for managers. Published in the Review of Economics and Statistics, Lintner's article gave the most elaborately quantitative of the three definitions of CAPM; it also most clearly described the assumptions and conditions under which the CAPM holds, and extended Sharpe's original formulation to include short selling of shares. The article suggested that "the identity of probability distributions over outcomes [which underlie portfolio theory and CAPM] covers corporate management as well as investors, and *includes potential corporate investments in the capital budget* as well as assets currently held by the company." With this statement, Lintner recommended that managers directly apply the notions of CAPM to real asset investment decisions.

To make the transition to capital budgeting, Lintner suggested that the corporations can borrow or lend at the same risk-free rate as investors, using the problematic assumption that "corporate management, ex ante, assigns probability zero to default on its corporate debt, and *investors also treat corporate debt as a riskless asset*." This assumption allowed Lintner to both confirm the Modigliani and Miller proposition that investors are indifferent to company financing decisions and to directly apply CAPM to company investment analysis. If company managers can borrow and lend risk-free as investors are held to do under CAPM, their risky investments in real assets can be made strictly on the basis of covariance with the market portfolio, as is the case with portfolio investments in financial assets.

Lintner's definition of CAPM postulated that managers can increase the value of the company's equity by investing in projects that increase expected company cash returns over and above the market price of the risk of these investments. This extension of Sharpe and Treynor's definition has become canon in capital budgeting textbooks and practice such as “value based management” (VBM). He demonstrated this by expressing returns and variances as changes from the firm's existing returns, and showing that one can multiply the estimated variances in cash flow of a project times the slope of the security market line (Sharpe's $\beta$, or $\gamma$ in Lintner's formulation) to establish the cash price of the additional risk incurred. The value of a firm will be increased if the incremental cash return $H_i$ is greater than the price-of-risk coefficient times the variance of those incremental returns $H_{ii}$ , i.e., if the following inequality is met.

$$\Delta H_i > \gamma \Delta H_{ii} \qquad 3.1$$

This postulate is a straightforward extension of the CAPM variance/covariance concept to cash returns on projects. A simple numerical example reveals both the simplicity and usefulness of this normative rule, and its fundamental weakness. Say a firm invests in an aircraft expected to increase its cash flow by a \$100m on average. The firm's shares have an estimated $\beta$ (or $\gamma$) of 1.25, while the statistical variance of these incremental cash flows is estimated at ±\$50m. The price of the risk is the product 1.25x50 or \$62.5m, so the project’s expected return more than justifies the risk and it should be accepted. The weakness is that the price-of-risk coefficient must include the riskiness of the project at hand (or the riskiness of the project must be identical to the overall firm's risk), and is therefore very difficult to estimate in practice: this estimation difficulty has dogged practitioners ever since. Still, the implications of this extension are many. It added a project-portfolio dimension to the implementation of CAPM absent in earlier publications, leading to four normative conclusions for managers.

First, managers seeking to increase shareholder's wealth should actively seek real asset investment projects that improve the company's risk-return profile from its current situation, by finding lower-risk and/or or higher-return projects compared with those currently present in the company's business.

Second, Lintner carried the project-portfolio logic to its extreme mathematical conclusion, stating that projects should be analysed not only in terms of their returns, but also in terms of their correlation with existing business, going as far as to suggest that in extreme cases, even negative-return projects should be accepted if the they reduce the variance of the firm's returns as a whole through negative correlations. This "business portfolio" reasoning became very popular in the 1950s and 1960s, as many firms (the most famous example being ITT) sought to diversify business risk by investing in new business unrelated to its core activity (telecommunications in the case of ITT. Though success stories tend to be rare, the logic remains popular today. In the aviation business, the best example is General Electric, which prior to the financial crisis of 2008 was owner of a television network, medical instruments and plastics fabrication divisions, a finance and insurance arm, as well as its "core" power generation businesses including jet engines. This particular implication of Lintner’s version of CAPM is not further addressed in this research, but one can note the strong influence of financial theory on business practice in these examples.

Third and most significant for this research, Lintner pointed out that the risk-return framework of investors require that managers must introduce "appropriate risk variables explicitly into the analytical framework used in the analysis, and that these risk variables will be an essential component of any optimal decision rules developed." The framework developed by Lintner specifies statistical analysis of cash flows to estimate, and price, variances which may impact the project. For Lintner, this requirement is inherent in the use of CAPM by company managers. This research will show that in practice, risk estimation and valuation are more subjective than mathematically rigorous.

The fourth implication of Lintner's framework is that the *company* cost of capital "is not the appropriate discount rate to use in accept-reject decisions on individual projects for capital budgeting." This follows both naturally and mathematically from the search for projects with different risk-return characteristics than the firm's existing business. On the other hand, it poses clearly the discount-rate estimation problem, which must be dealt with by practitioners without a well-defined framework. As we discovered in the field research, this tends to lead in practice to the use of vaguely-defined heuristic rules and subjective adjustments to cost of capital with little empirical grounding.

Lintner was also the most frank of the CAPM authors, as toward the end of the article he points up the "rather heroic set of simplifying assumptions which were made" to establish these rules, admitting freely that "too many factors that matter very significantly have been left out (or assumed away)." However he then concluded the article somewhat ambiguously, first suggesting that "the above conclusions will still hold under more realistic (complex) conditions," and then asserting that the simplifying assumptions concerning lending and borrowing rates, taxation, and investors' common probability assessments of future returns play havoc with the postulates and calculations of CAPM. Even further, Lintner goes on to state that the existence of limited liability corporations and "market risk" in debt markets "are sufficient to make the optimal project mix in the capital budget conditional on the finance mix," in direct contradiction to the Modigliani and Miller propositions.

This was a provocative conclusion to an article which labours mightily over 25 formula-strewn pages to confirm the coherence of these same theories. Thus the precepts of returns independent of capital structure and the linear relationship between individual share returns and overall market returns are held to be useful and necessary normative rules in spite of "heroic assumptions" and serious methodological gaps between theory and practice. One finds this sort of ambiguous conclusion in many authors on the subject through the present day, which leads to an interesting chicken-and-egg question in financial economics: is financial theory used because it has been proved correct in empirical testing, or do its postulates tend toward verifiable results because of consistent application in the field?

The remainder of this chapter covers field research in the general business community and our field research in the aviation business, to determine the state of practice regarding investment analysis and capital budget approval criteria. The goal is test the degree and nature of application of the financial theories discussed, in order to establish the consistency of financial theory with today’s practice.

## 3.2. Practices identified in the literature

The academic literature survey focuses on articles which attempt to establish the trends in capital budgeting and investment valuation practices over the last thirty years, in the context of the broad and deep body of theoretical recommendations for managers discussed above. The literature reveals a sharp distinction in the field between accounting-based measures inspired by the traditional view, and the statistically-oriented and classical, which focus on cash investment returns rather than financial statement data. Most of these surveys were performed in the United States, which presents a very large sample size, without barriers of language to confuse surveying efforts.

### 3.2.1. Investment valuation techniques used in the business community

The first major field research into the topic was published in the Journal of Finance by James C.T. Mao (1970). Mao found “wide disparities between the theory and practice of capital budgeting.” The article tests hypotheses regarding the objectives of investment and the treatment of uncertainty, by means of executive interviews. Following both Modigliani and Miller and Lintner’s postulate that the managers should apply investment criteria that maximise the market value of the firm’s common shares, Mao postulated that the price of a share is a function of expected future earnings (profits), and a cost of capital including the “pure rate of interest,” and the "price of risk". The hypothetical investment criteria are those which maximise the firm’s accounting profits per share, which should cause investors to bid up the share price through the Price-Earning Ratio (PER) mechanism. Mao's formulation of the capital budgeting decision was thus an amalgamation of the traditional approach with its emphasis on reported earnings, and the classical approach with the focus on a price of investment capital and associated risk, expressed as an annual percentage rate.

In his interviews with eight companies in electronics, aerospace, petroleum, household equipment, and office equipment, Mao found that the share price maximisation objective is “translated into the operating targets of growth and stability in the earnings stream,” consistent with the view that earnings per share (EPS) is an appropriate measure of investment performance. EPS is not a cash-flow based measure, since earnings are adjusted for depreciation of assets. For companies such as airlines that make enormous up-front investments that produce results over time, the differences between cash-flow and profit performance are enormous. The “pure” EPS approach identified in Mao (1970) lacks a specific focus on valuing investments over time.

The second study identifying investment analysis practice is Schall et al. (1978), also published in the Journal of Finance. The research method was statistical analysis of surveys, as opposed to Mao’s interview-based approach. A sample of 424 U.S. firms was selected, and 189 firms (46.4%) responded. Responding firms tended to be larger companies with more stable shareholder rates of return than non-respondents. A primary objective of the study was to identify the use of Accounting Rate of Return (ARR), Payback period (PBK), Internal Rate of Return (IRR) and Net Present Value (NPV) by U.S. companies. Definitions and a brief discussion of each method follow.

ARR reflects the traditional view, based as it is on accounting rules and financial statements. It is calculated by dividing the average accounting profits over the investment horizon, by the average investment in fixed assets over the same horizon. ARR is very similar to the well-known Return on Investment (ROI) measure of corporate profitability. Clearly not a cash-based measure, ARR results are conditioned by accounting policies, and specifically, depreciation method and period. Depreciation methods vary widely in the global airline industry, as they are determined by government policies and regulation, tax codes, and national or international accounting standards. ARR can produce results distorted by accounting standards and company policies, but go beyond the pure earnings approach identified by Mao, in that they explicitly measure profits in relation to the investment in fixed assets such as aircraft.

NPV reflects the classical view of valuation. It is a cash-based measure that reflects the classical approach to investment valuation's emphasis on cash and risk pricing.

The formula for NPV is:

$$\sum_{t=1}^{T}\frac{CF_t}{(1+r)^t} - \textit{Initial investment} \quad \text{.......... 3.2}$$

where T is the investment horizon, CF are the expected cash flows in period t, and r is the cost of capital. IRR is a complementary measure, being the discount rate which produces a breakeven NPV of 0. Many practitioners hold that IRR is easier to grasp than NPV, because it is directly comparable to an interest rate return. NPV on the other hand requires a separate assessment of the project's cost of capital, which as we have seen, is not fully elucidated in the theoretical literature. NPV and IRR are clearly not distorted by depreciation policies, and are therefore viewed by financial economists as more adequate measures of investment value.

PBK is certainly the oldest and most intuitive of all measures, being the number of periods (months or years) required to recover the initial investment. For example, an investment of $20m that produces cash returns of $1.5m per period would have a payback of 13.33 years. Usually given short shrift in academic articles and textbooks, PBK is cash-based measure, but ignores the time value of money that is captured in the discount rate in NPV/IRR. This research shows a strong renewal of interest in this measure, both as a measure of risk and, potentially, an approximation of more sophisticated valuation techniques.

Schall et al. discover in their survey that the overwhelming majority of companies use a *combination* of these measures, a recurring theme in this research. For example, PBK was used by the greatest number of respondents (74%), but that only 2% use *only* this technique to evaluate investments. This pattern is confirmed in Table 3.1.

| Methods used | Percent using | Percent using ONLY |
|---|---|---|
| PBK | 74% | 2% |
| IRR | 65% | 6% |
| ARR | 58% | 4% |
| NPV | 56% | 2% |

Table 3.1: Methods used by US companies in 1978 survey (Schall et al.)

Cross-tabulating the survey responses, the authors found that over 86% of companies were found to use one cash-based method or another while on the other hand, only 16% use either IRR or NPV without recourse to ARR or PBK, reflecting a mix of traditional and classical measures. Clearly, the responding financial managers preferred to take a balanced view of the profitability of investments, and well over half consider that reported profits (as measured by ARR) should be taken into account. The survey thus implies a higher level of adoption of cash-based measures compared to Mao's interview-based findings, while retaining the notion that projected earnings are significant criteria for investments in real assets.

The authors also established that 41% of firms used these techniques to evaluate all investments, while the remaining 59% use them to evaluate "certain types of investment." Finally, this early survey identified the indirect method of calculating cash flow as the preference for 62% of the 135 firms responding to the question. In this method, the firm first estimates the profits from the project, then adjust this for non-cash items such as depreciation. Only 18% reported calculating cash-flow directly (that is, excluding depreciation from the calculation, while only 7% reported using net income, and 13% used 'various different methods.' While not hugely significant, it does tend to suggest that managers at this time were reasoning *from* profits as a starting point before moving to cash flow, rather than estimating cash flow directly.

A third major survey was published in 1980 by Oblak and Helm, who found in a survey of 226 of the Fortune 500 largest US firms that fully 90% of projects were evaluated using the investment analysis techniques outlined above. Interestingly, they also found that 85% of companies that formally evaluated projects reported an acceptance rate for the projects of 75% or more. Such a high rate of successful projects suggests that formal evaluation techniques are used in an iterative budgeting process which tends to raise projects to acceptable levels of profitability, as opposed being subjected to a one-time "go/no-go evaluation process.

Table 3.2 summarizes the primary and ancillary methods used to evaluate investments.

| Methods used | Primary use of the method | Ancillary use of the method |
|---|---|---|
| IRR | 60% | 21% |
| ARR | 14% | 33% |
| NPV/Profitability Index | 14%/2% | 36/12% |
| PBK | 12% | 74% |

Table 3.2: Methods used by US companies in 1980 survey (Oblak and Helm)

Oblak and Helm distinguished between "primary" and "ancillary" use of the techniques, and found that cash-based measures are prevalent, with IRR being the preferred primary method. ARR, NPV and particularly PBK are less commonly used as primary methods, but have significant perceived value as complementary (or ancillary) measures.

The most widely used ancillary method was NPV, which is used nearly half the time, either by itself (36%) or in combination with the Profitability Index, the ratio of NPV to initial investment (12%). The Profitability Index is a common capital rationing technique, which shows the amount of value creation per dollar of invested capital.

The Oblak and Helm study confirmed earlier research suggesting that a variety of different measures are used to test the viability of investment projects, while showing a distinct trend away from traditional and toward classical valuation methods by 1980.

Trahan and Gitman (1995) was written as an attempt to identify gaps between theory and practice in corporate finance, in response to "recent indictments of business education" identified by the American Assembly of Collegiate Schools of Business (AACSB) in 1991, confirmed by the Financial Management Association in their 1992 annual meeting. For this research, the article offered an interesting perspective as well as an update from the earlier studies showing a trend toward classical– that is, cash and time-based - valuation methods. The authors cite Ramirez, Waldman and Lasser (1991) who found that financial research was out of touch with practice in fields such as regulation, corporate ownership (today the widely discussed field of corporate governance), as well as both short-term and long-term financing. Trahan and Gitman's article went into far more detail with a survey of 700 financial managers, or which 84 (12%) were returned from, 58 from members of the Fortune 500 largest firms, and 26 from (generally smaller) Forbes 200 firms.

The questions covered five specific areas:

1. the usefulness of academic research
2. capital budgeting and risk methods
3. impact of financial decisions on stock price
4. international financial management
5. areas where managers would like further information

In each area managers were asked whether they *understood* the methods, whether they *used* them, and whether they would like *more information* about them.

Capital budgeting methods used were broadly consistent with earlier surveys, with some differences found between the larger Fortune 500 and smaller Forbes 200 firms responding. This research focuses on the overall result of all respondents.

| | Understand method | Use method | Need more information |
|---|---|---|---|
| PBK | 86.9% | 66.7% | 1.2% |
| ARR | 84.5% | 59.5% | 6.0% |
| NPV | 94.1% | 81.0% | 7.1% |
| IRR | 91.7% | 79.8% | 8.3% |

Table 3.3: Methods used by Fortune 500 and Forbes 200 companies in Trahan and Gitman (1995)

The results confirmed the “market penetration” of the classical valuation techniques in the mid-nineties, these being both substantially better understood and more frequently used than the traditional methods. NPV is clearly ascendant compared to Oblak and Helm (1980), with the highest "score" of all, over 4/5ths of managers using the technique.

The primary differences found between larger and smaller firms are two: more large-company managers cite all the methods more frequently, and they also have a slightly higher use of IRR over NPV, contrary to the smaller firms' quite significant preference for NPV. An echo of this distinction was found in the airline survey discussed in section 3.3.

Two categories of more advanced techniques were advanced by the authors. The first is MIRR, a more prudent form of IRR where intermediate positive cash flows are formulaically "reinvested" at a lower rate than the company cost of capital. The intuition is that the company is not necessarily able to achieve the cost-of-capital rates of return on any positive intermediate cash flows. Commonly stated in terms of NPV, the formula is:

$$\left(\frac{-NPV(reinvestmentrate, positivecashflows)*(1+reinvestmentrate)^n}{NPV(\cos tofcapital, negativecashflows)*(1+\cos tofcapital)}\right)^{\frac{1}{n-1}} - 1 \quad ......... 3.3$$

The survey respondents showed indifference to this method, with only 15.5% saying that they used the method, even if 39.3% claimed to understand it. The authors also inquired about the profitability index method as did Oblak and Help, and obtained very similar responses to that for MIRR. Over 20% of managers did cite the need for further information on these more advanced techniques, but in terms of common practice, the very "pure" forms of classical theory dominated U.S. capital budget valuation by the mid 1990s[7].

### 3.2.2. Cost of capital estimation – evolution of practice

Most of the traditional and classical capital budgeting techniques in use today require an estimate of the *required* return on investment, calculated as a percentage, to which the investment return of the project is compared in the investment appraisal process. In the case of ARR, the percentage is calculated as profits over average investment, while NPV calculates the cash value created over the project, using an explicitly calculated cost of capital to deduct the required rate of return in each period. The output of IRR is a rate of return, which can be compared to a required rate (often referred to in practice as the 'hurdle rate') for investment returns.

The other two techniques discussed in this chapter, PER and PBK, do not require this type of estimate. PER focuses on accounting profits (specifically EPS) and growth projections as a driver of share price, reflecting the traditional approach to investment analysis. PBK measures the time required to recover the invested capital, an extraordinarily simple and intuitive metric which does not, however, estimate the size of the returns or profits garnered by the project.

The classical method for estimation of cost of capital is derived directly from Modigliani and Miller's propositions and portfolio theory. The method is intuitively logical and seems as if it should be easy to apply. This section of the research explores on the one hand the evolving state of practice, and on

[7] The author's field experience in the airline industry has revealed that Lufthansa has fully adopted Qualified Internal Rate of Return (QIRR), identical to MIRR, as an investment decision criterion

the other the difficulties practitioners face in using theoretically validated methods to estimate the cost of investing in real assets.

Not all companies find the need to explicitly estimate a cost of capital or hurdle rate. Mao (1970) discovered that the managers interviewed implicitly use a PER valuation approach, by selecting projects that meet operational targets of growth and stability in profits. Under this valuation method, growth will incite investors to bid up the share price by increasing the PER they are willing to pay, while stability shows the effectiveness of risk management. Graham and Harvey (2001) found that the growth-oriented PER method was still quite commonly cited (nearly 39% of managers use it), with a significant preference for the method in firms where the CEO was older than 59 years.

Schall et al. (1978) discovered that PBK was the most commonly-cited measure of investment performance (74% of 189 respondents). The use of PBK remained high in the other surveys performed, either as a primary or ancillary technique. Graham and Harvey found that over 86% of executives cited basic or discounted PBK in current use, implying that the more ‘modern’ techniques of NPV/IRR are still complemented by this old favourite. The literature increasingly identifies PBK as a risk measurement and management tool, as discussed in the Chapters 6 and 8.

The first of the field surveys to specifically discuss the methods used to estimate cost of capital was Schall et al. (1978). The most common method cited (46%) to calculate the cost of capital or discount rate was the weighted-average cost of capital (WACC), as formulated by Modigliani and Miller in equation 2.16.

The pure cost of debt was the second most popular discount rate used, by 17% of firms, while the cost of equity capital was used in fewer than 10% of the responding firms. This figure rises to 17% if one adds the "risk-free return plus a premium" method which is essentially a CAPM approach to estimating the cost of share capital.

| Cost of capital estimates | Percent using the method |
|---|---|
| Cost of debt | 17% |
| Cost of equity | 9% |
| **WACC** | **46%** |
| Risk-free return plus a premium associated with the risk class of the investment | 8% |
| **Subjective estimates** | |
| Measure based on past experience | 20% |
| Expectations with respect to growth & dividends | 17% |

Table 3.4: Cost of capital estimation methods in Schall et al. (1978)

Schall et al. also found significant use of subjective measures of the cost of capital, finding that executives often prefer to use a combination of objective and subjective methods to estimate cost of capital. The wide use of subjective methods is somewhat surprising given the breadth and depth of capital markets in the U.S. Firms in this market have access to plentiful and statistically reliable data on historically observed (objective) returns, which are readily used as a basis for estimating expected returns in the future (with the usual caveats about forecasting using the past as a guideline for the future). The implications of such subjective estimates are discussed in Chapter 6 of this research.

Regarding the treatment of corporate income tax, Schall et al. discovered that the overwhelming majority (88%) of firms cited using after-tax discount rate applied to after-tax cash flows.

The discount rates cited by the 69 respondents that use an after-tax discount rate showed the following pattern.

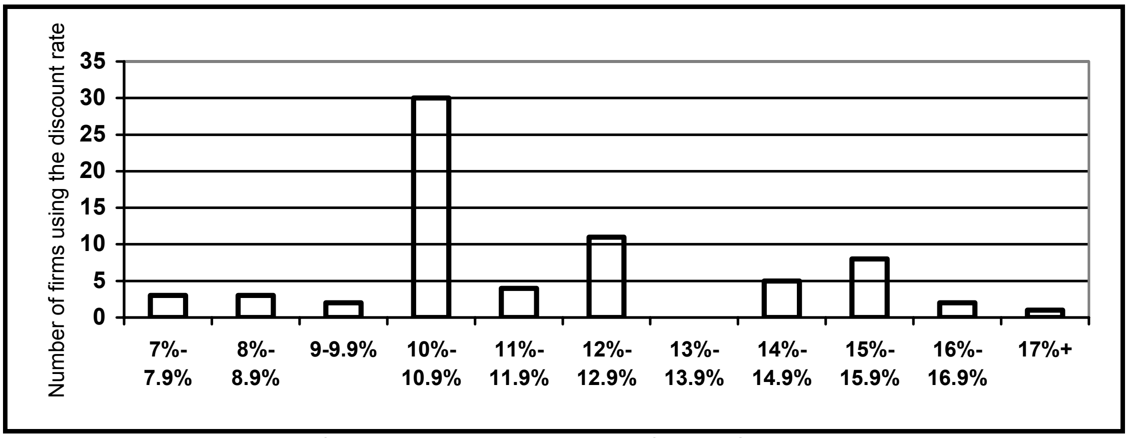



Figure 3.1: After-tax discount rates used by firms in Schall et al. (1978)

This pattern shows clear central tendency at 10%, with smaller peaks at 12% and 15%, yielding a distribution skewed toward the higher side of the mode.

Oblak and Helm (1980) reported practices broadly similar to the findings of Schall et. al, with 54% of respondents using WACC, while 22% use either cost of debt or cost of equity alone. The major difference from Schall et al. is that Oblak and Help report that only 21% of firms use subjective measures, compared to 37% reported in the earlier survey. The findings of the two articles were quite consistent with one another, and revealed substantial consensus around the use of classical analytical techniques and cost of capital estimation methods.

Bruner et al. (1998) went a step further than earlier research: it was at once an update on the state of practice and a close examination of the ambiguities and pitfalls of the WACC method of estimating cost of capital. The authors found that fully 85% of the 27 firms interviewed by telephone (and identified by name in the survey) use a "combination of capital cost to determine a WACC." The authors chose a small sample of firms selected by their peers for their excellent financial management in an earlier 1992 study. In this way they identified practice in a rather selective and normative way, identifying practices of the "best" financial managers. Going further, the authors interviewed 10 investment advisors, and consulted seven books (four finance textbooks and three trade books), to round out the survey. This pedagogical approach is quite typical of the Financial Practice and Education (now Journal of Applied Financial Management, published by the Financial Management Association) where the article was published.

This research will concern itself with the responses from the corporate financial managers. Consistent with the authors goal of elucidating pitfalls in applying the theory, the telephone survey technique allowed the authors to best explore "the areas where finance theory is silent or ambiguous," exploring the hazards of application as well as identifying techniques.

Broadly speaking, Bruner et al. found that practice by 1998 was fully consistent with classical financial theory, which had apparently been successfully "coded" into corporate finance text books, lectures and case studies used in graduate business programmes. Discounted Cash Flow (DCF, a general term for cash-based analysis using metrics such as NPV and/or IRR as decision criteria) is the dominant valuation technique, CAPM was dominant in cost of equity estimation, and WACC was used in a theoretically correct way by the great majority of practitioners responding.

The balance of the article is a dissection of components of CAPM. The authors examined the terms one by one, identifying theoretical gaps and issues both from the literature and with the survey respondents. One of the strengths of CAPM is precisely that it can easily be decomposed into a series of component terms, which can be separately analysed and estimated. Each component (interest rates, market returns, risk coefficient for individual company) makes intuitive sense to the finance practitioner, but as Bruner et al. revealed, the devil is in the details for users of the theory. The following sections combines Bruner et al.'s discussion with the author's observations on difficulties met in practice.

### 3.2.3. Pitfalls in cost of capital estimation

The most common formulation CAPM (Formula 2.14) is repeated for convenience: $E(R_j) = r_f + \beta_j \left[ E(r_m) - r_f \right]$.

Pitfall #1 – the risk-free rate

The risk free rate in CAPM is implicitly a short-term rate because the model is single-period: textbooks usually recommend using a 90-day Treasury Bill (T-bill) yield to estimate the rate. However, using short-term rates to evaluate investment over many years represents a serious mismatch of maturities (many financial firms taken down in the current financial crisis would have done well to remember this basic match-funding principle in finance). In practice, the authors found that corporate managers choose between a 90-day rate and a long-term bond, with 70% of the "best-practice managers" using a maturity 10 years or greater, and "many" specifically matched the investment horizon to the tenor of the bonds used to estimate the risk-free interest rate. This contrasts sharply with the 43% of textbooks recommending 90-day T-bill rates vs. 29% for long-term Treasury bond yields, reflecting a preference for the pure interpretation of CAPM in the academic community.

Pitfall #2 – estimating Beta (β)

The second problematic element of CAPM is the slope of the Security Market Line, the Beta (β) coefficient. On one hand, it is hard to overstate the significance of the intuition of this coefficient both for the theory and practice of finance. For practitioners, the insight that investors can and do hold combinations of the risk-free and risky portfolios of assets allowed the use of a single linear coefficient to estimate expected market returns of a single share within an optimized portfolio, in place of the problematic, curvilinear "efficient frontier" of Markowitz. For finance theory, the intuitions and methodology of the CAPM have served as the basis for more advance valuation techniques such as arbitrage pricing and financial options pricing.

A cottage industry of academics continues to dedicate itself to testing the beta formula using historical market returns. The nature of the beta formulation in the field lends itself to this type of test. The coefficient is strictly defined terms of statistical calculations, specifically the covariance of the market portfolio return $Rm$ and the return of the share in question, $Ri,$ normalized by dividing it by the market portfolio's variance:

$$\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)} \qquad 3.4$$

The empirical evidence testing retrospective beta is ambiguous, as discussed in Chapter 2. However, this is not the greatest practical problem with using the coefficient: Bruner et al. pointed out that theory states that beta must be forward looking, while most information providers use linear regression on historical share returns to estimate company betas. Additionally to this future vs. past conundrum (present everywhere in business planning and finance, quite different to science and engineering), theory is silent on several other methodological pitfalls in using beta. A trade-off must be made between the freshness of the data and statistical validity (which argue for measuring weekly or even daily returns over the most recent period, yielding a large recent sample size) and the long-term nature of the investments being analysed with the cost of capital, which (as with the risk-free rate) argue for a long-term analysis of company betas.

Another estimating problem concerns the "market portfolio" used to calculate market returns, the independent variable for the regression analysis. While theoretical the market portfolio should be composed of all risky assets, a "minimum" sample size and composition of the market portfolio is not established. Out of expediency, Beta providers tend to opt for returns on market indices, claiming that the indices provide a representative sample of market returns.

The default parameters for three major online sources of Betas values are cited by the authors, as summarized in Table 3.4.

| | Bloomberg | Value Line | S&P |
|---|---|---|---|
| Time interval | Weekly | Weekly | Monthly |
| Sample size | 102 (2 yrs) | 260 (5 years) | 60 (5 years) |
| Market index | S&P 500 | NYSE Composite | S&P 500 |
| Average Betas | 1.03 | 1.24 | 1.18 |

Table 3.5: Beta estimation parameters identified in Bruner et al. (1998)

Alone among the three services, Bloomberg allows the user to vary the estimation parameters according to the terms of the specific study, providing at least a sort of sensitivity analysis to provide the analyst with perspective, in partial response to the statistical estimation problem.

The greater gap between theory and practice and challenge to practitioners lies in determining a "forward-looking" beta as demanded by theory. In the rush to statistical expedience (and profit-making provision of information), information providers and many practitioners seem to forget that the returns in portfolio theory and CAPM – both market and individual share returns - are *expected* returns as defined in relation to utility theory. Even more, Sharpe's original formulation calls for uniform investor expectations of returns, an assumption later relaxed without damaging the CAPM's theoretical coherence. The analytics group Barra (now MSCI Barra) is the only major information provider which takes this into account in their methodology. In Barra founder Barr Rosenberg (1985), beta "should forecast the future response of the stock return to the market portfolio return." To reach what he considers an intrinsic or equilibrium value for beta, Rosenberg suggests using a factor between 0 and 1 as an adjustment to smooth short-term swings, drawing the beta estimate toward its average value. This approach allows Barra to constantly re-calibrate beta estimates based on their predictive ability by using long-run averages. These are held to be equilibrium betas, termed "fundamental" beta by Rosenberg.

The second methodological improvement in Rosenberg (1985) was to integrate the intuition that different industries have specific risk characteristics into the analysis. Many analysts today calculate the systematic risk inherent in industries using industry betas. This approach again shows how amenable Sharpe's formulation is to statistical analysis. A portfolio beta is simply the weighted average of individual company betas. Using weights presumably based on the market capitalization of each company, Campbell Harvey (1995) calculated betas of 1.8 for air transport, 1.3 for aerospace, and 0.6 for energy, a wide range of betas that reflects the differing investor risks for each industry. Barra's approach to including industry-specific items in beta estimates is more subtle (and unpublished).

The third innovation is the logical extension of Barra's use of more than one factor to estimate systematic risk. In their model, the estimated beta is made up of a number of coefficients and descriptors, including size, earnings volatility, technical analysis indicators such as market momentum of the share price, and "value factors" from traditional security analysis such as dividend payout and debt ratios. Unlike the multiple regression approach of Ross' Arbitrage Pricing Theory, Barra's model retains the single-factor beta coefficient, adjusting the beta coefficient to arrive at a predictive beta by a series of adjustment terms:

$$\hat{\beta}_n = I_n + c_1 H\beta_1 + c_2 D_{2N} + c_3 D_{3N} ... + c_j D_{jN} \quad \text{.............................................} 3.5$$

Where
$I_n$ is the industry effect on company n
$c_{1...}c_n$ are the coefficients for prediction rule
$D_{1...}D_n$ are the descriptors

Rosenberg (1985) did not describe the specific methodologies used to arrive at the coefficients and descriptors, but the article did compare his methodology with the retrospective approach to beta estimation, and finds that his model is "1.67 times more predictive than simple historic beta as a predictor of future betas." More modestly, Rosenberg reports the following predictive power of historic vs. Barra betas, by calculating the $R^2$ over the period 1976 – March 1984:

| | Historical beta $R^2$ | Barra beta $R^2$ |
|---|---|---|
| Jan '76 – Dec '80 | .29 | .45 |
| Apr '79 – Mar-84 | .25 | .46 |

Table 3.6: Explanatory power of historical and Barra betas in Rosenberg (1985)

In Rosenberg's analysis, 45-46% (one might add, *only* 45-46%) of the variation in company beta over the periods studied was predicted by the Barra model, compared with less than 30% using purely historical data to predict future betas. The Barra information service results estimating airline betas were compared with other providers, as well as further methodological alternatives and issues in airline beta estimation, were covered in Turner and Morrell (2003), and discussed in section 3.3 of this research.

The survey respondents in Bruner et al. indicated a wide variety of approaches to beta estimation. Queried about the source of beta estimates, 52% of respondents used a published source, with another 30% calculating beta themselves. Only 3% sought an estimate from a financial advisor, while the remaining 15% did not use CAPM to estimate cost of capital. With 85% of respondents using it, the authors again found that (at least in this selective group), CAPM has been strongly adopted, in spite of its methodological difficulties. When asked *how* CAPM was used, respondents indicated a tendency to look at a variety of beta sources: of the four qualitative responses cited, two used more than one data source, while the other two "adjust" the beta values. Of the other two, one uses management judgement to adjust beta if the published source seems too high, while the other uses the common approach of estimating betas for different divisions, based on comparable "pure play" listed companies.

Pitfall #3 – the equity risk premium

The final element of CAPM discussed in Bruner et al. is the equity market risk premium, $Rm - Rf$. In addition to the same risk-free rate selection, sample size, periodicity, investor horizon and "future=past" methodological problems of beta estimation using historical data, another problematic estimation issue for the risk premium is the proper kind of average to calculate, geometric or arithmetic. Sharpe's original single-period model naturally was silent on the question of measuring multi-period returns on investments. Arithmetic means therefore best reflect the original CAPM, because they make no "buy-and-hold' assumptions about investor behaviour, as would a compound return (geometric average) approach. Arithmetic means are also consistent with the efficient markets framework underlying classical portfolio theory and CAPM, in that returns from one period to the next are held to be completely independent of one another, that is, there is no positive or negative autocorrelation between what are held to be normally distributed returns. A final advantage is that individual year returns as a basis for average return calculations allows the complementary calculation of measures of dispersion such as standard deviation. Arithmetic means require the analyst to individually measure each year's returns, and are calculated very simply, as follows:

$$Arithmetic\_Mean = \frac{\sum_{t=1}^{n} annualreturns}{n} \qquad 3.6$$

On the other hand, geometric means better capture the returns experience of "buy and hold" long-term investors, and by their nature take into account any momentum-based positive or negative autocorrelations, making no assumption whatever about the pattern of individual annual returns in relation to other periods. A further convenience is that the analyst can calculate geometric returns with just two data points, the first and last portfolio value in the series over $n$ years, as follows:

$$GeometricMean = \left( \frac{(1 + lastyearporfoliovalue)}{(1 + firstyearportfoliovalue)} \right)^{\frac{1}{n}} - 1 \qquad 3.7$$

. Arithmetic mean calculations thus best measure variance of returns and more closely reflect classical finance valuation theory than geometric means: in practice, both are in current use.

To demonstrate the range of possible estimates using the same historical data, Bruner et al. calculated the range of possible risk premia using data from 1926 – 1995. As with testing of the explanatory power of beta, estimation of market returns and risk premia has become a major industry among information providers and academics. Probably the best known, and certainly the most comprehensive recent study of returns and premia is Dimson, March and Staunton (2002), which examines 101 years of returns in global financial markets. The results for the U.S. study in Dimson et al. (results in bold italics) with the 1998 study of Bruner et al. are compared in Table 3.7.

| | Short-term $Rf$ (T-bill returns) | Long-term $Rf$ (T-bond returns) |
|---|---|---|
| Arithmetic mean | 8.5% / ***7.7%*** | 7.0% / ***7.0%*** |
| Geometric mean | 6.5% / ***5.8%*** | 5.4% / ***5.0%*** |

Table 3.7: Historical estimates of equity market risk premia in Bruner et al. (1998), Dimson et al. (2002)

In all cases, the geometric mean is less than the arithmetic mean due to the compounding effect, and the risk premium over short-term T-bills is higher than that over long-term bond returns, reflecting the "normal" positive term structure of interest rates over time. The calculated risk premia over long-term bonds is quite a bit more consistent between the two studies' results than that for short-term premia, whether for historical or methodological reasons.

The textbooks consulted by Bruner et al. tended to recommend using an arithmetic mean over t-bills, more consistent with Sharpe's CAPM formulation (but out of line with the long-term nature of capital budgets). The financial advisor practitioners in Bruner et al. also tended to recommend arithmetic mean over t-bill, but were more evenly divided than the textbooks. Overall, the risk premium in these published sources is between 5% and 8.5%, a wide spread which can have significant influence on capital budget evaluations. Corporate practitioners revealed an even wider disparity of estimates for market premia. Deliberately asked the question in an open-ended way, managers stated the following range of practices:

| | Percent responding |
|---|---|
| Use fixed rate of 4-4.5% | 11% |
| Use fixed rate of 5-6% | 37% |
| Use 'geometric mean' | 4% |
| Use 'arithmetic mean' | 4% |
| Use average of historical an implied | 4% |
| Use financial advisor's estimate | 15% |
| Use 'premium over treasuries' | 7% |
| Use Value line estimate | 3% |
| No response | 15% |

Table 3.8: Practitioner estimates of equity market risk premia in Bruner et al. (1998)

When queried on specifics, the best-practice companies revealed a very wide range of methodological choices: self-estimation, averaging polled financial experts, direct use of published sources, Monte Carlo (MC) simulation, dividend discount, and 'smoothing techniques' were all cited by the CFOs.

### 3.2.4. Cost of capital estimation – summary and conclusions

To summarize the impact of the various parameter choices, Bruner et al. calculated minimum and maximum WACCs resulting from the choice of different CAPM parameters for two of their best-practice companies. Using three "clusters of practice," they found WACCs of 8.5%-12.8% for Black & Decker, and 9.3%-11.6% for McDonald's, spreads of 430 and 230 basis points respectively. The "clusters of practice" used for the cost of equity estimates were:

1) short-term risk free rate (90-day T-bill), arithmetic mean risk premium from Ibbotson (information provider)
2) long-term risk-free rate (30-year T-bill), financial advisor modal risk premium of 7.2%
3) long-term risk free rate, corporate CFO modal risk premium of 5.5%

The authors pointed out that as the yield curve was quite flat in the mid 1990s, most of the variation is explained by beta and the risk premium used. In fact, the use of a common cost of debt tends to reduce the overall range due to the WACC calculation. The true spread of values is best viewed by calculating cost of equity under varying beta values, for each of the three clusters of practice, which the authors did:

| | | |
|---|---|---|
| *Cluster 1* | | |
| 90-day t-bill yield: | 5.36% | |
| Equity premium | 8.50% | |
| (Ibbotson arithmetic average since 1926) | | |
| Bloomberg | 1.06 | 14.4% |
| Value Line | 1.65 | 19.4% |
| S&P | 1.78 | 20.5% |
| | **Range:** | **6.1%** |
| *Cluster 2* | | |
| 30-year T-bond yield: | 6.26% | |
| Equity premium | 7.20% | |
| (Modal recommendation of final advisors) | | |
| Bloomberg | 1.06 | 13.9% |
| Value Line | 1.65 | 18.1% |
| S&P | 1.78 | 19.1% |
| | **Range:** | **5.2%** |
| *Cluster 3* | | |
| 30-year T-bond yield: | 6.26% | |
| Equity premium | 5.50% | |
| (Modal practice of company CFOs) | | |
| Bloomberg | 1.06 | 12.1% |
| Value Line | 1.65 | 15.3% |
| S&P | 1.78 | 16.1% |
| | **Range:** | **4.0%** |

Table 3.9 Black and Decker cost of equity values in Bruner et al. (1998)

With this range of values, it is not surprising that responding best-practice company managers took the beta estimates with a grain of salt, whether by adopting an average value for the information providers, estimating beta themselves, or adjust the provided betas using subjective management judgement.

From the study, the authors draw several conclusions about best practice in U.S. companies that is relevant for this research:

1) Classical financial theory was in wide use in best-practice companies
2) CAPM was preferred for cost of equity estimation
3) Beta values provided were frequently adjusted by management, and long-term data sources are preferred (they do not substantiate this last point)
4) Risk-free rate should match the tenor of the cash flows being valued, using the appropriate T-bond yield.
5) A striking variety of risk-premia are in use, reflecting controversy on methodology. Managers tend to use a premium of 6% or less, while advisers and textbooks recommend higher figures.

Though they state that managers can get no closer to a true WACC than ±1.5%, the authors close with axiomatic recommendations; that managers not "throw the baby out with the bath water" by rejecting theory out of hand, and that "even a blunt axe is better than nothing."

The evidence from Bruner et al.'s open-ended survey approach is to sum extent anecdotal and limited to practice within a selected set of "best-practice" U.S. companies. Still, it is the closest examination of theory-practice gaps found in the general literature, and will be compared to airline-specific research including previous articles, as well as the airline CFO survey and interviews performed as part of this research.

## 3.3. Airline investment analysis practice

With this research as background, this the most current state of practice in both the general business community and the airline industry is now identified. For the state of practice in the general business community, the research of John Graham and Campbell Harvey carried out in 2000, and published in the Journal of Financial Economics in 2001, is used as the baseline of business practice in U.S. companies. The comparison of airline practice with this research has several advantages: it is quite recent, exhaustive in its scope of inquiry, and benefits from a very large sample size.

### 3.3.1. Research methodology

This research designed and carried out an airline CFO survey designed to be directly comparable with Graham and Harvey, while addressing specific issues of known concern in aviation finance, the most apparent being the large sunk-cost problem of committing to aircraft types, the well-established volatility of airline financial performance, and the inherently long-term nature of aircraft investments, and the apparent existence of strong links between investment and financing decisions ("outlawed" under the normative conclusion and interpretation of the Modigliani & Miller propositions). The results of this survey, referred to as Gibson and Morrell (2005) are discussed in the relevant chapters throughout the remainder of this research.

The following specific research questions were identified, covering the research areas of investment valuation methods, interactions between investment and financing decisions, and risk management:

Valuation techniques

Do airlines use techniques consistent with classical financial theory in forecasting investment returns and evaluating capital projects?

1. What are the valuation metrics used to evaluate (ARR, NPV, IRR, PBK…)?
2. For what size or type of project, and for what purpose, are such techniques used?
3. How often do they evaluate project performance?
4. How is the airline's cost of capital estimated, if it is needed for the analysis?
5. Do airlines use more advanced techniques such as Adjusted Present Value (APV), Real Options Analysis (ROA), or Economic Value Added (EVA)?
6. Questions of calculation methodologies: are income taxes included in the analysis, as strongly suggested by theoreticians? Is accounting profit + depreciation the basis for the cash-flow calculation, or do companies calculate cash-flow directly?

Investment - Financing interactions

7. Is there a "pecking order" in project financing decisions, i.e., a preference for internal funds, debt, equity?
8. Do executives prefer debt, equity, or internal funds to finance aircraft investments?
9. Are valuation techniques used to evaluate financing decisions (such as operating leasing vs. purchasing and borrowing)?
10. Is the firm focused on debt or equity project returns, or both?

Risk management

11. Is the cost of equity capital used in the investment analysis based on quantitative analysis or heuristics?
12. How do airlines estimate risks in investments?
13. How does the perceived risk of the investment influence financing decisions?
14. What methods do they use to adjust the valuation for risk?

Among the survey topics, the primary focus of the current chapter is valuation techniques, including cost of capital estimation. Chapter 5 returns to the survey in the context of fleet planning investment-financing interactions, while the current theory and practice of investment risk management is discussed in Chapters 7 and 8.

The questions were designed to measure the strength of preferences for the different approaches to valuation. Airline managers were asked whether they Never use (score of 0), Sometimes use (1), or Always use (2) a given technique. The preferences thus expressed are comparable to preferences expressed in Graham and Harvey (2001). The complete survey form and results are presented in Appendix A of this thesis.

<u>Sample and response to the survey</u>

This research seeks to identify best practice among leading airlines around the world, and to provide a consistent body analysis of airlines surveyed and the governance and financial performance analysis performed. For these reasons, the airline surveyed were drawn from the world's largest airlines present in both in the Air Transport Intelligence database of airline ownership, and the Airline Business annual survey of financial performance. 249 surveys - with a cover letter addressed to the CFO by name - were posted, with a follow-up fax ten days before the due date. These 249 airlines are the same as those whose ownership patterns and financial performance in analysed in this research, lending continuity to the various analyses performed.

To establish characteristics of the respondents, the author asked firms to identify for their company:

1. ICAO region
2. Fleet size
3. Fleet diversity (number of aircraft types)
4. Total assets
5. Total revenue
6. Revenue growth

7. Majority ownership (govt, private, subsidiary, listed company)

Table 3.10 shows the regional composition of the sample and the response characteristics.

| Regions | Airline CFOs surveyed | Responses | Response rate | Sample composition | Response composition |
|---|---|---|---|---|---|
| Africa | 7 | 4 | 57% | 3% | 11% |
| Asia | 58 | 4 | 7% | 23% | 11% |
| Europe | 85 | 20 | 24% | 34% | 54% |
| Middle East | 22 | 4 | 18% | 9% | 11% |
| North America | 58 | 5 | 9% | 23% | 14% |
| South America | 19 | 0 | 0% | 8% | 0% |
| Totals | 249 | 37 | 15% | 100% | 100% |

Table 3.10: Airline CFOs surveyed and responses by ICAO region

The authors received responses from airlines in all ICAO regions except South America. The greatest response in absolute terms came from European carriers, who returned 20 completed surveys, perhaps reflecting familiarity with Cranfield University in European aviation circles. In percentage terms European, African and Middle Eastern airlines responded above the overall 15% response rate. The overall rate compares favourably with Graham and Harvey (2001), who experienced a 10% response rate in their survey of 4,087 companies in the U.S. Responses from South America were nil, while only 9% of North American and 7% of Asian airlines responded.

The responding companies tended to be mature or moderate -growth, with 41% reporting annual revenue growth rates between 6% and 15%, and another 30% reporting 3 to 5% growth. Over two thirds of the respondents operate between 10 and 50 aircraft, and six major airlines with 75 or more aircraft responded. In spite of our offer of confidentiality, many airlines responded on their company letterhead, and several asked to receive the survey results.

Graham and Harvey (2001) pointed out that 8-10% is a usual response rate to surveys about company financial practices, which in many cultures is quite sensitive. The 15% response rate of the present research yielded 37 respondents. While we can see relations between individual airlines characteristics (size, growth etc.) and their preferences for various techniques, the relatively small total number of airlines in the world (and the 15% response rate) preclude the use of correlation of preferences against the airline characteristics as was performed in the Graham and Harvey research. Response bias is clearly present given the disproportionate responses of European carriers. Additional response bias could be present, since the respondents quite probably represent more sophisticated and/or financially transparent airlines, also typical of financial communication with listed share ownership, notably in Europe and the United States. A second bias is the number of aircraft operated by respondent airlines, which differed from the population of 249 airlines: 78% of respondents operated fewer than 50 aircraft, compared to 65% percent in the large-airline population. The survey responses are thus biased toward European airlines with relatively small fleets compared to the population, and the conclusions are most relevant for these groups.

The survey results are thus limited in describing the overall population. The 37 responses allow only broad conclusions about global airline preferences, particularly descriptive of European carriers, predominately those operating fewer than 50 aircraft.

### 3.3.2. Current investment valuation practices

Graham and Harvey (2001) sent questionnaires to all Fortune 500 companies, as well as 4,400 members of the Financial Executives Institute, a professional association. Since there was some overlap in the two groups, a total of 4,087 surveys were sent. A team of 10 MBA students at Duke University followed up with telephone and faxes to maximise the response rate, which came in at 392 completed surveys, a 10% response rate. The authors pointed out that a major shortcoming of such surveys is that they reflect beliefs rather than proving practices. On the other hand, the high number or responses allowed a high degree of statistical reliability in the testing of several hypotheses and correlations.

The authors cited earlier surveys reviewed in this research, which tended to confirm that the vast majority of U.S. firms use some sort of cash-flow analysis to evaluate investment projects. The Graham and Harvey survey goes beyond these and the earlier surveys discussed in this research, to inquire about the use of additional techniques for calculating returns: Adjusted Present Value (APV) is discussed extensively in this research and in Gibson and Morrell (2004). Additionally, they ask managers about use of the traditional price-earnings (PER) approach, where forecasted per-share earnings are divided by current EPS to determine the implicit price earnings ratio.

The authors also question managers about the use of advanced techniques used to capture risk, such as Monte Carlo simulation, Real Options Analysis and Value at Risk. These results are discussed and contrasted with airline practice in Chapter 7.

Graham and Harvey's survey results showed a clear preference for classical metrics, with IRR and NPV being the dominant metrics used, followed by PER. Slightly over 20% of executives in the survey use Accounting Rate of Return (ARR), far lower than the 58% found by Schall et al. in 1978. More common is the use of the PER method, which relies on a somewhat mixed bag accounting data and share market metrics. Consistent with the earlier studies, the authors found a clear tendency to use more than one method to evaluate projects. NPV has pulled nearly even with IRR among cash-based measures, presumably facilitated by advances in the knowledge of techniques to estimate cost of capital.

The large sample size allows the authors to test the use of various techniques against several CFO and firm characteristics. They assigned a "preference rank" for each technique. The survey allowed choices of never use, sometimes use and always use, on a scale of 0 to 4. Scores above three indicate a very common use of the method. The differences between scores are tested at a 1%, 5% and 10% significance level. Grouping IRR/NPV as Cash-based, PBK and PER as Accounting-based, the following pattern emerged at the 1% significance level.

| Methods preferred | Cash-based | Accounting-based |
|---|---|---|
| Large firms | X | |
| Leveraged firms (high level of debt) | X | |
| Firms that pay dividends | X | |
| Manufacturing firms | X | |
| Management ownership low | X | |
| CEO older than 59 years old | | X |
| CEO tenure long | | X |
| Regulated | X | |
| CEO holds MBA | X | |
| Widely-held corporation | X | |
| Foreign sales | X | |

Table 3.11: Type of companies using cash vs. non-cash measures in 1999 survey (Graham and Harvey)

The authors found that firms with older, longer-tenured CEOs showed a preference for accounting measures, implying that the cash-based techniques taught in MBA programmes are more up-to-date. These preferences do not indicate that the firms preferring cash-based measures don't use the accounting-based measures as well, but rather, that they more commonly use cash than accounting-based calculations. It is worth noting that ARR received scores of less than 1.5 in all categories, while PBK and PER tended to score above 2.5: clearly, ARR has become much less frequently cited by U.S. financial executives, since the 1978 Schall et al. survey.

Among the control variables, the most relevant for our research into airlines are the ownership structure, level of debt, and degree of regulation. Airlines – particularly those in emerging markets - are often state-owned (see Gibson and Morrell 2004), often highly indebted, and the sector is heavily regulated compared to other service industries. If the airline sector follows the patterns identified by Graham and Harvey, we would expect to observe a preference for cash-based measures.

### 3.3.3. Valuation techniques in airlines

In the first survey performed for this research, airline CFOs were asked to state which techniques were used to analyse investments, choosing from a list of six common metrics (PBK, ARR, IRR, NPV, APV, ROA, as well as Economic Value Added (EVA), a corporate profit performance measure that multiplies the firm's assets by WACC to establish an acceptable level of profits produced.

They were asked to state preferences for the various techniques as never use, sometimes use and always use, assigning scores of 0, 1, and 2 to each respective preference.

A score of 1.5 indicates a strong preference for the method; while any score under .5 indicates a method that is rarely used. Graham and Harvey (2001) used a five-point 0, 1, 2, 3, 4, with 2 as the midpoint. These responses were divided by two to be placed on the same scale. The choice of a simpler three-point scale in this research resulted from a desire to not overwhelm the potential respondents with choices, which a five-point scale would have tended to do.

Strong preferences were found for two metrics in each case, but the two were not the same ones.

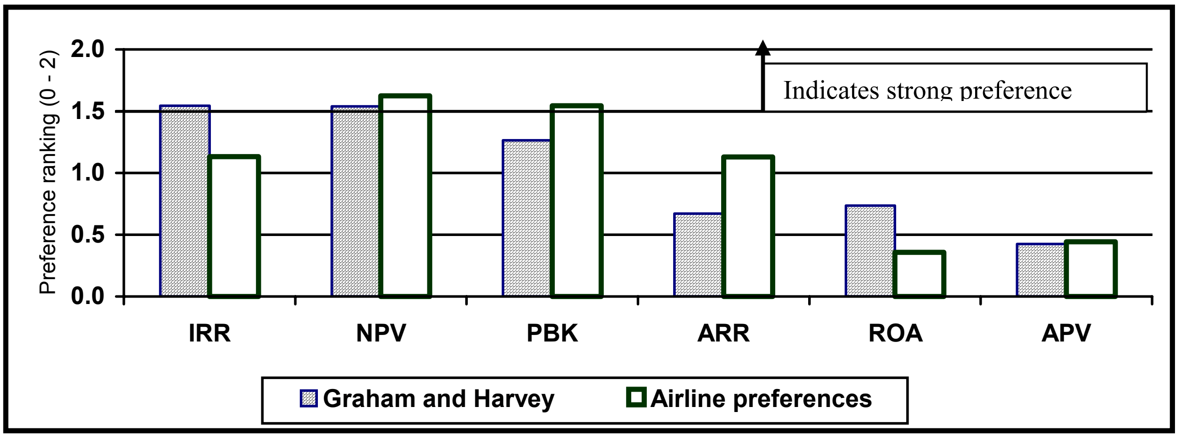


Figure 3.2: Preferences for valuation techniques in Graham & Harvey (2001), Gibson & Morrell (2005)

Graham and Harvey found strong preferences for the NPV and IRR measures, and relatively little preference for the other "standard" measures, PBK and especially ARR. NPV and IRR are best viewed as complementary measures, usually consistent with one another. Each has its methodological pitfalls: NPV requires the cost of capital as an input to the calculation, raising all the estimation conundrums discussed in the previous section, and is less intuitive to grasp than the simple percentage return, which can be compared to a bond or bank account return.

IRR calculation does not require an a priori cost of capital, but has several pitfalls of its own. It can produce results contrary to NPV, is not useful in capital rationing because it doesn't adjust for project size, and finally, yields multiple solutions complex projects in which cash flows change sign more than once over the life of the project. For these reasons, finance textbooks tend to strongly favour NPV.

Graham and Harvey's findings of nearly even preference echo more recent surveys such as Trahan and Gitman, in contrast to the earlier Schall et al. and Oblak and Helm surveys, which for their part found a marked preference for IRR among executives.

Airline preferences were sharply different in three respects. First, the respondent airlines indicated a stronger preference for Net Present Value compared to IRR than found by Graham and Harvey. Response bias may exist, as over half the respondents come from Europe, where the trend toward full listing of company shares has been very pronounced over recent decades: British Airways, Iberia, and Lufthansa are very prominent examples of airlines whose entire shareholding is listed on respective national bourses. Full listing of shares facilitates estimation of cost of equity capital, compared to closely held or state-owned carriers dominant in many regions. International airline ownership and investment appraisal patterns are discussed in the next chapter.

Second, the airline CFOs showed a substantially higher preference for PBK than their U.S. general business community peers. The use of PBK has recently been "revitalized" by authors who liken PBK to a simplified form of real options analysis to capture risk. Indeed, this time-to-repayment measure is a very primitive form of what investment bankers call duration, that is, average time to repayment of capital.

The third major difference in findings between Graham and Harvey (2001) and Gibson and Morrell (2005) is the greater preference expressed by airlines CFOs for the traditional Accounting Rate of Return method of investment valuation. Practice in the field shows that indeed, the range of valuation metrics is extremely varied in aviation worldwide, and ARR is apparently in some common use to value investments.

In Figure 3.3 below, we complete the comparison, showing the strongest possible "always use" (2 out of 2) for airline CFOs with the less-definitive "almost always or always use" (3 or 4 out of 4) of Graham and Harvey (this being their only published response). On the red outlined and lightly shaded bar, we add "sometimes" (1 of 2) to the airlines' "always" responses.

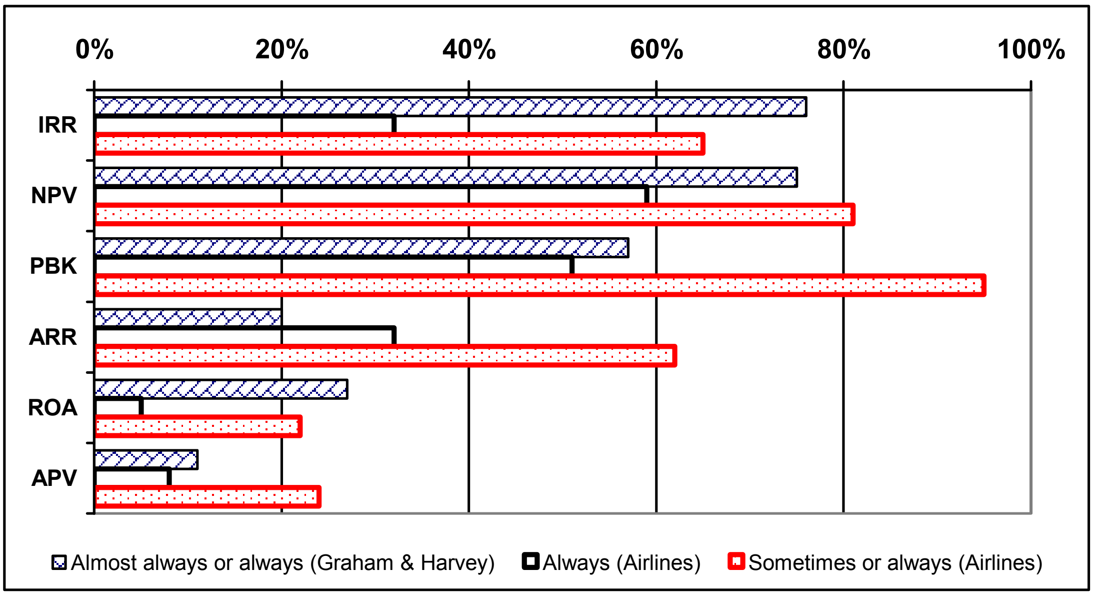



Figure 3.3: Frequency of valuation technique use in Graham & Harvey (2001), Gibson & Morrell (2005)

Even in the weaker "always" form for the airlines, we see the predominance of NPV (nearly 60% always use), vs. slightly over 30% for IRR, reaching 80% when the "sometimes" response is included.

Payback is *always* used by half of the executives: when "sometimes use" is added in, the figure reaches 95%, the highest frequency of use for any of the techniques listed.

ARR shows a use pattern just a bit under 1/3 of the time, compared to 1/5 for U.S. CFOs. This figure jumps to 62% frequency of use when "sometimes" is added in.

There is a slightly different pattern when looking at Real Options Analysis (ROA) and Adjusted Present Value (APV). While each is always used by fewer than 10% of the time by our responding airlines, adding "sometimes" brings the figure closer to Graham and Harvey's. Use of APV, potentially useful for valuing tax benefits of different financing vehicles, may actually exceed the use frequency of the general business community.

On the other hand, Real Options has reached substantially more acceptance among U.S. CFOs than among the responding airline CFOs, as only 21% said they used ROA even "sometimes", compared to the 25% found to being using it "nearly always or always" by Graham and Harvey. This last finding was somewhat surprising, given aircraft manufacturers' extensive use of aircraft purchase rights, delivery options and aircraft family conversion options in selling their products. Adjusted Present Value as applied to fleet investment valuations, and Real Options valuation of aircraft options, are discussed in Chapters 6 and 7 respectively.

Airline financial managers were found to prefer using more than one technique to analyse investments. Responding airline managers use between two and six different valuation techniques. The central tendency (mode) is four techniques used, and only 9 of our 37 respondents use fewer than three techniques. This confirms the earlier research showing that financial managers prefer to balance techniques against one another to get a complete picture of investment dynamics.

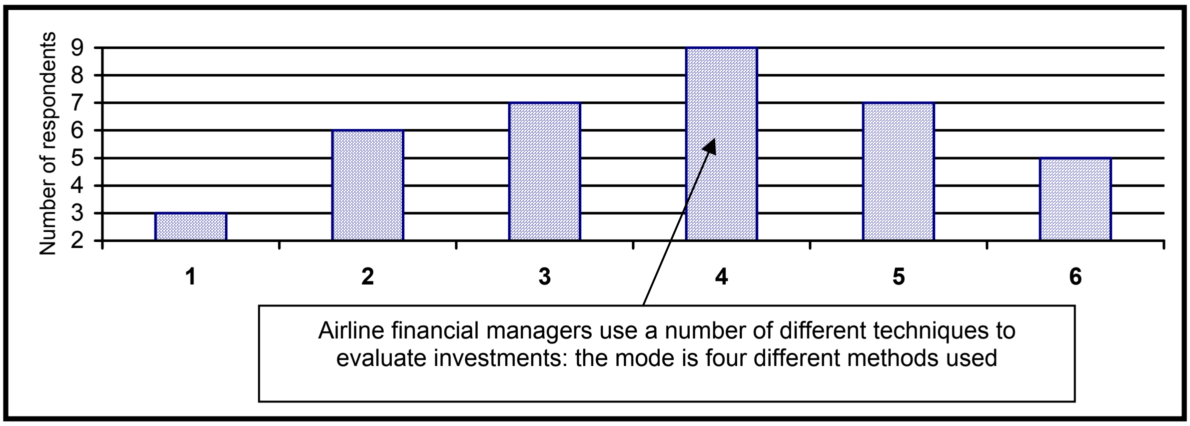



Figure 3.4: Number of different valuation techniques used to evaluate airline investments

Looking deeper at the use of multiple techniques, airline managers indicated that fully 43% always use both NPV and PBK, and another 32% sometimes use both metrics, representing an overall 75% preference for using these methods in tandem. Interestingly, the cash flow pattern of PBK and NPV can be represented on a single graph. An example of cash flow patterns for an investment in a single-aisle aircraft operating in Europe and sold at the end of year six of operation is depicted below.

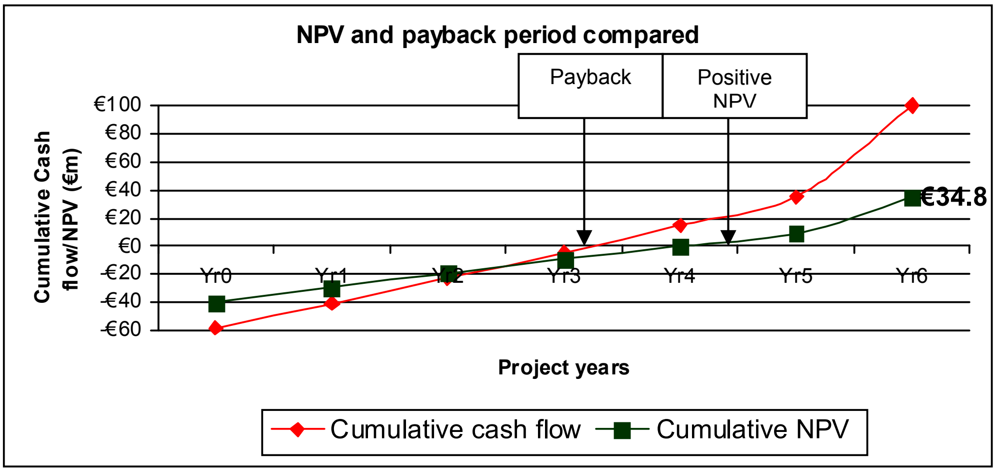



Figure 3.5: NPV and PBK depicted graphically, showing the difference in breakeven points

The graph reveals that payback is achieved during year four, when the company recovers its cash invested in the aircraft, while the NPV reaches its total of €34.8million at the end of the project, after turning positive in year five. This time to reach a zero NPV is often known as discounted payback. These complementary measures can be seen as measuring the risk (PBK-how long is the cumulative cash position negative) and the return (NPV) in a common visual framework. McDonald (1998) and Alesii (2003) suggest that heuristic measures such as PBK may in fact approximate the conclusions of valuations using more sophisticated techniques such as Real Options Analysis.

Looking briefly at regional preferences, the found the strongest preference for NPV in the Middle East and Asia (1.75 of a possible 2.00 preference ranking). Airlines in these regions showed an equally strong preference for PBK. NPV showed slightly lower preferences in North America (1.67) and Europe (1.61). IRR is still in common use in the Middle East (1.75), where share markets are less developed than in other regions and statistical cost of capital estimation is difficult. In the other regions of the world, IRR showed a preference ranking of only 0.98. Consistent with the existence of broad and deep share markets and the corresponding ease of estimating the cost of capital for NPV calculations, U.S. respondents showed the lowest preference for IRR, at only 0.75.

The other questions regarding project analysis practices yielded the following patterns. A majority (60%) of airline managers perform investment analysis for all investment projects, while an additional 30% analyse projects with over a certain size, frequently $100,000, thus including all aircraft investments. Only three responding managers indicated that they analyse projects according to risk class.

A common criticism of NPV is that joint revenues and costs of different aircraft operating on the same routes, and the specific cash-based accounting required, make it difficult to follow up on results after the project is launched. Among our airline respondents, a large majority (81%) follow up to measure project results in some way, with a full 65% looking at results at least annually. Another 18% measure results at the end of the project.

68% of airline financial managers prefer to calculate cash flow directly, rather than begin with profit and add back depreciation as in Schall et al. (1978). A less clear preference was cited for after-tax analysis recommended by analysts and academics. Finally, 35% of airline managers report using after-tax analysis, while 32% do the analysis pre-tax, and the rest declined to respond.

### 3.3.4. Airline cost of capital estimation

Companies financing themselves in mature markets such as the U.S. and Europe have the advantage of large public securities markets for listing company shares and debt obligations on open exchanges. In these markets, statistical estimation methods based on historical data can readily be used to estimate an acceptable financial return – or cost of capital - for investment projects. On the other hand, there is significant doubt as to the usefulness of these purely statistical approaches for firms which are thinly traded, or closely held by governments, other companies or families, which often characterise airline shareholding. As with investment valuation techniques, the literature reveals that executives prefer to use a combination of different approaches to arrive at a proper cost of capital. These include both objective/market-based and subjective/heuristic methods.

In addition to inquiring on the use of the WACC methodology, the Campbell and Harvey survey asked whether firms use the Capital Asset Pricing Model (CAPM) to estimate the cost of equity capital. Campbell and Harvey find that 73.5% of respondents use CAPM to estimate cost of capital, another 39.41% used average share market returns (i.e., without adjusting for the systematic risk of their company), while 34.29% used the "dividend discount model," an IRR calculation using expected future dividends and today's market share price, to estimate cost of capital. They discovered a very strong preference for CAPM among large firms which, in the U.S., tend to be listed on major share exchanges. Similar to the findings earlier in this research, the use of multiple techniques suggests that managers prefer to weigh up several alternative measures to arrive at an appropriate cost of equity. In this section, we open the question of whether statistical methodologies such as CAPM should be applied to airlines, and present the state of practice among our 37 respondent airline CFOs.

Turner & Morrell (2003) examined both the variety of published betas for airlines, and seeks to identify methodological pitfalls and disparities (along the lines of those discussed in section 3.5) which may account for the variety of published betas in the marketplace. They focus on "pitfall #2," that is estimation of beta.

To do this, the authors analyzed 10 airline beta values, revealing several pitfalls of CAPM for calculating expected returns. The authors begin with the observation that different financial information services report substantially different betas for the same airline on the same date. Further, the two of the three services report an average beta of less than 1.0 for the airlines examined, suggesting that these airline shares are less volatile than the market as a whole. This runs counter to the view that airlines are subject to both highly cyclical demand (particularly in high-margin business class), and broad volatility in input prices, notably jet fuel, and hence should generally have beta values significantly higher than 1.0 (see for example, Morrell (1997)). The published-source values are presented in Figure 3.5, and served to establish that different methodologies must be in use by the three providers (unless one or more is making calculations in error!). The forward-looking superiority claimed for the Barra methodology in Rosenberg (1985) based on superior goodness-of-fit was not verifiable by the authors, as Barra apparently did not provide the relevant $R^2$ calculations for its estimates. Of those that did provide them, the estimates are extremely low for Bloomberg (for all but Lufthansa and to a lesser degree British Airways), and almost suspiciously high for Datastream, keeping in mind that in Rosenberg (1985), values between .25 for the historical estimation method, and .46 for the 'forward-looking' Barra estimates were found.

| | BARRA | | BLOOMBERG | | DATASTREAM | |
|---|---|---|---|---|---|---|
| | $\beta$ | $R^2$ | $\beta$ | $R^2$ | $\beta$ | $R^2$ |
| Singapore | 1.209 | N/A | 1.090 | 0.39 | 0.917 | 0.732 |
| Cathay Pacific | 1.033 | N/A | 0.920 | 0.30 | 0.643 | 0.434 |
| British Airways | 1.857 | N/A | 1.270 | 0.22 | 1.599 | 0.623 |
| Qantas | 0.878 | N/A | 0.940 | 0.05 | 0.860 | 0.275 |
| Varig | 0.746 | N/A | 0.740 | 0.05 | 0.301 | 0.127 |
| Finnair | 0.145 | N/A | 0.470 | 0.03 | 0.166 | 0.239 |
| Austrian Airlines | 0.977 | N/A | 1.270 | 0.18 | 1.095 | 0.625 |
| Southwest Airlines | 1.085 | N/A | 0.420 | 0.01 | 0.726 | 0.395 |
| SAS | 1.383 | N/A | 0.570 | 0.03 | 0.581 | 0.466 |
| Lufthansa | 1.185 | N/A | 1.120 | 0.46 | 1.140 | 0.682 |
| ***AVERAGE*** | ***1.050*** | | ***0.881*** | | ***0.803*** | |

Table 3.12: Variability in Beta estimation among service providers, from Turner and Morrell (2003)

Having established the disparity, the authors re-calculated the same airline betas using under four different calculation methodologies:

- Method 1 calculates annual returns over a 60 month rolling period, adding the annual dividend yield to the percentage change in share price
- Method 2 calculates monthly returns, adding an averaged 12-month dividend yield to the share price change
- Method 3 calculates monthly returns, adding the cash dividend to the final share price before calculating the percentage return
- Method 4 calculates daily returns, adding a dividend yield averaged over the number of trading days in the year

One of the stickier problems identified by these methods is the treatment of the dividend yield. In order to demonstrate the variety of results from different methods, in Methods 1, 2 and 4 the authors calculate the dividend in terms of a percentage yield and add it to the annual/monthly/daily percentage change in share price, corresponding to the period of the specific method used.

Another approach to this problem is simply to add the cash dividends distributed to the ending share price before calculating the percent return (used in Turner and Morrell's Method 3). As the timing of dividends is important to determine yields, this method should be more accurate the more frequent the sample is made. This measurement issue can be added to the list of CAPM pitfalls outlined in Section 3.5. As mentioned above, Brunel et al. cited weekly frequency for two of the three providers, and monthly for the third, with horizons between two and five years. This is the method adopted by

Turner and Morrell for their Method 3. After calculating the beta coefficient for each of the ten airlines, they performed a regression analysis on four different methods of calculating airline betas, to determine goodness of fit of CAPM, using $R^2$ as the measure of fit.

In most cases, the methods of calculating annual returns calculated month-to-month over the past 60 months (Method 1), and daily returns over the past year (Method 4), yield better fits than other methods. However, the authors pointed out, $R^2$ varies from a minimum of .001 for Southwest Airlines, to a maximum of .870 for Singapore Airlines under the former method, and from .0125 for SAS to .401 for Singapore in the latter. CAPM statistical validity was widely variable in the airline industry, during the years 1996 – 2002, as Table 3.13 from their article shows. This suggests that at least at certain points in time, the yield of a share (Southwest is the most striking example), the return on a share is strongly conditioned by factors other than its systematic risk, as measured by covariance with the market.

Table 4
Regression estimation results

| Airline | Method 1 | | Method 2 | | Method 3 | | Method 4 | |
|---|---|---|---|---|---|---|---|---|
| | $\beta$ | $R^2$ | $\beta$ | $R^2$ | $\beta$ | $R^2$ | $\beta$ | $R^2$ |
| Singapore[a] | 1.332 | 0.870 | 0.209 | 0.036 | 0.216 | 0.038 | 1.195 | 0.401 |
| Cathay Pacific[a] | 0.020 | 0.599 | 0.112 | 0.006 | 0.111 | 0.006 | 0.922 | 0.321 |
| British Airways | 0.422 | 0.086 | 0.711 | 0.062 | 0.740 | 0.066 | 1.510 | 0.247 |
| Qantas | 1.678 | 0.090 | −0.185 | 0.004 | −0.204 | 0.005 | 1.113 | 0.074 |
| Varig[a] | 1.719 | 0.357 | 0.269 | 0.009 | 0.239 | 0.007 | 0.641 | 0.056 |
| Finnair | −0.076 | 0.033 | 0.108 | 0.027 | 0.147 | 0.043 | 0.049 | 0.005 |
| Austrian Airlines | 2.046 | 0.335 | 0.228 | 0.013 | 0.338 | 0.028 | 1.390 | 0.184 |
| Southwest Airlines | 0.195 | 0.001 | −0.053 | 0.001 | −0.054 | 0.001 | 1.107 | 0.289 |
| SAS | 0.102 | 0.005 | 0.117 | 0.007 | 0.092 | 0.004 | 0.241 | 0.025 |
| Lufthansa | 0.993 | 0.736 | 0.385 | 0.069 | 0.380 | 0.068 | 1.011 | 0.382 |
| Average | 0.843 | | 0.190 | | 0.201 | | 0.918 | |

Table 3.13: Variability in Beta estimation for airlines, from Turner and Morrell (2003)

The authors concluded that the cost of equity, a key input to the WACC calculation and hence to NPV calculation (or hurdle rate determination), is itself subject to broad variation, and that CAPM generates results which are, for many airlines, of doubtful statistical validity.

In an approach similar to Brunel et al., the authors then calculated the resulting cost of equity under the various published and calculated beta results, presented in Figure 3.6. The spread among the different cost of equity estimates is even more dramatic than that found in the previous article, leading to serious questions about the usefulness of CAPM in the airline industry.

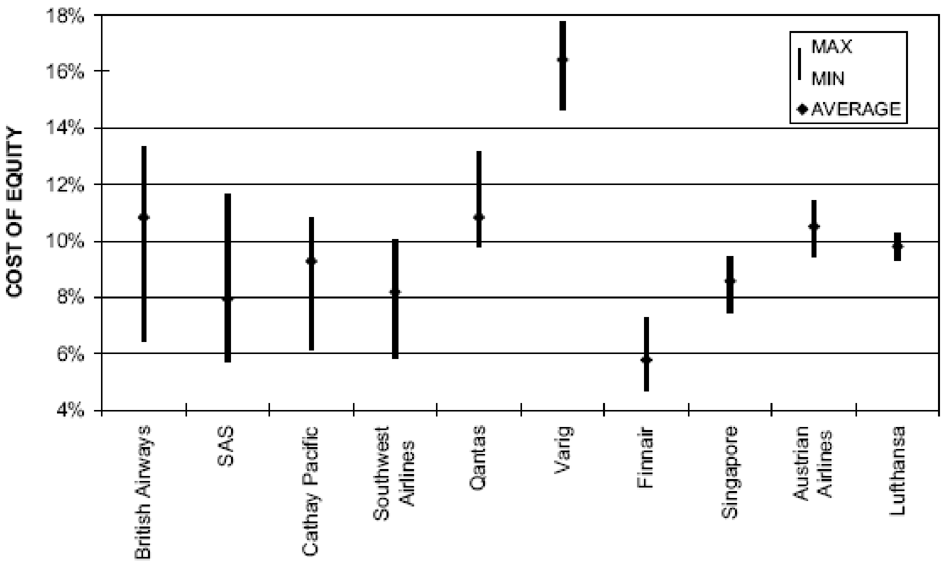



Figure 3.6: range of cost of equity estimates in Turner and Morrell (2002)

The WACC and CAPM methods of calculating cost of capital are widely used in U.S. industry, with its broad and deep securities markets and tradition of public listing of company shares on open exchanges. On the other hand, there is significant doubt as to the usefulness of these purely statistical approaches for firms which are thinly traded, or closely held by governments, other companies or families, which often characterise airline shareholding. Listing the percentage of shares listed and the daily share turnover for each company, Turner and Morrell conclude that closer examination of airline shareholding, governance and international market behaviour may provide additional insights into airline cost of capital and airline investment behaviour.

As with investment valuation techniques, the literature reveals that executives prefer to use a combination of different approaches to arrive at a proper cost of capital. These approaches include both objective/market-based and subjective/heuristic methods.

The airline managers were asked about preferences among four methods of setting the discount rate, cost of debt, cost of equity, WACC, and a rate based on the project financing. Overall, the managers expressed a distinct preference for WACC as a discount rate, followed by cost of debt. The former indicates a balanced view between shareholder and lender expected returns, while use of cost of debt may indicate that NPV analysis is used to justify projects to banks, that the cost of equity is considered nil because the company is a public service owned by the state, or both of these. As Figure 3.6 shows, the preference for cost of debt is nearly 1.5 in the Middle East, with lower but still significant preferences for this measure elsewhere. The preference for using the (higher) cost of equity finance is very low among these respondents. On the other hand, companies in the Middle East , Asia and Africa sometimes or often set a discount rate directly related to the project's financing, pointing toward significant investment-financing interactions, discussed in Chapter 6 of this research.

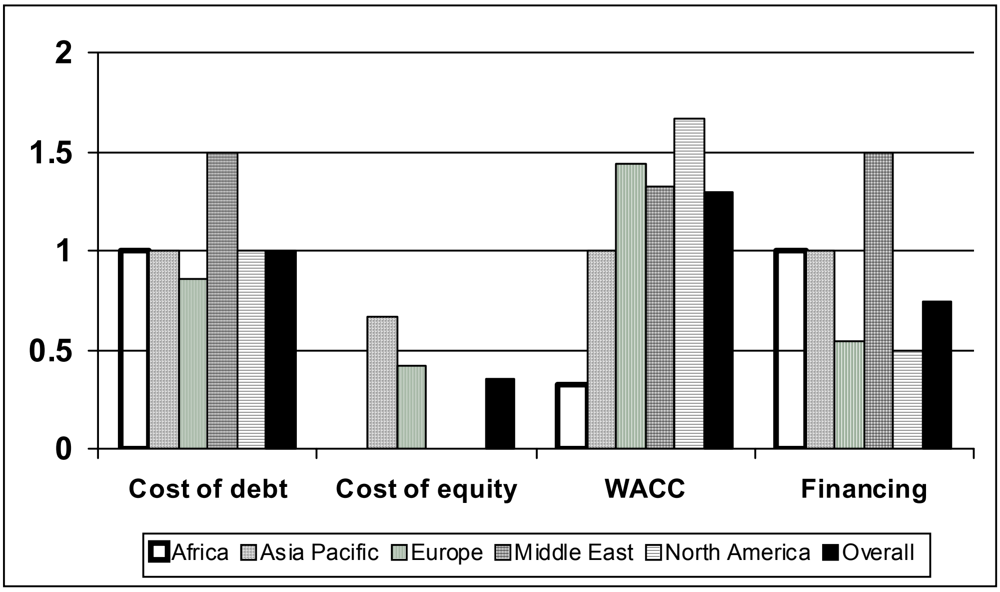



Figure 3.7: Airline preferences for cost of capital estimation, author survey

Cost of equity is an important input to a WACC calculation, and yet airline managers did not express a strong preference for any estimation method, as shown in Figure 3.8, whereas Graham and Harvey clearly identified CAPM as the preferred method, reflecting U.S. financing market practice. Our global airlines respondents expressed moderate preference for this method, and equal preference for measures based on "experience," or heuristic methods, a method not surveyed by Graham and Harvey.

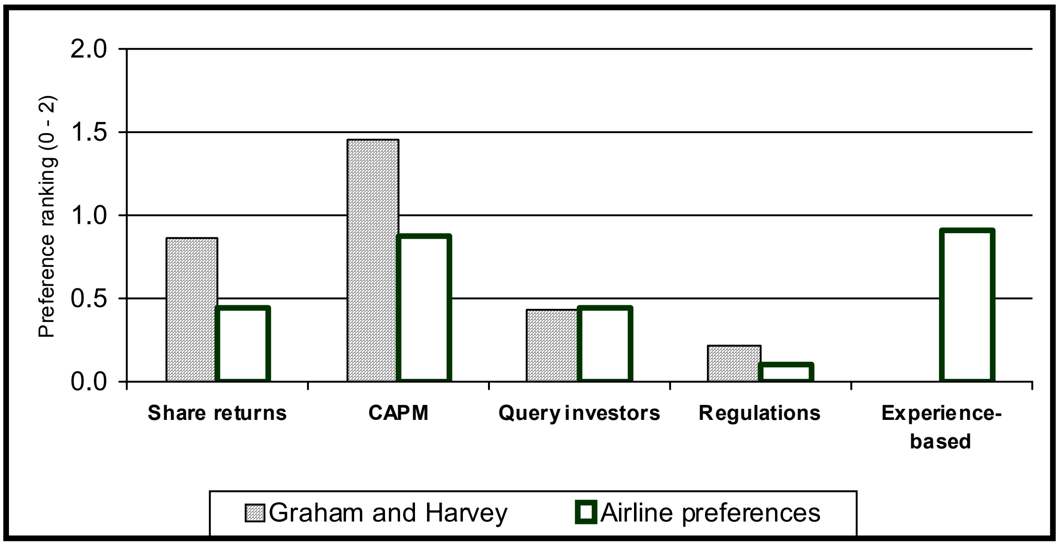


Figure 3.8: Airline preferences for cost of equity estimation

The strongest use of experience-based measures is in the Middle East, where no use of CAPM was reported. Government requirements and regulations for returns to investors, the primary method used during the days of airline regulation, apparently has an impact only on the Asian respondents, and there only weakly. Consistent with Graham and Harvey's findings, preference for CAPM is very strong in the United States, and weaker but still significant in Europe and Africa. These results are detailed in Figure 3.9, below.

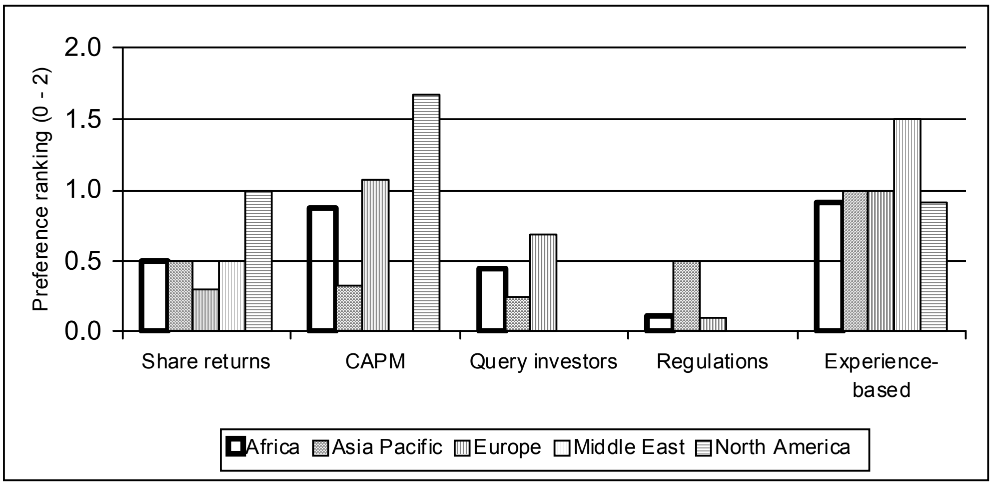



Figure 3.9: Regional preferences for cost of equity estimation

## 3.4. Conclusions

Since the advent of corporate finance and portfolio theory in the 1950s and 1960s, there has been a steady increase in the adoption of classical financial valuation methods for capital budgeting purposes. These methods are based on cash flow rather than accounting results, and attempt to find market values of risk and returns.

The most commonly recommended valuation techniques, NPV and IRR, are nearly equal in preference among financial managers today, in spite of major methodological gaps between theory and practice, reviewed in this chapter. Portfolio theory has not resolved the problem of estimating future expectations based on historical results: if anything, the business of supplying company and industry beta information supports the inherent weakness of classical theory.

In the airline industry, the trend toward classical valuation is also clear, but somewhat less pronounced: traditional valuation methods based on financial statements also remain common. In the aviation field there is a very clear preference for using a balance of methods to evaluate investments, including the theoretically primitive payback method.

Within the airline industry, there appear to be dramatic regional differences in techniques used both to value investments, and to estimate the cost of investment capital.

Finally, airline financial managers, like their counterparts in the general business community, often use subjective methods of estimating of cost of capital, in the absence of perfectly reliable methods of quantifying investor expectations whether through lack of historic data, or because historical returns are not considered reliable estimators of future expectations.

These findings suggest strongly that the models and constructs of classical finance theory have taken hold, especially CAPM & WACC for cost of capital estimation, and the cash-based NPV/IRR metrics for investment approval. At the same time, a firm foundation for the “science” of statistical expected-return estimation remains problematic even in developed markets, and may be even more problematic in the developing world’s markets.

# 4. Financial markets, airline ownership and investment analysis

The research thus far shows clear signs of progressive, though not rapid, adoption of investment valuation theory by financial managers in corporations, revealed by research performed largely in the United States. The classical theory of capital structure from Modigliani and Miller was published in 1958, while the three CAPM articles were written between 1962 and 1965. Mao (1970) found that these theories had largely not been adopted by practitioners. It wasn't until the end of the 1970s, 15-20 years after the classical theories, that they found wide application in the practice of investment analysis.

The research also reveals that the theories are in common use by airlines in advanced economies such as the U.S. and Europe, in spite of major theoretical and methodological pitfalls. The 39 large airline CFOs surveyed confirm preferences for NPV and IRR.

This chapter extends the research beyond the confines of the U.S. and Europe, and examines the relevance of purely classical financial theory to airline financial managers around the world. The theory is based in a western governance and equity financing model marked by three salient characteristics. The first is the presence of large quantities of publicly available financial market data facilitating estimation of the CAPM and WACC parameters. A second and related requirement is for broad and deep markets offering publicly traded financial instruments, to guarantee wide availability of the investment vehicles underlying the CAPM concept, to wit, risk-free interest-bearing securities and equity shares. Lastly, the theories best fit a capitalistic model with corporate governance based on separation of ownership and control: in this model of governance, a formal investment appraisal using classical finance techniques provides the economic justification for a given project to representatives of the widely-held firm's shareholders. One could add a fourth underlying characteristic, perhaps too often taken for granted in discussing airline financial management: the profit motive, and more specifically shareholder value creation by the company, are assumed to be the primary objectives for any firm adopting classical valuation techniques.

Each of these three characteristics underlying classical theory is examined in turn in this chapter, in order to identify gaps where the "pure" valuation theory popular in the west may not be applicable elsewhere in the world, and specifically in the airline industry. A bottom-up airline equity ownership study is performed and an airline governance typology is established for each of the world's aviation regions, and this typology is associated with investment analysis techniques identified through the airline CFO survey.

## 4.1. Investment returns and the information revolution

The most commonly used techniques for estimating the CAPM and WACC parameters use historical capital market data on share returns and interest rates. Increasing availability of reliable statistical data and news information concerning investment returns worldwide would support the adoption of classical financial theory, notably facilitating historically-driven cost of equity and WACC calculations.

The internet, with its public-domain financial news sites (e.g., Yahoo Finance, which reports beta values for listed companies) and file-sharing capabilities has spurred a huge expansion of information available to current and potential shareholders, in the form of annual reports, investor day presentations, business plans and the like. The airline industry has definitely followed this trend, having gone in some regions from one of the world's most financially secretive to a highly transparent business, driven by privatization and requirements following the listing of shares, but also by the hunger for capital in light of low profitability and the multi-billion dollar investment requirements of successive generations of jet aircraft. The private European majors, but also the "big three" PRC airlines (Air China, China Eastern, China Southern), government-owned companies such as Emirates, start-ups such as Gol and privately-controlled LAN Airlines in Latin America, are a few examples of airlines offering a wealth of financial data available for download. Even more striking for the depth of information were the aircraft acquisition prospectuses from Ryanair and easyJet cited in Chapter 1, and the successive, detailed business plans published by Alitalia on its website as the company faced bankruptcy and sought private investors in 2004 and 2005.

### 4.1.1. The definitive study: Triumph of the Optimists

The amount and regional scope of financial information available to practitioners and researchers, as well as further evidence of estimation pitfalls in applying financial theory, was brought to the fore in Dimson, Marsh and Staunton (2002), a book of 339 pages covering 101 years of returns to investors in sixteen countries around the world over the 20th century. That Dimson et al. were able to reconstruct these 101 years of returns is a testament to the increasing availability of financial information in advanced countries. Of interest to this research is its international coverage, as well as methodological questions regarding the usefulness of such information for cost of capital estimation.

### 4.1.2. Data scope and corrections for statistical biases

The primary significance of Dimson et al. for this research is the detailed discussion of possible biases in the historical record and attendant sampling methods, which may cause users to under- or over-estimate past returns. Secondarily, the authors speculate about the conundrum of using historical data to estimate future investors expectations, and suggest a method for adapting their research to classical financial theory.

Figure 4.1 illustrates demonstrate the scope of the research done by Dimson et al., showing nominal equity returns and standard deviations of markets in the 16 countries selected for research, over the century from 1900-2000. The blue columns are the average returns, measured on the left-hand scale, while the red thatched columns are the standard deviations of returns over the period, measured on the right-hand scale.

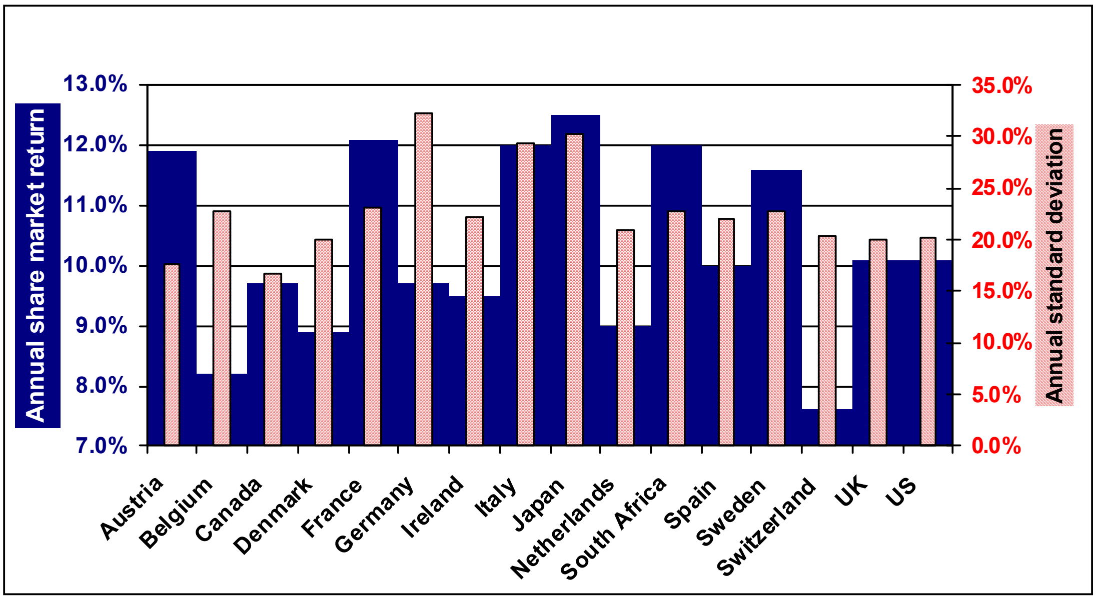



Figure 4.1: 101-year equity investor returns in 16 countries in Dimson et al. (2002)

In addition to equity returns, the authors explored government bill and bond returns. The investment returns studied are in fact precisely those needed for cost of equity estimates under CAPM and WACC. The authors measured both real and nominal returns using country-specific inflation rates. Each type of return was further calculated as both arithmetic and geometric average, and standard deviations were calculated for each one. Figure 4.1, for example, presents nominal, geometric average equity returns in each country over the 20th century, with the geometric returns reflecting 'buy-and-hold' investment strategies. Additionally, exchange rates were examined over the period, showing changes in real exchange rates and testing purchasing power parity along the way.

All of this makes for an unprecedented compendium of data, graphs and analysis, proof of the extraordinary access researchers have to information in today's world of global transport and communications. As their research proceeded, the authors identified and discussed methodological errors with earlier studies and providers, of which the best-known is Ibbotson, one of the providers studied in Bruner et al. (1998).

The most serious previous measurement errors corrected for by Dimson et al. were various types of sample bias present in simpler approaches that use changes in equity share prices, and bond yields, as proxies for returns in those markets. The authors attempted to capture total returns, including dividends and bond price changes, the goal being to "maximize the extent to which comparisons can be made across national boundaries."

The fundamental data element used to study equity returns was the market index for the country’s primary share markets. The most critical bias Dimson et al. identified in using this index, critiqued other studies for ignoring, and corrected for in their study, is survivorship bias, in which failed or de-listed companies are excluded from the sample because by definition, their security prices were not available at the time the index was launched. Ignoring the effect of such companies clearly places an upward bias on the returns calculated for any share market observed.

A second related bias is success bias. Companies selected for index membership are invariably among the largest and best-known in the market, creating another upward bias in historical return estimates. Both of these biases are caused by the methodological error of selecting the companies to be observed in hindsight, as members of a published index at the time the study is done, which are by definition survivors, and are usually quite successful blue-chip shares, large and successful enough to be included in the index in the first place.

Thirdly, the authors cite Roden (1983), who showed that commonly-used S&P and FTSE Actuaries All Share indexes use approximations of dividend *yields* rather than raw dividend data to calculate returns. The 101-year study of the U.K. and U.S. markets were entirely free from such errors, as Dimson et al. used share-market data "underpinned by scholarly research based on original stock-level price and dividend data", for example, the University of Chicago's Center for Research in Security Prices (CRSP) database and system, all of which are presumably corrected for survivorship bias (the authors do not say how), while at the same time using the broadest available index data to minimize success bias.

The authors are thus quite sure of the data quality for the U.S. and U.K. markets. Data for many other countries was not quite so easily available, particularly for the early part of the century, and Dimson et al. were forced to use published dividend yields (as opposed to actual monetary amounts divided by opening share prices) in combination with index returns, to calculate overall share returns for the country. The study contains a chapter discussing estimation issues for each of the 16 countries analysed.

The most serious potential bias, ever-present in economics research, is “easy-data” bias, the error of extrapolating based on the simple availability of data in one market, and generalizing the analysis to markets not studied. One could say that nearly all financial research (including this research) is subject to this, because the U.S. market tends to be used as a primary source of data for both academic and field research. This tendency reflects a sort of inherent success bias due to the size of U.S. markets, which according to Dimson et al., represented 46% of world stock market capitalization and 47% of world bond market value at the start of 2000. The next-largest stock and bond markets (both in Japan) represented 12.6% and 18.3% respectively. By its nature, the methodology of Dimson et al. to some extent escaped this particular bias, because each national market is studied irrespective of movements in other countries.

Easy data bias finds other reflections in the commercial sources cited and criticized by Dimson et al., including many related to the survivorship and success biases already discussed. These include the tendency to use more recent market returns, where data is easier to obtain and returns have been better than during the balance of the 20$^{th}$ century. The authors cite six commercial sources of data for the 16 countries studied, and calculate overestimates of annual equity returns on the part of these sources ranging from 0.3%/0.7% for the Japanese and U.S. markets, to highs of 8.5%/9.8% for Italy and Ireland respectively. From their perspective, the reason for these estimation errors is that the start date for the prior studies was 1978 for Italy, and 1988 for the Irish market, reflecting a period of relative prosperity and health of financial markets compared to the turbulent early- and mid-century.

Easy data bias is, according to the authors, evidenced by the avoidance of times when data are difficult to obtain, as for example during wartime. They cited the convenient choice of common post-war start dates in previous studies – U.K. 1918, Netherlands 1947, Germany 1952, Japan in 1971 – as examples of such bias.

To summarize the biases, the authors compared their research with the mid-century U.K. return study published by de Zoete and Gorton (1955). Dimson et al. suggest that de Zoete overestimated 1919-1954 returns in the U.K. by 3.49% compared with their own research. They concluded that in this particular case, survivorship biases led to the largest overestimate or returns (+1.57%), while the easy-data bias of excluding the First World War was (+1.12%) compared with their century-long study. Success bias was not explicitly cited by the authors, as it is difficult to separate from the other two. For the practitioner of investment valuation, a difference of nearly 3.5% in equity return estimates is significant and confounding.

### 4.1.3. Estimates of the equity risk premium

The portion of the research in Dimson et al. concerned with estimating the equity risk premium, the most problematic input to the CAPM calculation, is significant both for what is presented and for what is missing. The authors' ability to obtain data and calculate with precision what they considered to be reliable returns information from 16 advanced economies around world over 100 years demonstrates a world of market information available to practitioners. The underlying data (not made available by the authors) can be used for any of these countries to make history-based estimates of returns under CAPM. On the other hand, of course, the majority of the world's countries are excluded from the analysis, implying that in the world's most populous countries and key emerging markets such as Brazil and Russia, such market benchmarks are either unavailable or hidden from the researcher's eye, a serious drawback for practitioners in a global business such as air transport. This shortcoming comes in addition to the “bias” of assuming that public markets are the most reliable way to determine investment returns throughout the world, in issue discussed in Turner and Morrell (2003).

The authors calculate the equity risk premium in the following way:

$$Equity\_premium = \frac{(1 + equityreturn)}{(1 + riskfree\_rate)} - 1 \qquad 4.1$$

As is conventional, government debt returns were used as a proxy for the risk-free rate. Because it is a ratio of equity returns to government debt returns, this risk premium "has no obvious numeraire in terms of currency", and can be compared internationally without any regard to nominal vs. real rates of return or currency values. Dimson et al. calculated an average risk premium for each year in this way, and used these annual figures to calculate the arithmetic average premium over the century.

Their findings for the countries studied are in Figure 4.2, below, including the U.S. premium of 5.8% (geometric) or 7.7% (arithmetic), which can be compared with the range from 5.5% (CFO practice) to 7.2% (financial advisors) from Bruner et al. (1998), and the more recent 7.3% cited from Ibbotson (2000). Looking around the world, one notes relatively high risk premia among the protagonists (and particularly the losers) of World War II, which reflect the relatively high variance of returns experienced in those countries. Dimson et al. claimed that the existence of relatively high premia in many regions of the world argue against the survivorship and success bias claims often mentioned by analysts, who insist that risk premium estimate for U.S. and U.K. are too high. They also reminded the reader that at 5.8% and 4.8%, their estimates of the U.S. and U.K geometric average risk premia are "around 1.5% lower than those that have been reported in previous studies."

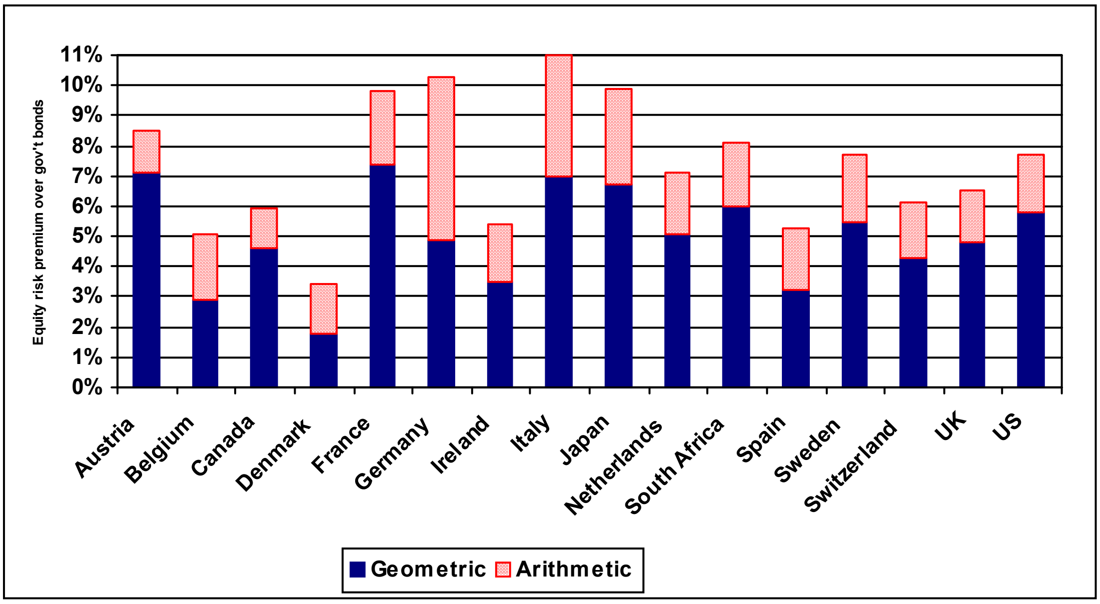



Figure 4.2: 101-year equity risk premia in 16 countries in Dimson et al. (2002)

Dimson et al.'s attempts to bridge the historical-expected gap in risk premium estimation took several forms. The first point made is that arithmetic risk premia are the best for forward-looking analysis, because they better reflect volatility (dispersion of returns over time), taking into account negative as well as positive individual-year returns during the period under study. An understanding of historical volatility allows the application of ex post probabilities to future estimates (while not escaping the historical vs. expected return dilemma). The impact of differing measurement methods can readily be seen looking at the red-shaded arithmetic means in Figure 4.2, where the defeated countries in World War II show far higher arithmetic risk premia than the other 13 countries.

The authors recognized that statistically speaking, using this ex post data for future estimates is not particularly reliable, even using 101 years of returns. The Standard Errors of the historic risk premium range from 1.7% to 3.5% worldwide. Taking the example of the U.S., the authors are only two thirds confident that the true premium is 7.7% ± 2%, again casting doubt on the usefulness of historical data.

Dimson et al.'s discussion of bases to estimate forward-looking risk premia is summarized in Figure 4.3.

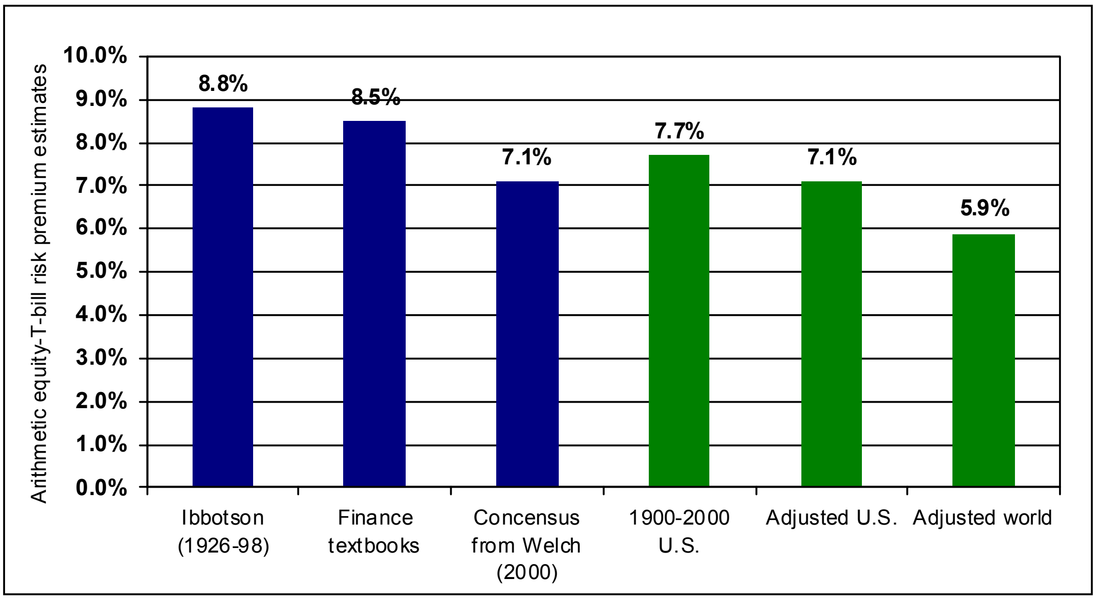



Figure 4.3: Estimates of future risk premia in Dimson et al. (2002)

The first three columns represent Ibbotson's analysis of U.S. market data from 1926-1998, yielding an 8.8% equity risk premium over bills. Ibbotson is widely considered as a benchmark for such estimates. Finance textbook recommendation of 8.5% is stated next. As the authors point out, Ibbotson's research and widely-published recommendations in textbooks are highly influential "from the classroom, to the boardroom, to the dealing room, to the courtroom." Finally, the authors discuss the forecasts in Welch (2000), obtained by surveying 226 financial economists. The consensus found by Welch suggests to the authors that the survey and textbook estimates may be too high, by 1.4% to 1.7%.

With these estimates and benchmarks as background, the authors begin their own estimation of future risk premia with the 7.7% U.S. arithmetic premium depicted in Figure 4.2. They adjust this historic risk premium by triangulation:

historic U.S. share returns depicted in Figure 4.1 demonstrated a standard deviation of 20% over the 20th century. The authors set the *expected* volatility of returns at 16%, substantially lower than the historic volatility of any individual market. Not surprisingly, they arrived at estimates lower than the historic risk premia for all countries (7.1% for the U.S.): what is a bit disappointing is the alacrity with which the authors assumed lower market volatility than in the past, without seeming to justify their decision to do so. Presumably they are basing the 16% on more recent share market data, but they declined to state with any precision the basis of their volatility estimate, mentioning simply "current projections of early 21st century volatility." One wonders whether these volatility projections might not be slightly higher in the midst of the current financial crisis.

The final method and estimate proposed by Dimson et al. was qualitative. Beginning with the observation that risk premia from 1950-2000 were far higher than those in the preceding 50 years because of booming share markets, they posited two secular, fundamental factors which call for downward adjustments of the historic record.

The first was for productivity increases and relative calm of the post-WWII period, for which dividend growth was used as a proxy. The second was for an accompanying fall in required risk premium, measured by the authors as an increase in the share price / dividend ratio (the reciprocal of the dividend yield). In the U.K., for example, this ratio has increased from 23 in 1901 to 42 a century later, presumably reflecting expectations of higher growth, as well as more appetite for risk and hence, a lower premium. The U.S. T-bill premium thus falls from the historic 5.8% to 4.1%, while the U.K. equivalent drops from 4.8% to 2.4%, reaching an intermediate 3.0% for world equity markets. Reading this section of Dimson et al., one is tempted to conclude that with the proper set of assumptions, nearly any projected figure could be reached, which would leading to questions of incentives and agency conflicts of interest, problems addressed later in this research.

The exhaustive nature of Dimson et al. is an example of the plethora of financial information available today. Their work shows the usefulness and highlights remaining pitfalls in light of this wealth of data available, and does in addition highlight the lack of visibility into many emerging economies which will lead aviation growth in the 21st century.

The authors' approach was rigorous, and fully consistent with financial theory, and yet firm results are elusive. This is certainly not stopping the ever-increasing flow of information. Leading information provider Morgan Stanley Capital International (MSCI), now MSCI-Barra after the tie-up with Barra is now producing market returns data for 67 countries - 22 advanced economies with data dating from 1970 and 45 emerging economies beginning in 1988 - using well-defined methodologies, similar to those used by Dimson et al.

| Developed markets indices | Emerging markets indices | |
|---|---|---|
| AUSTRALIA | ARGENTINA | MAURITIUS |
| AUSTRIA | BAHRAIN | MEXICO |
| BELGIUM | BRAZIL | MOROCCO |
| DENMARK | BULGARIA | NIGERIA |
| FINLAND | CHILE | OMAN |
| FRANCE | CHINA | PERU |
| GERMANY | COLOMBIA | PHILIPPINES |
| GREECE | CROATIA | POLAND |
| HONG KONG | CZECH REPUBLIC | QATAR |
| IRELAND | EGYPT | ROMANIA |
| ITALY | ESTONIA | RUSSIA |
| JAPAN | HUNGARY | SERBIA |
| NETHERLANDS | INDIA | SLOVENIA |
| NEW ZEALAND | INDONESIA | SOUTH AFRICA |
| NORWAY | ISRAEL | SRI LANKA |
| PORTUGAL | JORDAN | TAIWAN |
| SINGAPORE | KAZAKHSTAN | THAILAND |
| SPAIN | KENYA | TUNISIA |
| SWEDEN | KOREA | TURKEY |
| SWITZERLAND | KUWAIT | UKRAINE |
| UNITED KINGDOM | LEBANON | UNITED ARAB EMIRATES |
| | LITHUANIA | VIETNAM |
| | MALAYSIA | |

Table 4.1: List of countries covered by MSCI indexes

These data are market rather than company-specific, and so are insufficient in themselves to estimate company beta and cost of capital. Still, they represent benchmark market returns that can be helpful to managers in understanding investor returns from a historical perspective. Many other analysts, including Barra, but also Erb, Harvey and Viskanta (beginning in 1995 & 1996), are building estimates for "country betas" based on this data and classical methodologies, which are in turn integrated into information services such as Bloomberg, one of the providers discussed in Turner and Morrell (2003).

A selection of airline WACCs provided by Bloomberg in May of 2007 is presented in Table 4.2.

| May 2007 Airline WACC | | | | |
|---|---|---|---|---|
| Airline | Cost of equity | Cost of Debt | Debt ratio | WACC |
| Iberia | 9.66% | 5.30% | 26.83% | 8.49% |
| BA | 9.36% | 7.34% | 36.94% | 8.61% |
| easyJet | 9.69% | 5.12% | 14.50% | 9.03% |
| Ryanair | 8.85% | 5.19% | 17.40% | 8.21% |
| Air France-KLM | 9.30% | 4.89% | 51.79% | 7.02% |
| Lufthansa | 9.01% | 3.65% | 23.79% | 7.73% |
| Alitalia | 8.73% | 5.81% | 59.79% | 6.98% |
| GOL | 12.35% | 4.50% | 9.91% | 11.57% |
| LAN Airlines | 12.05% | 5.36% | 25.42% | 10.35% |
| China Eastern | 11.21% | 5.06% | 89.62% | 5.70% |
| China Southern | 10.69% | 3.19% | 78.02% | 4.84% |
| Air Asia | 12.39% | 3.39% | 23.03% | 10.32% |
| Qantas | 9.59% | 4.77% | 49.95% | 7.18% |
| Singapore Airlines | 9.61% | 3.11% | 10.18% | 8.95% |
| Southwest | 9.04% | 3.38% | 12.78% | 8.32% |
| American Airlines | 12.80% | 3.45% | 63.53% | 6.86% |

Table 4.2: Bloomberg sample cost of capital estimates for world airlines, May 9, 2007

These estimates reveal some of the major pitfalls of the WACC approach, most notably, the reduced cost of capital resulting from high levels of debt (Alitalia, the Chinese majors), a problem still largely without a quantitative solution in financial theory. Also, these estimates are only available for companies with listed shares, an issue for airline analysis elucidated in the next section. Finally, the news service uses market values for equity (market cap), while debt values are derived from balance sheets for companies without outstanding bonds. Still, they are available at a mouse click to paid subscribers to the relevant services, and are clearly in use around the world[8]. The information revolution is clearly removing the structural impediments to calculating returns and cost of capital around the world. Though the necessary information is not available for all markets of the world, it is increasingly so. The methodological difficulties of estimating risk premia and equity raised in Chapter 3 were confirmed in the most recent comprehensive research. Notwithstanding, a lack of financial market information is certainly not itself a block to adopting classical financial techniques around the world.

[8] These data were kindly provided by Airbus, which is a subscriber to the service

## 4.2. Airline ownership and financing patterns

The second premise of classical financial theory is widely-held shareholding, which implies a strong separation of ownership and control. In this section the constraints to equity capital flows in airline financial regulations are examined, and the shareholding patterns found in airlines around the world are identified, resulting in a governance typology for the aviation sector. The propensity of the different governance types to use classical financial techniques is identified, using the results of the airline CFO survey from this research.

### 4.2.1. Political and legal restrictions to capital flows

Deregulation of airline markets – in the sense of allowing free choice of which air services to offer and liberalized fare-setting - has been gathered pace since it began in the U.S. with the Airline Deregulation Act in 1978. Williams (2002) traced the evolution of market deregulations, finding that Canada, China, Taiwan, and Chile deregulated domestic markets during the 1980s, followed by another 20 countries in the 1990s. The results of this deregulation have been spectacular growth in capacity offered in countries such as China, Taiwan, Chile, Turkey, and Thailand, while growth was more modest in the USA, and negative in Canada and Venezuela, owing to airline failures in those countries. Williams also showed that the impact on number of routes operated has been far less uniformly positive, as 17 out of the 30 countries studied operated fewer routes in 2000 than in 1989, reflecting closure of unprofitable routes and the rise of the hub and spoke system of operations. On the other hand, emerging market countries such as Turkey and China showed increases around 150% in routes operated.

Concerning international services, Williams found that both seats-offered and routes-operated growth has been more uniformly positive since 1989: all thirty countries studied increased seat capacity between 112% and 585%, while route growth ranged from 93% to 400%, in spite of the fact that most international markets remain governed by restrictive treaties among International Civil Aviation Organization (ICAO) member states.

Under the near-universal interpretation of the ICAO Conference in 1944 (commonly known as the Chicago Convention after the host city), which established the legal framework for establishing international airline services, airlines must be "substantially owned and effectively controlled" by nationals of the country in which they are based, in order to benefit from the bilateral Air Service Agreements (ASAs) negotiated between countries.

The framework of these agreements is embodied in the "Five Freedoms" of international operations, defined as part of the Chicago accords. Each succeeding "freedom" grants a nation the following cumulative rights:

1) to fly over the territory of a foreign nation
2) to land on the territory of a foreign nation for refuelling or repairs
3) to unload passengers and cargo in a foreign nation
4) to load passengers and cargo in a foreign nation for travel to the home nation
5) to carry passengers and cargo from one foreign nation to another, given a route origination or destination in the home country

To this original list three more have been added:

6) carry passengers and cargo between foreign countries by connecting in the home country
7) carry passengers and cargo between two foreign countries, without connecting in the home country
8) carry passengers and cargo wholly within a foreign country

The eighth Freedom, known commonly as cabotage, is extremely rare in practice, though the 2008 services agreement between the U.S. and the European Union does grant U.S. carriers the right to transport passengers within the European Union. European airlines certainly hope that the E.U. transport officials will achieve similar treatment within the U.S., in the next round of negotiations.

Within this framework, the ASAs simultaneously open and restrict operations between countries, specifying routes, designating carriers and their allowed capacity, and tariffs in more or less restrictive forms, calling either for each state to approve fares, or for both states to disapprove them.

The complex web of bilateral agreements worldwide severely restricts airline opportunities to grow and generate cash flows for their projects. The ownership and effective control provision is often interpreted as the requirement that 50% or more of voting shares be held by nationals of the home country. This restriction alone creates a substantial barrier to free flow of capital among the world's airline finance markets. In addition, many national governments place further legal limits on foreign shareholdings of airlines. Chang and Williams (2001 and 2004) analyse the reasons for this, the difficulties it poses, and evolution and potential for further change. Chang and Williams (2004) present an extensive list of ownership restrictions in effect reproduced in Table 4.3, below.

| Country | Maximum percent foreign ownership |
|---|---|
| Australia | 49% for international airlines<br>100% for domestic airlines |
| Brazil | 20% of voting equity |
| Canada | 25% of voting equity |
| Chile | No limitation |
| China | 35% |
| Colombia | 40% |
| India | 26% for Air India<br>40% for domestic carriers |
| Israel | 34% |
| Japan | 33.33% |
| Kenya | 49% |
| South Korea | 50% |
| Malaysia | 49%, 20% for any single foreign entity |
| Mauritius | 40% |
| New Zealand | 49% for international airlines<br>100% for domestic airlines |
| Peru | 49% |
| Philippines | 40% |
| Singapore | None |
| Taiwan | 33.33% |
| Thailand | 30% |
| U.S. | 25% of voting equity |

Table 4.3: National airline equity ownership restrictions in Chang and Williams (2004)

One example of the potential effect of ASA restrictions can be seen in the 49% foreign investment limitation on international airlines in effect in Australia and New Zealand, where by contrast, purely domestic airlines have no restrictions to ownership. Many of the most restrictive laws are seen in countries such as the U.S., Canada, and Japan, where capital markets are highly developed. Airlines in these countries have extensive access public equity markets, and may and do use classical financial theory to establish the viability of investments. Morrell (2007) indicated that 41 of the top-150 revenue airlines had listed shares, and that the market appetite for airline Initial Public Offerings has been substantial in the most recent decade, with 13 airlines – most using low-fare business models – had successfully offered shares in no less than 12 different share markets around the world.

The regulation and restrictions of share ownership in airlines around the world do not themselves constitute an obstacle to listing shares, or to using classical valuation techniques to justify investments to Boards of Directors representing holders of listed shares. They can however prevent airline companies from fully benefiting from the depth and size of more advanced share markets to finance their growth and investments.

Chang and Williams (2001) reviewed several cases on international investments in airlines, discussing the benefits and opportunities, as well as the risks and dangers of opening airline capital internationally. An update of these cases since the dramatic events of 2001 reveals more the latter than the former, showing how the effective control provisions can hinder the effective management of international airlines. The authors cite the adventures of SAir Group with a 49.5% stake in Sabena, and 20% in TAP Air Portugal, to which were added minority shares in Air Outre Mer (AOM), Air Littoral, Air Liberté (through AOM), LOT, and South African Airways. One very plausible line of argument is that the over-extension and eventual collapse of SAir Group in 2001 was largely caused by the inability of the minority shareholder to manage these companies as part of a clear overall strategy to gain access to markets, notably on a European level. An irony of the SAir saga is that were Switzerland part of the E.U., absolute majority ownership stakes in foreign airlines would be largely permissible under today's evolving ASA agreements at E.U. level, as has been see with the acquisition of 100% of British Midland by Lufthansa, as well as its takeover of Austrian Airways and of Swiss. One failed minority venture was the 25% stake that British Airways held in U.S. Airways the 1990s, subsequently written off by the British carrier. A similar ongoing struggle by a British company to enter the U.S. air transport market is the ongoing Virgin U.S. saga, with its 25% share regularly challenged by competitors and U.S. regulatory authorities. Another current example of muddled management control with a minority share is the 49% stake of SAS in Spanair, which has for several years faced the prospect of bankruptcy, a situation now exacerbated by the crash on take-off of a MD-80 in Madrid in the fall of 2008 under questionable safety procedures. More successful was BA’s 25% stake in Qantas, which allowed the two companies to strengthen their alliance and co-operate in systems development, before BA sold the share.

Even holding majority shares of foreign airlines or outright mergers is no guarantee of success, as witnessed by the meltdown of the very confusing Air New Zealand / Ansett Australia merger in the wake of the 2001-2003 airline recession, resulting in the renationalization of ANZ and the outright demise of Ansett in 2002. Several of the partial acquisitions cited by Chang and Williams and updated above were allowed by the national governments to improve the market prospects of national carriers (Sabena, LOT, the French regionals) or simply to allow domestic airlines access to international capital.

Although not directly related to this research, it should be noted that the most serious economic disadvantage of the current ASA system is the structural impediment to international consolidation, contributing to the lack of economic rationalisation which negatively impacts industry profitability. Airlines have resorted to forming Alliance groupings – usually without equity participations – to compete globally, offer travellers a more seamless alternative to the old IATA interlining system, improve procurement conditions with suppliers, and rationalize maintenance operations. Across the North Atlantic, anti-trust immunity is routinely sought by Alliance groupings who seek to go a step further, fully coordinating the carriers' schedules. These moves do little or nothing to improve the member carriers' access to capital markets.

Europe has gone furthest to eliminate such structural impediments among E.U. member states, creating a very dynamic environment where consolidation has become a reality, and where new carriers can obtain capital in various European share markets. Of the 12 national equity markets tapped for IPOs and cited by Morrell (2007), half are in Europe, and all but two (London, Warsaw) took place in the Euro area.

Chang and Williams (2001) argued that one of the strongest impetuses to the 1990s wave of minority stake acquisitions was the objective of obtaining access to air travel markets in neighbouring countries, citing moves in this direction by British Airways, KLM, Lufthansa, and SAS. The first major-airline successor these somewhat tentative movements on a European scale was brought about with the groundbreaking Air France-KLM merger of 2004. This carefully-worded merger bridged the way to today's more liberal environment, leaving majority voting control for KLM in the hands of Dutch shareholders while creating a combined holding company which holds the "economic rights" to the KLM's cash flows. This merger has led the way to many other such proposed and consummated groupings, including the Austrian Airways and British Midland acquisitions cited above, as well as the ongoing saga of a perspective merger between British Airways and Iberia. The 2008 Air Services Agreement between the U.S. and the European Union (E.U.) reinforced the notion of a European carrier, effectively granting any E.U. carriers "unrestricted" access to landing rights – though not cabotage – in the U.S. The successful Air France-KLM tie-up and the new precedent-setting ASA between the E.U. and the U.S. have opened the door to more straightforward international mergers within the E.U., although in the spring of 2010, the Russian authorities challenged the landing rights of Austrian Airlines based on the Russia-Austria bilateral, “violated” by Lufthansa’s outright ownership of Austrian.

Chang and Williams (2004) reviewed and discussed recent international agreements that may reduce the ownership requirements, if adopted in future ASAs between countries or regions. They began by reviewing the fundamentals of the many "Open Skies" agreements signed following the 1992 U.S. Open Skies initiative adopted by the U.S. Department of Transport: 20 "Open Skies" agreements were signed with European countries (one notes the conspicuous absence of the U.K., which long remained an effective duopoly), 12 in Africa, 13 in Latin America, 8 in the Middle East, though only 6 in the vast and fast-growing Asia-Pacific region. These agreements principally eliminate the former restrictions on capacity (seats), flight frequency and route operating rights, while leaving entirely intact the principle of "effective ownership and control" of the respective airlines, and refusing any form of cabotage on U.S. soil. One reason for this somewhat peculiar protectionism in the U.S. is the requirement that airlines provide capacity for military purposes during both peace and wartime: under this logic, foreign-owned airlines could not necessarily be relied on to perform this function. The authors stated flatly that the Open Skies policy was intended to divide Europe, and indeed, only sixteen year later in 2008 was this policy revised regarding European airlines.

The authors also examined significant progress made outside the large and contentious North Atlantic and U.S. markets. The ICAO Worldwide Air Transport Conference of 2003 produced a suggested "model" airline designation clause for future ASAs, which separates the notion of ownership from that of effective control. ICAO retained a strict definition of regulatory control (as opposed to management control), particularly regarding Safety and Security, its traditional purview. Rather than ownership, on the other hand, the suggested clause is that the airline "has its principal place of business (and permanent residence) in the territory of the designating [country]." A footnote defining criteria for "principal place of business" includes local incorporation, base of operations and capital investment in facilities, tax, aircraft registration, and employment of nationals. In this definition, capital could flow internationally as it can in other businesses. The Organization of Economic Co-operation and Development (OECD) "all-cargo" proposal of 2002 took a similar approach, as did the 2001 Agreement within the Asia Pacific Economic Council (APEC), where Brunei, Chile, New Zealand, Singapore and the U.S. agreed to strike the ownership provision among carriers in these five states. These agreements are limited in scope, and to date, a level playing field for airline access to capital has yet to be achieved.

Clearly, progress is being made to grant airlines more liberal access to capital they need to develop their businesses, but the impediments identified by

ICAO in 2001, and cited in Chang and Williams (2004), will be difficult to completely overcome. Using a points scale, the member states were asked the reasons for imposing national ownership and control (note that they ownership and control were not separated). In descending order, the most significant reasons given were:

| Order | Issue | Points |
|---|---|---|
| 1 | National development/economic interests | 107 |
| 2 | Conformity with international agreements | 103 |
| 3 | Economic interests of national airlines | 88 |
| 4 | Trade and tourism needs | 82 |
| 5 | Aviation safety | 81 |
| 6 | Job creation and preservation | 74 |
| 7 | National security | 58 |
| 8 | Foreign exchange earnings | 46 |

Table 4.4: Reasons cited for imposing national ownership regulations in Chang & Williams (2004)

The priorities and the nature of items in the list demonstrate the tangle of interests in the world's airlines, and the difficulty of finding solutions which satisfy all. Items one, four, and six are standard arguments advanced by developing countries, and go along way to explain why each country in the world has at least one airline. Since 2001, several national governments have chosen to dissociate the national carrier from economic development: Kuwait's creation of competitors to Kuwait Airways (Jazeera, Wataniya), the creation of AirAsia with substantial funding from the Persian Gulf, GOL's creation and listing on the NYSE and eventual acquisition of Varig, are examples of political and economic development without protection of the “national champion” airline.

The second item points up the self-perpetuating nature of capital restrictions, which are held to be necessary in light of current ASAs: it would take at least one complete "generation" of ASAs around the world to remove this item from the list.

The third reason given is outright protectionism of the kind highly disfavoured under World Trade Organization multi-lateral accords as well as many and bilateral "most-favoured-nation" trade agreements. Item seven is the standard argument in the U.S., and is not without a certain legitimacy in a world where wars can and do break out suddenly (the allied bombing of Serbia, 9/11 and subsequent wars in Afghanistan and Iraq). I

Item five is probably the most legitimate concern of all, fully addressed in ICAO's suggested new ASA clause, as well as in the OECD and APEC agreements cited by Chang and Williams.

In contrast to the dubious third and fourth economic arguments, item eight is a powerful economic argument for mandating national ownership of airlines: indeed, the cash flows from international traffic accrue directly to the national carrier and hence the home country's reserves. It is certainly relevant in countries such as Egypt (for example), which are net importers of food and clothing and highly dependent on in-bound tourist revenue. Then again, the Egyptian government is showing an increasing willingness to allow third-party airline start-ups such as Air Cairo to compete with the national carrier. As in Kuwait and Brazil, this tolerance implies a policy-maker calculation that the on-the ground expenditure of the marginal inbound traffic created by new carriers is more important than the foreign-exchange revenue lost by EgyptAir for these same travellers.

The inevitable inertia created by a web of bilateral agreements, confusion of economic interests, national security and aviation safety concerns combine to create a unique set of legal and financial gymnastics required to reduce severe impediments to smooth international capital flows to airlines. In this rigid context, airlines in countries with broad and deep financial markets and widely-held shares are expected to more carefully follow capital budgeting procedures consistent with financial theory to justify investments, while countries without such markets certainly display more diverse approaches to the question of economic justification. In practice, given the global nature of the business, this research identifies substantial diversity in airline shareholding from one region to the next.

### 4.2.2. International financial markets and financing opportunities

Recent studies in the financial literature raise questions about the use of classical financial analysis techniques in less-developed regions of the world. Both the governance models of emerging markets and the financing patterns and opportunities are held to influence the investment decisions of companies in these markets.

Pinches and Lander (1997) suggested that the whole question of appropriate capital budgeting techniques should be re-opened when looking at "newly industrialised and developing countries" such as South Korea, Taiwan, Singapore, and India. The authors conducted thirty formal interviews with company managers, as well as informal interviews with "government officials, development officials, and professors knowledgeable and interested in capital budgeting."

They found that NPV is not used by the companies, although the managers interviewed are familiar with the technique. Rather, they appear to prefer PBK and ARR to NPV, citing the difficulties in the process of estimating cash flows as a primary source of concern with NPV.

In addition to methodological concerns, the authors identified four broad reasons for the rejection of NPV

- Firms are pursuing strategic goals such as seizing "now-or-never opportunities," building market share, or substituting capital for labour override preclude a purely financial evaluation, and this in markets which are higher-growth and more volatile than more mature markets such as the U.S.;
- Government incentives for investments, such as tax credits, cheap financing, and land grants can override market-driven economics;
- Banks are very influential in the decision to invest or not, and commonly "the initial standards used by firms in all these countries were dictated by the banks";
- Company founders tend to make decisions more intuitively, relying less on formal analysis and quantification of results, and are less risk-averse than professional managers.

The authors suggested that in these markets, more dynamic methods of investment appraisal such as Monte Carlo and Real Options Analysis are appropriate tools than 'static NPV.'

These business practices suggest that the appropriate investment appraisal techniques in these markets are very much subject to governance questions such as government and bank influence, as well as the ownership of the company and the attitudes of company founders and managers pursuing long-term strategic goals, overriding rigorous financial analysis. In countries where the ownership of companies is widely held, such governance questions are addressed in financial terms by properly estimating the cost of capital.

The work of Booth et al. (2001) also suggests that financing patterns in developing countries may influence the way firms analyse investments. They investigate capital structures in ten developing countries for clues as to why this might be so, and discover major differences from developed countries. In developing Asian countries such as India, Malaysia and Pakistan, companies rely much more on short-term debt than in developed countries, including South Korea, the U.K. and the U.S.

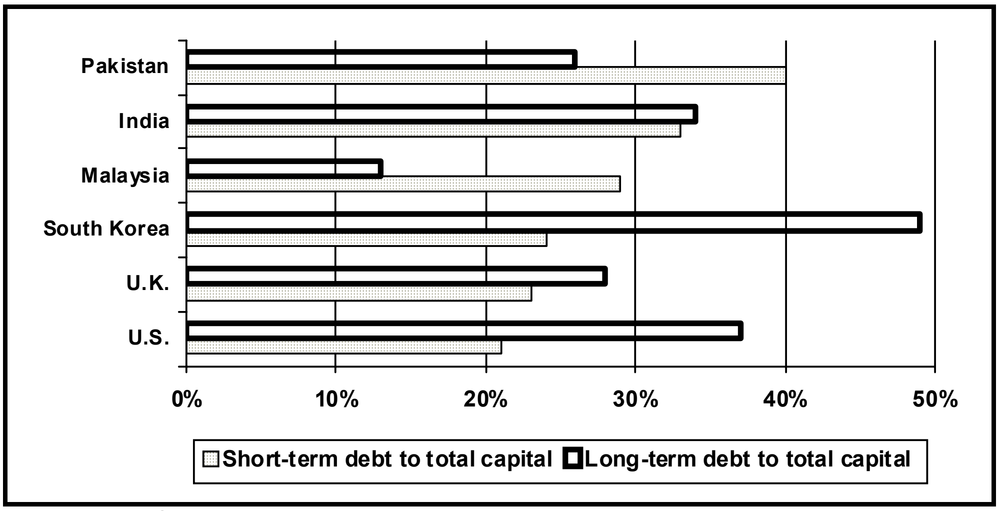



Figure 4.4: Short- and long-term debt in company capital structures in Booth et al., 2001

Figure 4.4 shows the emerging-markets in the same region as Pinches and Lander study, for comparison: Booth et al. find that in countries such as Mexico and Brazil, the reliance on short-term borrowing is even more pronounced. While this difference does not in itself prove that WACC is not a valid measure of the company's cost of capital, it does point up the possibility that financing arrangements can significantly alter their investment valuations. Under WACC, the debt in the capital structure is long-term debt, used to finance long-term investment projects. If firms cannot or do not raise significant long-term borrowing, WACC may well be considered an inappropriate measure of the firm's true cost of capital.

LaPorta et al. (1999) observed the 20 largest firms in each of 27 'wealthy' countries, and group ownership structures into three broad categories, widely held (traded on bourses), Family controlled, and State controlled. Looking (for comparison to the other studies surveyed) at countries in Asia, broad differences in control, defined as a minimum 20% shareholding by one group, are found.

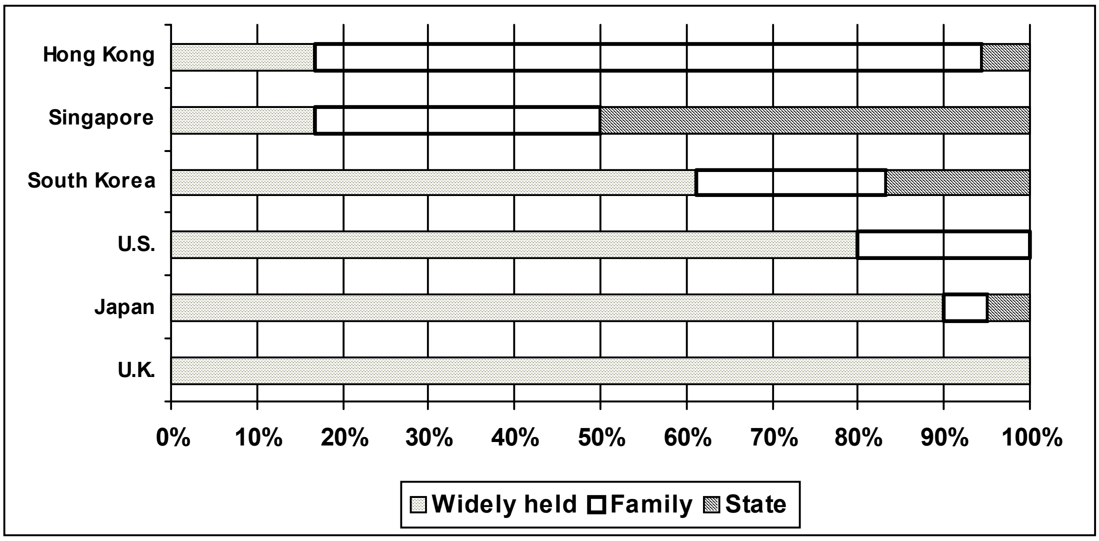


Figure 4.5: Company ownership structures in LaPorta et al., 1999

While in the U.K., the U.S. and Japan broad share ownership is the rule, families control significant numbers of large companies in Hong Kong, Singapore, South Korea and the U.S. Pinches and Lander found that founder-controlled firms use more intuitive techniques to evaluate investments, and are less averse to risk than professional managers.

LaPorta et al. found a significant positive relationship between the number of widely held firms and the level of minority shareholder protection under the legal systems of the various countries.

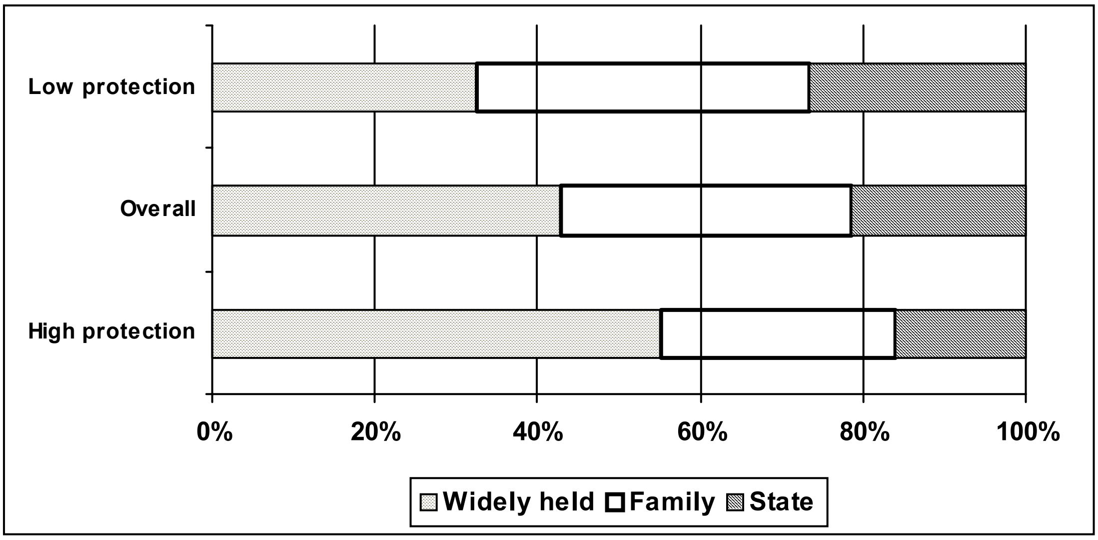


Figure 4.6: Company ownership structures in LaPorta et al., 1999

The authors found a pattern of family and state ownership in countries where small shareholders are not well-protected (including Hong Kong and Singapore), and a majority of firms widely held in countries where minority shareholder protection is strong.

Both of these studies raise substantial questions about the use of classical financial analysis techniques in emerging markets. In the next section, governance patterns that may strongly influence the investment analysis process are identified for the world's airlines.

Against this backdrop of the unique regulatory restrictions faced by airlines, as well as substantial difference in financial market practice and governance patterns around the world, the research now examines in detail the ownership patterns found in the world's major airline companies.

### 4.2.3. Regional patterns of airline shareholding

Gibson and Morrell (2005) compared the shareholding pattern found among 149 international airlines cited in the 2001 Airline Business Alliance Survey - hereafter AB (2001) - with the respondents to our survey of airline capital budgeting techniques. This annual survey is one of the few trade publications where one can find consistent and relatively comprehensive information about the shareholding of international airlines. The authors identified the largest shareholder in each company, and totalled each category to compare with our Airline CFO survey respondents, who were asked to identify "the largest shareholder in the company."

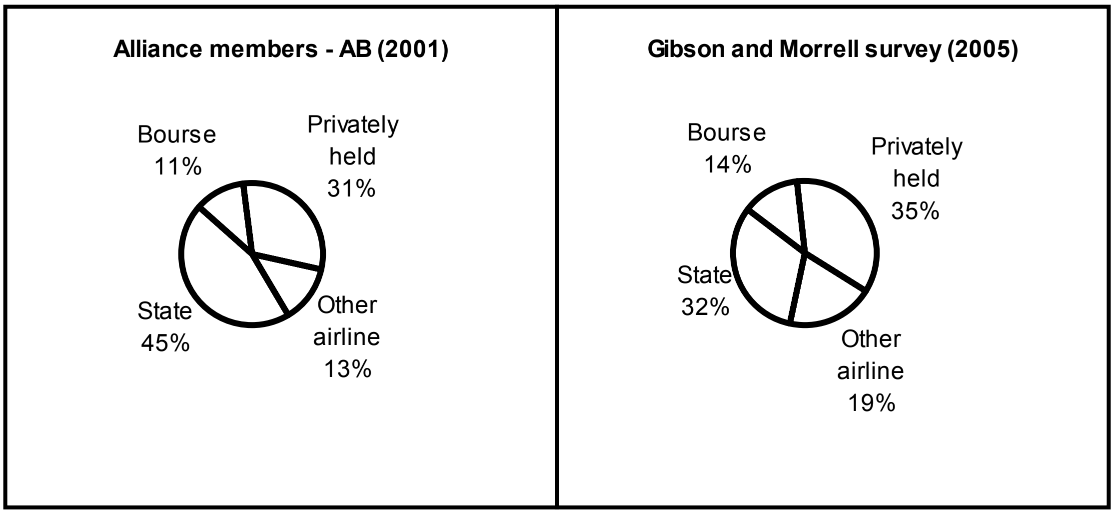



Figure 4.7: Majority ownership of the world's airline alliance members (left), and airline survey (right) in Gibson and Morrell (2005)

There were marked differences between the two samples, at least partially reflecting the fact that 54% of survey respondents were European airlines. Respondents were substantially more frequently in private hands, 32% only had the state as the largest shareholder, compared to the AB (2001) sample which was 45% state-owned. Relative to AB 2001, the private shareholding of our respondents was rather evenly spread among the categories: +3% were held in the form of publicly traded shares ("Bourse" in the article), +4%

privately held (aka closely held), +6% majority owned. That is, the shape of the pie-chart in Figure 4.7 is not dramatically different from AB (2001): our airline respondents were more private, but the pattern is roughly similar to the broader AB (2001) sample.

This research now examines in substantially greater detail the airline population, using the following definitions:

- **Listed company** – widely traded on a public stock exchange
- **Governments** – held by national, regional or municipal authorities
- **Other airline** – held by another airline or airline group
- **Closely held** – held by private investors
- **Institutional investors** – held by financial institutions, broadly defined
- **Management** – held by employees or managers of the company

The sources of the data used are the Reed Air Transport Intelligence online service, Airline Business, Air Transport World, and Flight International.

The sources of the airline ownership data are diverse and somewhat anecdotal. Precise shareholder information is considered confidential in many countries, making disclosure uneven and in many cases fragmented among the different sources. Similarly, significant shareholdings can also exist even when shares are listed, with sometimes patchy reporting of such blocks of shares in ATI. Finally, the nature of private investors with large stakes can be masked by a corporate identity of the investor which does not indicate the extent or nature of the investor's role in the management of the company and hence, its role in capital budgeting. In spite of these difficulties, this research argues that clarity on the nature of the shareholding and associated governance bodies is useful to understand and predict how airlines will approach fleet and investment planning processes.

The airlines included in this analysis are the largest 200 passenger airlines in the world in 2007, measured by Revenue Passenger Kilometers (RPK), as well as the largest 150 in terms of Revenue in 2007, which adds to the sample cargo operators such as Fed Ex, UPS, DHL and others. Added to this are the airlines analysed in the sample from AB (2001) and not part of the 200/150 largest airline group: they were included in AB 2001 because they are Alliance members, regardless of size. The airline data compiled in this research is presented in Appendix B.

Capacity and financial performance is measured over the five-year period from 2004 – 2008. The data source for the airline capacity, revenue and profit figures is the annual Airline Business survey, published in August of each year. Eliminated from the sample were the nine airlines for which no reliable shareholding data was available from ATI, Airline Business' 2007 Alliance survey, or a web search by the author.

The resulting sample of 249 airlines covers all regions of the world, allowing the linking of ownership with performance data in terms of production (passengers, RPK), capacity (fleet size) and financial performance (revenue, profits) for those airlines included in the annual Airline Business surveys. Regionally, Europe has the largest number of airlines in this group (97), followed by Asia-Pacific with 61 and North America with 55. Twenty Middle-Eastern airlines are within the group, 13 from Latin America, while only three African airlines are large enough to be in the sample.

The results of this analysis are summarized in aggregate, and the specific characteristics of each group are then discussed. Table 4.5 below summarizes the results for each region, showing the percentage of airlines having each shareholder type as the largest single group.

| Largest shareholder type, 2009 | Africa | Asia-Pacific | Europe | Middle East | North America | South America | Totals |
|---|---|---|---|---|---|---|---|
| **Listed** | 33% | 13% | 14% | 5% | **44%** | 8% | 20% |
| **Government** | **67%** | **33%** | 23% | **85%** | 2% | 0% | 25% |
| **Other airline** | 0% | 21% | 22% | 0% | 25% | 31% | 21% |
| **Closely held** | 0% | 31% | **32%** | 5% | 24% | **62%** | 29% |
| **Institutionals** | 0% | 2% | 8% | 5% | 5% | 0% | 5% |
| **Management** | 0% | 0% | 1% | 0% | 0% | 0% | 0% |
| Totals | 100% | 100% | 100% | 100% | 100% | 100% | 100% |
| Number of airlines | 3 | 61 | 97 | 20 | 55 | 13 | 249 |

Table 4.5: Majority ownership of 249 large airlines in 2009, by region

In total, the results show wide diversity of airline shareholder types around the world, as well as consistency with the respondents in Gibson and Morrell (2005). The main divergence from the CFO survey is that the Government-owned group is smaller (25% vs. 32%), while the Listed-share group is six percentage points greater. The other categories are largely consistent with the earlier study, keeping in mind that an "institutional" group is added to the current analysis, which must be added to "Closely held" to compare with Gibson and Morrell (2005).

Looking at regional ownership patterns Africa and particularly the Middle East show a strong propensity to government ownership of the largest share of equity. Asia-Pacific has a more muted – but still relative majority - propensity to government ownership, with diverse types of private shareholding and relatively few listed companies. On the other hand, North America has no government-owned airlines: 44% of airlines are listed, with a near-equal 25/24% of companies captive subsidiaries of other airlines or held by individual investors. South American carriers tend to be closely held, mostly by private investors but also by other airlines.

The differences in shareholding pattern among the regions are more sharply drawn when a measure of capacity is used to distinguish among the groups, especially when a distance-weighted production indicator such as Revenue Passenger Kilometres (RPK) is used, as in Table 4.6.

| Largest shareholder and RPK distribution, 2004-2008 | Africa | Asia-Pacific | Europe | Middle East | North America | South America | Totals |
|---|---|---|---|---|---|---|---|
| **Listed** | 19% | 30% | **54%** | 0% | **83%** | 13% | **51%** |
| **Government** | **81%** | **46%** | 14% | **93%** | 0% | 0% | 23% |
| **Other airline** | 0% | 4% | 9% | 0% | 6% | 19% | 7% |
| **Closely held** | 0% | 20% | 21% | 0% | 9% | **68%** | 17% |
| **Institutionals** | 0% | 0% | 1% | 7% | 1% | 0% | 2% |
| **Management** | 0% | 0% | 1% | 0% | 0% | 0% | 0% |
| Totals | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Table 4.6: Majority ownership of 249 airlines, weighted by 2004-2008 RPK production

In total, listed airlines were the largest producer of RPKs over the five-year period from 2004-2008, producing just over half of the world's large airline revenue passenger kilometres. Middle East RPK production even is even more strongly government-owned than the simple count of airlines, reinforcing the dominant position of this ownership model in the region. The successive privatizations of Europe's major international carriers make listed carriers the largest segment, followed at a substantial distance by closely-held and government owned airlines. Fully 87% of North American capacity comes from listed carriers: the numerous airline subsidiaries operating as feeders, and smaller closely-owned companies total only 13% of total capacity. Closely-held ownership is confirmed as dominant pattern in South America. None of the numerous government-owned carriers in this highly-fragmented region is large enough to be in the top 249. The family-owned TAM, TACA and LAN are far and away the largest producers in the region. Finally, the diversity seen in Asia-Pacific airline ownership gives way to a more concentrated landscape when viewed in terms of production. Government-owned carriers produce a relative-majority 46% of capacity, followed by listed carriers at 30%, against 20% for closely-held airlines. Asia-Pacific is far and away the largest and most diverse region, including both Oceania with its British-style governance models, and the PRC, where majority ownership is in the hands of the central government. These results would tend to suggest that "pure" classical financial theory – with valuation metrics based on widely-held, liquid share markets - would be applied more commonly in Europe and North America than in the rest of the world, which shows greater diversity of governance.

### 4.2.4. Airline ownership and financial performance

The wave of major airline privatizations led by British Airways in the 1980s, followed by Lufthansa, Air France, Iberia and other carriers, both reflected and created an airline industry dogma holding that private airline ownership should lead to superior financial performance and resistance to cyclical downturns. As these airlines all trade in relatively large and deep capital markets, the logical investor base was and is broad public shareholding. These companies have been found in this research to be consistent practitioners of classical financial techniques, as will be discussed in subsequent chapters. This section identifies the dominant ownership patterns in the world's regions, with profit (rather than production) as the weighting factor.

Measuring airline profits worldwide on a like-to-like basis raises the methodological issue of exchange rates. Airline revenue streams in different currencies are unique to each company. Cost currencies are equally variable, conditioned by the airline's geographical scope, national procurement regulations, and make-vs.-buy policy. The key commodity input, fuel, has its basis in global oil prices, currently denominated in USD: however, fuel is sold to airlines in domestic currency in most developing countries, at widely varying prices. The purchase and sale of aircraft and engines is transacted in USD, and loans against aircraft offered by international banks are usually denominated in that currency as well. Similarly, third-party maintenance, and operating leases are most commonly denominated in the U.S. currency. However, in preparing accounts, all airlines translate USD amounts at current exchange rates for both balance sheet and income statement preparation, creating wide variations in asset, liability, revenue, and cost valuations.

To examine financial performance, this research will focus on operating profits reported in the Airline Business annual surveys. Operating profit (and not cash flow) is the performance metric used in the Value Based Management approach derived from classical theory, discussed below in the context of European airline financial management. Both top-line revenue and profits are translated at average exchange rates in these surveys, an approach which at allows broad comparison. This research examines 2007, the most recent peak year for airline profits in spite of a high and increasing fuel price, as well as the five-year period 2004-2008, a period of recovery (2004-2007), and steep decline in 2008.

Examining the profit distribution of the world's 150 largest producers of revenue worldwide in 2007, the picture is markedly different from the production picture, in most regions.

In order to be consistent in comparing profit with RPK distribution, the contents of Table 4.6a below is revised to include only the passenger carriers among the top 150 airlines in terms of revenue generation. Keeping in mind that the top 150 airlines include cargo airlines (and by definition, only include the largest 150 airlines), the shares in each sample are broadly consistent. The exception is Europe, which has many airline subsidiaries that produce substantial RPKs, but with revenue not large enough to be included in the Airline Business Top 150 by Revenue.

| Largest shareholder and RPK distribution | Africa | Asia-Pacific | Europe | Middle East | North America | South America | Totals |
|---|---|---|---|---|---|---|---|
| **Listed** | 20% | 28% | **52%** | 0% | **83%** | 16% | **51%** |
| **Government** | **80%** | **46%** | 13% | **93%** | 0% | 0% | 23% |
| **Other airline** | 0% | 6% | 10% | 0% | 7% | 9% | 7% |
| **Closely held** | 0% | 20% | 22% | 1% | 9% | **75%** | 17% |
| **Institutionals** | 0% | 0% | 2% | 6% | 1% | 0% | 2% |
| **Management** | 0% | 0% | 1% | 0% | 0% | 0% | 0% |

Table 4.6a: 2007 RPK distribution of 150 largest revenue producing airlines

Airline operating profits for each shareholder type, as a percentage of the regional total, is shown in Table 4.7.

| Largest shareholder and Operating Profit distribution, 2007 | Africa | Asia-Pacific | Europe | Middle East | North America | South America | Totals |
|---|---|---|---|---|---|---|---|
| **Listed** | **82%** | **43%** | **89%** | 0% | **90%** | -2% | 62% |
| **Government** | 18% | 41% | 5% | **100%** | 0% | 0% | 19% |
| **Other airline** | 0% | 0% | -2% | 0% | 5% | 0% | 1% |
| **Closely held** | 0% | 16% | 8% | 0% | 6% | **102%** | **17%** |
| **Institutionals** | 0% | 0% | 0% | 0% | 0% | 0% | 1% |
| **Management** | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Totals | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

Table 4.7: 2007 profit distribution of 150 largest revenue producing airlines

In the very limited sample of Africa, the government-owned airlines (Ethiopian and South African) produced 80% of the RPKs, whereas listed carrier Kenya Airways produced 82% of the profits. In Asia-Pacific, listed airlines produced the highest profits are quite consistent with RPK shares, with listed carriers producing profits out of proportion with their production shares. Government-owned airlines produced slightly less profits than the listed carriers, and substantially less profit than production of RPKs. As La Porta et al. (1999) intimate, this growth region has a strong government and privately held corporate ownership pattern, reflected in the airline population

In Europe, the listed carriers dominate the profits with 89%, compared with only 52% of the RPK production. Particularly poor performers were the airline subsidiaries, where profits were negative in a boom year, and state-owned carriers which, thanks to Alitalia's $427m operating loss, earned practically no profits as a group in 2007. The overall ownership landscape of the major airlines is today very similar between Europe and North America. Performance over the cycle could not however be more different between these two high-production regions, as discussed in the conclusion to this chapter.

The Middle East region is dominated by government-owned airlines, both in terms of production and profits. In this it is similar to large portions of the highly diverse Asia-Pacific region. In these regions, government ownership did not preclude profit-making among large airlines.

South America shows a unique pattern, with the family-held airlines earning profits out of proportion to their production of RPKs, and the listed carriers earning less.

Almost totally missing from the ranks of owners worldwide (Russia's Transaero is the exception) is the category of inside managers. This is quite significant for this research, for it means that there is effective separation of ownership and control of the world's airlines (with some notable exceptions, such as Virgin Atlantic, but *not* more recent entrants such as Ryanair, which is only 4.5% owned by Michael O'Leary or AirAsia, in which Tony Fernandes' Tune Air owns 30.9%). In both theoretical and practical senses, the absence of management in majority shareholding necessitates highly formal processes for justifying investments, prepared by inside managers and presented to the governance body of the airline. These processes are precisely the type specified under classical financial theory, with capital budgeting practices presented in finance textbooks. On the other hand, the diversity of dominant shareholder types in all regions save Europe and North America gives rise to varying shareholder incentives and criteria for accepting investment projects in the world's airlines. Growth and profitability of the different shareholder models over the 2004-2008 period will be examined in the last section of this chapter.

In order to discuss the implications for management decision-making, it is important to look at the size and potential dominance of these largest shareholdings at the individual airline level: notably, the size of these "largest" shareholdings will help determine whether they are in fact dominant in decision-making.

Figure 4.8 shows the number of different types of shareholders among the large airlines analyzed in this research. A full 57% of the world's largest airlines (143 in number) have a single shareholder type, that is, they are 100% listed, or 100% government-owned, etc. Another 27% have two shareholder types, while the remaining 16% have three or four different types of shareholders, each of which may have a differing agenda regarding the firm's investment management.

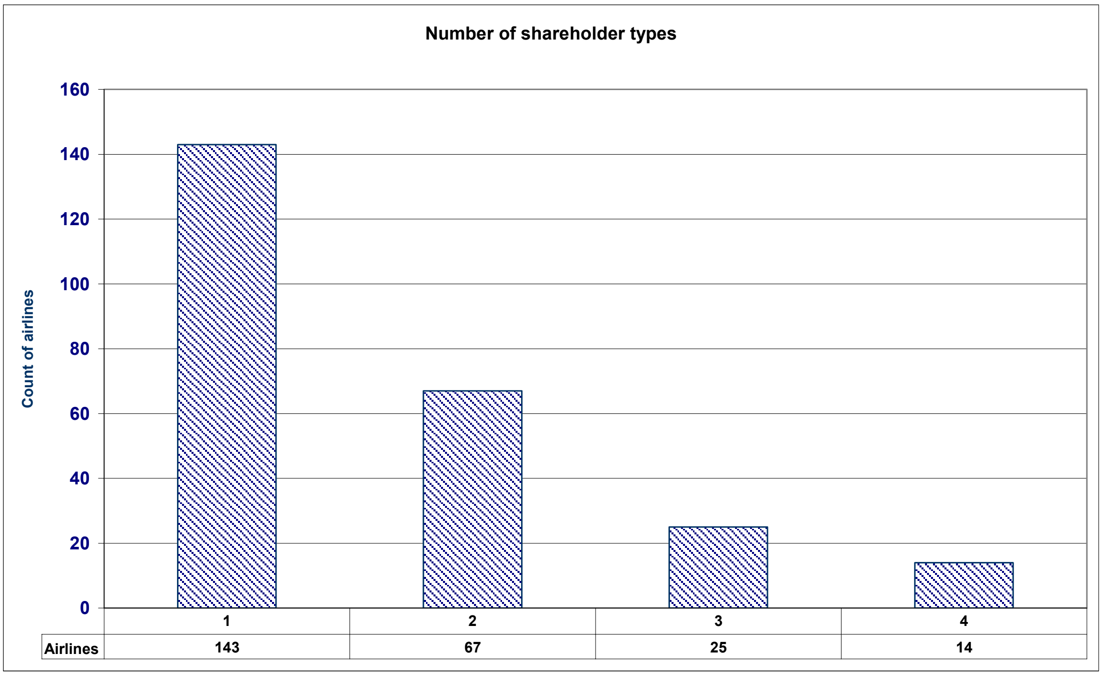



Figure 4.8: Number of different shareholder types among 249 largest airlines

The world's largest airlines tend to have a small number of different types of shareholders, with over half showing a single shareholder type and ¾ one or two types. Figure 4.7, supported by the airline-by-airline analysis below, shows that airline companies tend to be either tightly controlled by a single dominant group of investors, or on the contrary show the highly diffuse ownership characterizing the traditional western-style listed-company governance pattern, with its accompanying strong separation of ownership and control.

The following sections analyse the categories of shareholding characterizing the world's regions in detail, working from the individual airlines that make up each type of shareholder to develop a comprehensive governance typology of the world's airlines. Results of the field research regarding investment valuation techniques are then examined for each individual category.

The criterion for "type of shareholding" for each group is that the type of shareholder makes up the largest single shareholder group in the company's equity. In very many cases, the largest shareholder group is also an absolute majority shareholder: relative-majority shareholdings, more problematic in terms of management control of the airline's investments, are found to be relatively uncommon worldwide. Exceptions to this are discussed in each section.

### 4.2.5. Listed carrier equity finance and investment analysis

<u>Asia-Pacific</u>

Listed airlines represent only 13% of large airlines in Asia-Pacific in number, but they produce over twice that proportion of RPKs. Among the eight airlines present in Table 4.8, three types of shareholding pattern can be identified.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| **Japan Airlines Corporation** | | 100.00% | | | | | 0.00% |
| **Qantas** | | 100.00% | | | | | 0.00% |
| **ANA Group** | | 80.02% | 19.98% | | | | 0.00% |
| **Shandong Airlines** | | 77.20% | | | | 22.80% | 0.00% |
| **Korean Air** | | 61.14% | 21.49% | 12.13% | 5.24% | | 0.00% |
| **Shanghai Airlines** | 40.66% | 44.69% | 14.65% | | | | 0.00% |
| **spiceJet** | | 44.00% | 17.72% | 35.00% | | | 3.28% |
| **AirAsia** | | 43.50% | 21.60% | 30.90% | 4.00% | | 0.00% |

Table 4.8: Airlines with largest listed shareholders in Asia-Pacific

The first group is airlines in relatively advanced economies, which have broadly-listed shares along western lines: JAL, ANA, Qantas, and Korean Airlines. Compared to JAL, ANA has an institutional shareholding of nearly 20% in total, but the largest individual investor has only 4% shareholding.[9] The second group, spiceJet and AirAsia, have only relative majorities listed, while private investors hold shares of over 30%, giving them a substantial voice in management, with additional equity financing provided by shares raised from institutional investors. This pattern – a significant privately-held block often owned by the founder, and share listing supplemented by private placement - is common among the start-up airlines in the group.

The exception to many rules in airline governance, the two Chinese airlines listed have large listed shareholdings, but are largely ruled under the tight-knit Chinese government/civil aviation regime, with 40.66% of Shanghai owned by the government (with another 14.65% owned by the Bank of China), and 22.8% of Shandong owned by Air China, its largest shareholder. Thus, three of the eight airlines – four if we include Shandong – are significantly controlled by blocks of minority shareholders.

Europe

[9] Analysis regarding detailed shareholdings in this section are based on ATI information on the airlines' shareholders. This industry-standard information can be considered reliable because it is in such common use in the industry, examined by the parties concerned, and updated frequently.

Listed carriers in Europe provide 54% of the region's RPK capacity from 2004-2008. Europe includes the largest number of national carriers privatized since the era of deregulation began, British Airways, Lufthansa, Air France-KLM, Iberia, and THY Turkish Airlines, to which one could add the "oddity" of SAS, which has 50% - one share controlled by the governments of Sweden (21.4%), Denmark and Norway 514.3% each). Among these airlines, BA and LH are shown in this research to consistently and rigorously apply the techniques of classical finance theory to corporate financial management and investment appraisal.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| Icelandair | | 100.00% | | | | | 0.00% |
| Norwegian | | 100.00% | | | | | 0.00% |
| FlyGlobespan.com | | 100.00% | | | | | 0.00% |
| British Airways | | 100.00% | | | | | 0.00% |
| Lufthansa Group | | 89.44% | 10.56% | | | | 0.00% |
| Air France-KLM Group | 18.70% | 81.30% | | | | | 0.00% |
| Ryanair | | 81.24% | 14.26% | 4.50% | | | 0.00% |
| Iberia | | 72.40% | 17.60% | | | 10.00% | 0.00% |
| SkyEurope Airlines | | 71.90% | 28.10% | | | | 0.00% |
| Austrian Airlines | | 58.50% | | | | 41.46% | 0.04% |
| THY Turkish Airlines | 48.25% | 51.75% | | | | | 0.00% |
| Vueling Airlines | | 50.90% | 37.80% | | 11.30% | | 0.00% |
| SAS Group | 49.99% | 50.01% | | | | | 0.00% |
| Air Berlin | | 44.62% | 44.00% | 11.38% | | | 0.00% |

Table 4.9: Airlines with largest listed shareholders in Europe

A second group is the start-up no-frills carriers Ryanair, Skyeurope, Vueling, and Air Berlin. As in the case of the Asian start-ups, they have significant blocks of shares held by institutionals and/or private investors, with more participation from institutionals than in the Asian population. Ryanair exhibits an extreme case of the founder-owner pattern, with Michael O'Leary holding a stake now worth only 4.5%, which with his personal force of character is enough to ensure effective control of the company. Vueling is one of very few airlines worldwide with significant employee shareholding, with the balance of the private shares held by Catalan institutions. In 2009, the company agreed to merge with ClickAir, and Iberia offshoot which had been competing fiercely for Barcelona low-cost traffic. SkyEurope and Air Berlin represent classic venture capital start-up-IPO plays, with institutionals financing the start-up then selling a large stake to the markets (Vueling also exhibits this pattern).

North America

The North American airline community predominantly accesses the continent's wide and deep public share markets, as 83% of RPKs are provided by listed carriers. The continent's largest carriers are by and large 100% free-float, freestanding companies, although this is not true of the smaller, regional feeder airlines examined later in this section. Also conspicuously absent in this group is Air Canada, which became privately-held after its 2002 bankruptcy. The North American group is also distinguished by five additional Chapter 11 bankruptcies since 2001 – United (2002-2005), Atlas Air (2004-2007), Polar Air Cargo (2004), Delta and Northwest (2005 – 2008). All five emerged in the years indicated, but a sixth, Aloha Airlines, will certainly result in that airlines' liquidation.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline |
|---|---|---|---|---|---|---|
| **ABX Air** | | 100.00% | | | | |
| **Atlas Air** | | 100.00% | | | | |
| **FedEx** | | 100.00% | | | | |
| **Aloha Airlines** | | 100.00% | | | | |
| **Allegiant Air** | | 100.00% | | | | |
| **Pinnacle Airlines** | | 100.00% | | | | |
| **Mesa Airlines** | | 100.00% | | | | |
| **Hawaiian Airlines** | | 100.00% | | | | |
| **Frontier Airlines** | | 100.00% | | | | |
| **ExpressJet** | | 100.00% | | | | |
| **WestJet Airlines** | | 100.00% | | | | |
| **AirTran Airways** | | 100.00% | | | | |
| **Alaska Airlines** | | 100.00% | | | | |
| **US Airways Group** | | 100.00% | | | | |
| **Southwest Airlines** | | 100.00% | | | | |
| **Northwest Airlines** | | 100.00% | | | | |
| **Continental Airlines** | | 100.00% | | | | |
| **United Airlines** | | 100.00% | | | | |
| **AMR Corporation** | | 100.00% | | | | |
| **Delta Air Lines** | | 89.30% | | | 10.70% | |
| **Republic Airlines** | | 60.85% | 39.15% | | | |
| **Polar Air Cargo** | | 51.00% | | | | 49.00% |
| **JetBlue Airways** | | 49.00% | 15.00% | 17.00% | | 19.00% |

Table 4.10: Airlines with largest listed shareholders in North America

Only the last four of the listed airlines in Table 4.10 are under 100% free-floating, with JetBlue exhibiting once again the classic start-up founder/institutional/IPO pattern, albeit with a lower "cash-out" share sold to the public than Europe's carriers (and somewhat more than Asia's). The closely-held shares are owned by George Soros, whereas Lufthansa stepped in to take a 19% stake in the airline 2008. Here, as with the other start-ups, significant blocks of shares remain closely-held, whether by individuals, institutions, or other airlines.

## Other regions

Of the world's other regions, each has exactly one airline for which the largest shareholder type is a public share market.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| **Jazeera** | | 70.00% | | 30.00% | | | 0.00% |
| **GOL Transportes Aéreos** | | 100.00% | | | | | 0.00% |
| **Kenya Airways** | 22.00% | 32.50% | 4.36% | | | 26.00% | 15.14% |

Table 4.11: Airlines with largest listed shareholders in the Middle East, South America, and Africa

Kuwait's Jazeera is, as stated above, a clear distancing of the Kuwaiti civil aviation community from its national flag carrier, and is 70% listed on one of the only significant organized exchanges in the Arab Middle East. The Kuwaiti Boodai family controls the 30% closely-held share, easily enough to ensure management control of a widely-held company.

GOL is one of the few start-ups globally in which 100% of shares were floated in its 2004 IPO. Finally, Kenya Airways is the only African airline that managed to sell a relative majority stake to its domestic share exchange, leaving the government with 22%. KLM owns the largest individual stake at 26%, and is commonly viewed as having a close eye on the airlines operations (particularly maintenance), while not managing the company's fleet planning.

Having adopted western financing model of widely-held shareholding, these majority-listed airlines should be expected to use classical financial techniques to analyse fleet investments. The airline survey respondents from this research showed a pattern consistent with this intuition.

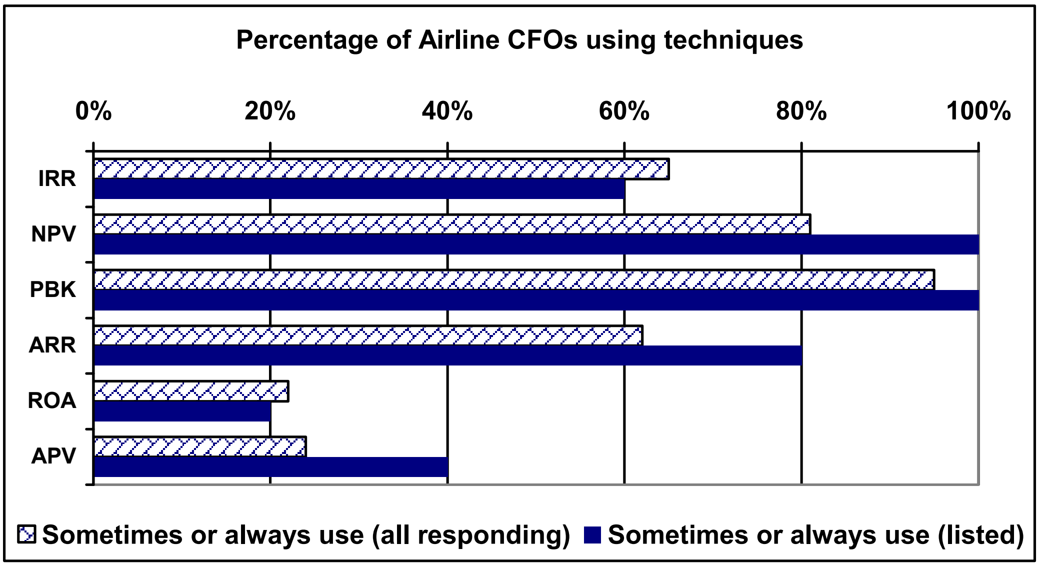


Figure 4.9: Valuation technique use by all airlines vs. majority listed airlines, Gibson & Morrell (2005)

All of the listed-majority respondents – two from European airlines, two from North America, one from Asia-Pacific use both NPV and PBK to evaluation investments, higher than the overall frequency in the airline sample. Fewer use IRR, which is consistent with the availability of cost of capital estimation data for their shares. Indeed, four of the five (the exception being the Asia-Pacific airline) use both WACC and CAPM to estimate the company's cost of capital.

Of less significance, four out of the five airlines also use Accounting Rate of Return (ARR) to evaluate investments, and two of the five also use Adjusted Present Value. Only one of these airlines uses Real Options Analysis (ROA). The CFOs of listed carriers responding to our survey have fully adopted classical financial valuation techniques.

### 4.2.6. Value-based management in listed carriers

One of the more widely-accepted applications of classical financial theory is Value Based Management (VBM), which has company cost of capital, defined as WACC, as one of its primary inputs. Two European carriers, British Airways and Lufthansa, have adopted VBM in corporate financial management. There are various forms and metrics for VBM, but they all share the same conceptual framework, which is a combination of classical financial theory and accounting expediency: the company's investments (variously defined) are charged with an investment cost by multiplying the investment by WACC, and this implicit investment cost is compared with various measure of cash flow or profits, to determine whether the company's managers are creating value by earning above investment costs, or destroying it by earning below such costs.

Since the introduction of the trade-marked Economic Value Added concept by the consulting Stern Stewart & Co, the most popular VBM metrics in the airline industry is Cash Value Added (CVA), adopted at the end of the 1990s by two major European carriers, British Airways (BA) and Lufthansa (LH). Scandinavian carrier SAS uses the related Cash Flow Return on Investment (CFROI) calculation. The methodology and issues surrounding these applications are discussed in detail in Morrell (2003). Of particular concern in Morrell's study was the valuation of assets, and the author found a wide diversity of methods: the airlines studied use methods ranging from simple historic cost with or without adjustment for inflation, to estimation of replacement cost of assets based on actuarial or current market value appraisal methodologies. All the airlines studied by Morrell use an estimate of the value of assets including the implied investment in operating leased aircraft: the treatment of leasing for investment valuation purposes is considered later in this research.

Classical financial theory is used in two specific calculations within CVA. First is the estimation of an "economic depreciation" to be deducted from operating cash flow (the usual proxy being Earnings before interest, tax, depreciation, amortization and rentals or EBITDAR). While depreciation is a fundamental concept necessary for any asset-based valuation, CVA substitutes a WACC-based calculation for simplistic accounting methods, be they linear or accelerated, purporting thus to calculate depreciation in a way consistent with financial market valuations (hence the "Cash" in CVA). A common approach to estimating economic depreciation is to find an annuity which discounts to the replacement cost of the firm's assets, a method requiring an estimate of the company's WACC or other appropriate discount rate. For this research, the range of approaches to estimating the parameters necessary to calculate airline cost of capital is relevant.

Table 4.12 is a comparison of the parameters used, and resulting calculation, for BA (reproduced from Morrell (2003)), and LH (from company annual reports).

| Comparison of WACC parameters | British Airways | | | LH 2001 | LH 2008 |
|---|---|---|---|---|---|
| Target debt/total capital ratio | 50% | 61% | 61% | 45% | 50% |
| Cost of debt | 5.3% | 4.8% | 4.8% | 6.3% | 5.4% |
| Risk-free rate | 5.3% | 5.3% | 5.3% | 5.1% | 4.2% |
| Beta | 1.25 | 1.35 | 1.5 | 1.05 | 1.1 |
| Equity risk premium | 6.6% | 4.0% | 2.5% | 5.7% | 5.7% |
| Cost of Equity (calculated) | 13.6% | 10.7% | 9.1% | 11.1% | 10.5% |
| Cost of Equity (stated) | 13.6% | 12.5% | 11.0% | 11.1% | 10.5% |
| WACC (nominal calculated) | 9.5% | 7.8% | 7.2% | 8.9% | 8.0% |
| WACC (nominal - stated) | 9.5% | 7.8% | 7.2% | 8.9% | 7.9% |
| WACC (real -stated) | 7.0% | 5.4% | 4.8% | | |
| WACC (real - calculated) | 6.8% | 5.2% | 4.6% | | |

Table 4.12: Cost of capital parameters & results: BA & SAS from Morrell (2003), LH from annual reports

While BA and LH apparently calculate cost of equity and WACC broadly in line with classical theory, several methodological choices reveal divergences. BA calculated WACC under three scenarios, with the first column in Table 4.12 reflecting their base case WACC. In this scenario, the airline used the same risk-free rate as the company cost of debt, an expediency not consistent with the notion that corporate debt is not truly risk-free, though it does reflect Lintner's (1965) assertion that company managers tend to view their own debt ask risk free.

In the other two scenarios, BA is presumably demonstrating the conservatism of their calculation. The cost of equity estimation shows the wide divergence in estimating the equity risk premium, as their estimates range as low as 2.5%, certainly below any estimates identified in this research. On the other hand, the company uses substantially higher betas of 1.35 and 1.5. This substantial range finds an echo in the dispersion of estimates from professional providers - betas from 1.27 to 1.857 in the case BA - found in Turner and Morrell (2003). Using these parameters, BA calculates equity costs substantially lower than the 13.6% used in the base case analysis. These wide-ranging parameter estimates demonstrate the lack of methodological certainty faced by practitioners attempting to put CAPM into practice.

Concerning that WACC sensitivity analysis, BA used an after-tax 4.8% for the company cost of debt, resulting in the questionable (but theoretically not impossible) estimation that BA's after-tax cost of debt is lower than the risk-free rate, which is by definition tax free. Again demonstrating the "conservatism" of the base case, they use equity costs of 12.5% and 11%, but this is countered by a higher 61% gearing and the lower cost of debt used. These scenarios appear geared to demonstrate that BA's cost of capital estimates are "realistic" or conservative, but to the researcher they are more revealing of methodological difficulties faced by practitioners.

The comparison with LH's estimates in 2001 and 2008 reveals many differences, most of which should reflect capital market and operational differences between the two countries. The two most striking differences are the substantially lower beta used by LH, consistent with the 2003 Turner and Morrell study, which found provider estimates of 1.12 to 1.19 for LH, both lower and in a narrower range than that of BA. LH also used a lower equity risk premium than BA's base case, which at 5.7% is very close to the "CFO practice" 5.5% reported by Bruner et al. (1998), a full percentage point lower than the 101-year German geometric average risk premium reported in Dimson et al. (2002), though again close to the forward-looking 5.9% "world" premium suggested by those authors. Not much can be said of the SAS methodology reported in Morrell (2003), as the company only provides the barest of information.

### 4.2.7. Government-owned carrier equity finance & investment analysis

Asia Pacific

This research identified 20 large, government-controlled carriers in Asia-Pacific, a vast region stretching from China to New Zealand, and including India as well. The airlines in this group produce 50% of the region's RPKs, and their shareholding patterns reflect the region's size and diversity of financial markets and cultures. Also distinctive is the fact that the government share is in no case less than 50%, a legacy of the rigidities inherent in ASA's.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| **Air India** | 100.00% | | | | | | 0.00% |
| **Biman Bangladesh Airlines** | 100.00% | | | | | | 0.00% |
| **Garuda Indonesia** | 100.00% | | | | | | 0.00% |
| **Royal Brunei Airlines** | 100.00% | | | | | | 0.00% |
| **Vietnam Airlines** | 100.00% | | | | | | 0.00% |
| **Air Madagascar** | 90.60% | | | | | 3.10% | 6.30% |
| **Pakistan International Airlines** | 87.00% | | | 13.00% | | | 0.00% |
| **Air New Zealand** | 76.50% | 12.90% | | 4.20% | | 6.30% | 0.10% |
| **Malaysia Airlines** | 72.05% | | 5.69% | | 10.72% | | 11.54% |
| **China Airlines** | 70.05% | | | | | | 29.95% |
| **Air Tahiti Nui** | 64.42% | | 8.61% | 19.92% | | 7.05% | 0.00% |
| **Air China** | 55.80% | 24.20% | | | | 20.00% | 0.00% |
| **Singapore Airlines Group** | 54.70% | | 45.30% | | | | 0.00% |
| **Thai Airways** | 53.76% | | 46.24% | | | | 0.00% |
| **Air Mauritius** | 52.87% | | | 15.50% | | 31.64% | -0.01% |
| **SriLankan Airlines** | 51.05% | | | | 5.32% | 43.63% | 0.00% |
| **China Eastern Airlines** | 50.30% | 38.38% | | 11.32% | | | 0.00% |
| **China Southern Airlines** | 50.30% | 49.70% | | | | | 0.00% |
| **Air Calédonie International** | 50.28% | | 43.31% | 4.32% | | 2.09% | 0.00% |
| **Air Pacific** | 50.00% | | | | | 49.97% | 0.03% |

Table 4.13: Airlines with largest government shareholders in Asia-Pacific

Five of these airlines are under 100% government control, found mostly in South Asia. With the notable exception of Air India, these airlines are found in countries without large public share markets. Air India, Garuda and Biman are part of a substantial group of airlines whose government shareholders have several times announced their intention to privatize the airline, processes which clearly have not as yet found the combination of political will and private interest which would allow them to open their capital. Air India, the largest of these companies and ranked 35 in worldwide revenue generation, was merged with Indian Airlines in 2007.

Singapore, Malaysia, and Thai show a mix of a substantial majority government stake and institutional investment. These countries do have substantial share markets, but the control of these national airlines is firmly in the hands of companies controlled their respective governments, while allowing them to benefit from additional institutional financing capacity.

Seven of the government-owned airlines have minority shares held by major airlines, giving them access to a certain amount of management expertise from their airline shareholders, while providing the shareholding airline with inside information on these government-controlled carriers. Three of these airline shareholdings are small stakes held by Air France in the airlines of former French colonies and Territoires d'Outre Mer (TOM): Air Madagascar (Air France 3.1%), Air Tahiti Nui (Air France 7.05%), Air Calédonie (Air France 2.09%). Air Mauritius has a more complex airline stakeholder group (B.A.

13.24%, Air France 9.58%, Air India 8.82%), reflecting its own colonial and historic ties to the Indian mainland. Emirates' 43.63% share of Sri Lankan's equity and concomitant management agreement gave the Dubai carrier a substantial say in Sri Lankan's management and fleet decisions. Similarly, Air Pacific can be considered highly controlled by (Qantas 46.3% and Air New Zealand's 3.67%). The final airline with a minority stakeholder is Air New Zealand (Singapore 6.3%), reflecting both ANZ's see-saw performance in the early years of this decade and the continuous flirtation of Singapore Airlines with stakes in carriers in Austria and New Zealand. Given the absolute government-held majority in all cases, none of these airline shares represents a controlling stake, but we can assume a certain amount of information-sharing and 'advice' from the outside airline regarding fleet decisions, particular in the case of the larger shares (Sri Lankan, Air New Zealand)

China's "big three" airlines have significant listed capital, while remaining majority controlled by the government. China Southern was the first of the three to privatize in 1997, and has a mix of Hong Kong listed shares (26.84%) denominated in HK$, and Shenzhen-listed denominated "A" shares (22.86%) denominated in CNY. China Eastern privatized the same year, but raised a smaller stake (H shareholders 32.2%, A shareholders 6.18%). Finally, the highly complex Air China has a 24.2% listed stake since its IPO in 2004, in addition to cross-shareholding with Cathay, giving the Hong Kong carrier a 20% stake (Air China owns 10% of Cathay's shares). The Chinese government's two-step aircraft procurement process through the China Aviation Services Group Company (CASGC) ensures that fleet decisions among these carriers will be complex, and highly subject to the overall procurement and industrial development policies and plans of the central government.

<u>Europe</u>

Europe's government-owned airlines number 22 (two more than in Asia-Pacific), but only account for 14% of the region's RPKs as a group vs. 50% in the Asia-Pacific region. Eight of the 22 are 100%-owned by the respective governments, and are found primarily in the former-communist countries of Central and Eastern Europe as well as Russia, as are an additional eight of the 22 airlines with less than 100% state ownership. The closely-held stakes of Croatia, Adria, LOT, Ukraine, CSA Czech, Aeroflot and KrasAir are typical of the unclear communication of the nature of private ownership found in this region. All of these airlines have experienced rapid growth over the last ten years, and all are included in the Airline Business top 200 airlines worldwide: TAROM, LOT, CSA Czech and Aeroflot, but also Air Astana and KrasAir are now within the top 150 revenue producing airlines, whereas in 2002 (for example), only LOT, CSA Czech and Aeroflot were in this group.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| **Azerbaijan Airlines** | 100.00% | | | | | | 0.00% |
| **Jat Airways** | 100.00% | | | | | | 0.00% |
| **Olympic Airlines** | 100.00% | | | | | | 0.00% |
| **Rossiya Airlines** | 100.00% | | | | | | 0.00% |
| **SATA International** | 100.00% | | | | | | 0.00% |
| **TAP Portugal** | 100.00% | | | | | | 0.00% |
| **TAROM** | 100.00% | | | | | | 0.00% |
| **Uzbekistan Airways** | 100.00% | | | | | | 0.00% |
| **Air Malta** | 98.00% | | | 2.00% | | | 0.00% |
| **Croatia Airlines** | 96.30% | | 2.20% | 1.50% | | | 0.00% |
| **Adria Airways** | 76.00% | | 8.00% | 13.00% | 3.00% | | 0.00% |
| **Cyprus Airways** | 69.62% | | | 30.38% | | | 0.00% |
| **LOT Polish Airlines** | 67.97% | | | 25.10% | 6.93% | | 0.00% |
| **Ukraine International Airlines** | 61.60% | | 15.90% | | | 22.50% | 0.00% |
| **CSA Czech Airlines** | 61.08% | | 4.33% | 34.59% | | | 0.00% |
| **Finnair** | 57.04% | 22.83% | 20.13% | | | | 0.00% |
| **airBaltic** | 52.80% | | | | 47.20% | | 0.00% |
| **Aeroflot Russian Airlines** | 51.17% | | | 27.00% | 19.00% | | 2.83% |
| **Air Astana** | 51.00% | | | | | | 49.00% |
| **KrasAir** | 51.00% | | | 49.00% | | | 0.00% |
| **Alitalia** | 49.90% | | 12.41% | 35.69% | | 2.00% | 0.00% |
| **Aer Lingus** | 28.82% | 28.29% | | | 16.76% | 25.22% | 0.91% |

Table 4.14: Airlines with largest government shareholders in Europe

With these former eastern-block airlines clearly under state tutelage as the largest group of the government-owned airlines in Europe, there are two exceptions that do not fit one particular pattern. Latvia's airBaltic is 47% owned by its employees, making it a rarity in the airline world. Air Astana was the result of an interesting approach in Kazakhstan: rather than try to reform Air Kazakhstan, the former flag carrier was disbanded, in favour of a joint venture between the government and BAE Systems.

Three Western European airlines in the group are the "remains" of the wave of privatization that has swept the E.U. in the last 25 years, a trend started by British Airways. Finnair is a typical partially-privatized carrier, with nearly 43% of the airline privately owned, around half of this in the hands of institutional investors. TAP Air Portugal and Olympic remain 100% in state hands[10]. None seems likely to participate in the current wave of consolidation sweeping the continent, even if TAP is a Star Alliance member and Finnair is trying to be the eastern wing of the oneworld alliance by focussing on Asian destinations through Helsinki.

[10] Olympic was sold to private investors at the end of 2009

Aer Lingus and Alitalia, on the other hand, were in 2007 takeover targets, and Aer Lingus is still so today, with over 25% of the company's shares held by Ryanair. The 2% of Alitalia held by Air France after its 50.1% privatization in January 2007 has now become 25%, with 75% held by "CAI", a group of Italian investors, in what seems like a face-saving deal destined to leave the carrier under the control of Air France-KLM in coming years.

Middle East

The other significant region of the world with large swathes of government ownership is the Middle East, where state-owned carriers produce 93% of the region's RPKs, and 98% of its profits.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| Air Algérie | 100.00% | | | | | | 0.00% |
| Atlas Blue | 100.00% | | | | | | 0.00% |
| Egyptair | 100.00% | | | | | | 0.00% |
| Emirates | 100.00% | | | | | | 0.00% |
| Etihad Airways | 100.00% | | | | | | 0.00% |
| Gulf Air | 100.00% | | | | | | 0.00% |
| Iran Air | 100.00% | | | | | | 0.00% |
| Iran Aseman Airlines | 100.00% | | | | | | 0.00% |
| Kuwait Airways | 100.00% | | | | | | 0.00% |
| Royal Jordanian Airlines | 100.00% | | | | | | 0.00% |
| Saudi Arabian Airlines | 100.00% | | | | | | 0.00% |
| Middle East Airlines (MEA) | 99.37% | | | | | | 0.63% |
| Royal Air Maroc | 95.39% | | | | | 3.82% | 0.79% |
| Oman Air | 80.00% | | 20.00% | | | | 0.00% |
| Tunisair | 74.42% | 20.00% | | | | 5.58% | 0.00% |
| Air Arabia | 51.00% | | 49.00% | | | | 0.00% |
| Qatar Airways | 50.01% | | | 49.99% | | | 0.00% |
| Ethiopian Airlines | 100.00% | | | | | | 0.00% |
| South African Airways | 98.20% | | | | 1.80% | | 0.00% |
| Air Jamaica | 100.00% | | | | | | 0.00% |

Table 4.15: Airlines with largest government shareholders in the Middle East, Africa, and North America

Eleven of the 17 airlines are 100% owned by their governments, but within these 11, there are two distinct management cases. First are the "traditional" state-owned airlines, founded practically at the same time as the country itself: Air Algérie, Egyptair, Iran Air, Kuwait Airways, Royal Jordanian, and Saudia. These airlines fill the traditional role of the state-owned carrier, serving destinations based on a mix of economic and political agendas, a mix that often confounds any management attempts to make sustained profits.

A second case among the state-owned carriers is the more recent and far more dynamic "start-up" carriers such as Atlas Blue (a Royal Air Maroc offshoot serving secondary destinations in Europe and Morocco), Gulf Air, a former "pan-Arab" carrier now the property of the state of Bahrein, Iran Aseman, and two of the three sixth-freedom mega-hub carriers of the group, Emirates and Etihad. Within the former group of staid airlines, Royal Jordanian and more recently Egyptair stand out as more dynamic, having joined global alliances (oneworld and Star respectively), largely to boost efficiency and modernize management, as well as to extend their networks facing the threats from the Gulf. One would like to add Middle East Airlines (MEA) to the dynamic group, but the airline has borne the brunt of hostilities between Arabs and Israelis in the years since 9/11.

The remaining Middle Eastern airlines fit the same two moulds, but have sold shares to some mix of different investor types: Royal Air Maroc fits the "tutelage" model previously seen in the South Asian carriers, with stakes held by Air France (2.87%), Iberia (0.95%). Tunisair also has a 5.58% share in the hands of Air France, and as well has the dubious benefit of having listed 20% of its shares on the languishing Tunis Stock Exchange.

The United Arab Emirates' no-frills carrier Air Arabia is 49% privately owned, with "substantial free float" according to ATI, while Qatar Airlines, the third sixth-freedom carrier channelling Europe-Asia traffic through the Gulf while building the Doha's attractiveness for business and leisure, is 50% minus one share privately owned. The salient characteristic of these "private" shares, and the funding model of the Gulf airlines in general, is substantial opacity regarding the exact nature of the shares and their owners. In the Gulf particularly, public and private ownership structures are not so easily distinguished.

In the interest of completeness Ethiopian and South African, and Air Jamaica are included in Table 4.15. SAA is known in the trade to be quite business-oriented and has a small employee-owned share. No other particular governance characteristics stand out in these three.

Twelve state-owned carriers responded to the airline CFO survey, one from Asia-Pacific, three from Europe, four from the Middle East and from Africa. As a group, they are less likely to use the classical techniques of IRR and NPV than the listed group. They in fact use ALL the techniques less than the listed group, reflecting the mixed agenda government ownership often brings to air transport.

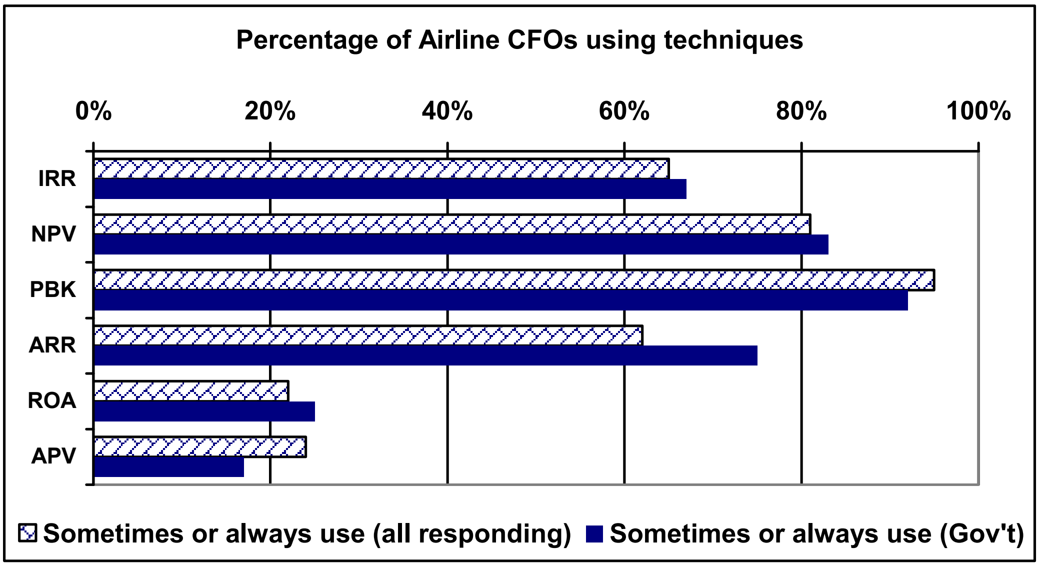



Figure 4.10: Frequency of valuation technique use by all airlines & majority government airlines

Within the averages there are large regional disparities: the four Middle-Eastern respondents show an analysis pattern nearly the same as the listed group, in that they all use IRR, NPV and PBK, and three out of the four use ARR as well. On the other hand, the Middle Eastern group does not use the more sophisticated ROA and APV techniques at all.

The Asia-Pacific respondent uses all the listed techniques, while the three European carriers are a mixed bag: all use PBK, and two out of three use NPV, whereas only one uses IRR.

Excluding Africa from the list of government-owned carriers, a picture of the analysis techniques in use by the responding state-owned carriers is similar to that found among the listed population, although they are less likely to adopt advanced techniques than listed carriers.

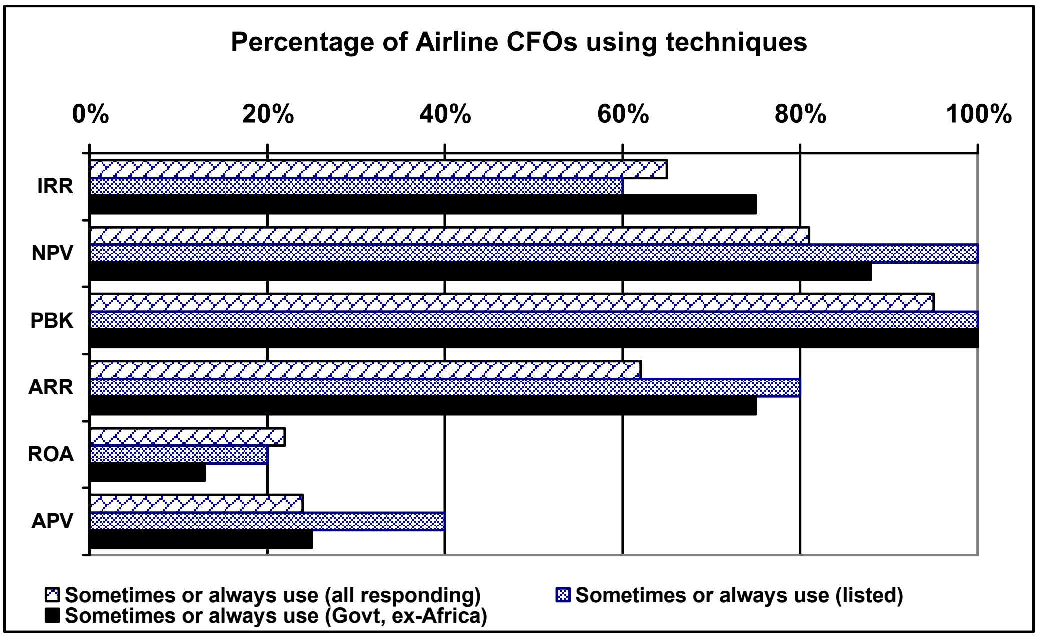



Figure 4.10a: Frequency of valuation techniques used by all airlines & majority government airlines ex-Africa

This adoption of classical financial techniques in the absence of market-based shareholding and governance by professional managers accountable to profit-oriented shareholders leads to questions of methodology (e.g., for cost of capital estimation in the absence of traded shares), which are discussed in this research.

### 4.2.8. Closely-held carrier equity finance & investment analysis

<u>Asia Pacific</u>

Of the 19 Asian airlines with the largest blocks closely-held, 17 show a clear absolute majority of this category of shareholders, and can be said to be wholly controlled by these blocks. They are certainly not the largest producers of RPK in the region, with only 20%, but they are the second most numerous group of airlines in the region, after state-owned carriers. Producing together 66% of Asian airline RPKs, the government and closely-held patterns of shareholding are dominant in the region, in sharp contrast to Europe and North America, but consistent with the findings concerning Asian shareholding patterns in LaPorta et al (1999). With the exception of Nippon Cargo Airlines (owned by Japanese shipping firm NYK Line), the 100% Closely-held airlines show a strong pattern of the "family", or individual, shareholding described in the LaPorta article, as do the larger Philippines Airlines (controlled by Lucio Tan), and Jet (by N. Goyal). Several have started operations within the last ten years (GoAir, IndiGo, Juneyao, Kingfisher, Lion, Skymark), and are largely run by their founders (although Kingfisher, in difficulty, may be edging closer to Jet). This is precisely the type of airline shareholding which Pinches and Lander suggested use "more intuitive" investment planning, with lower risk-aversion than publicly held firms.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| Bangkok Airways | | | | 100.00% | | | 0.00% |
| Cebu Pacific Air | | | | 100.00% | | | 0.00% |
| GoAir | | | | 100.00% | | | 0.00% |
| IndiGo Airlines | | | | 100.00% | | | 0.00% |
| Juneyao Airlines | | | | 100.00% | | | 0.00% |
| Kingfisher Airlines** | | | | 100.00% | | | 0.00% |
| Lion Airlines | | | | 100.00% | | | 0.00% |
| Nippon Cargo Airlines | | | | 100.00% | | | 0.00% |
| Skymark Airlines | | | | 100.00% | | | 0.00% |
| Asiana Airlines | | | 9.63% | 90.37% | | | 0.00% |
| Air Macau | 5.00% | | 5.00% | 90.00% | | | 0.00% |
| Philippine Airlines | 4.26% | | | 88.87% | 2.75% | | 4.12% |
| Jet Airways | | 20.00% | | 80.00% | | | 0.00% |
| Hainan Airlines | | | 12.72% | 78.36% | | | 8.92% |
| Virgin Blue | | | | 74.74% | | 25.26% | 0.00% |
| EVA Air | | 28.00% | | 72.00% | | | 0.00% |
| Skynet Asia Airways | 3.30% | 24.20% | | 57.60% | | 14.90% | 0.00% |
| Cathay Pacific | | 25.00% | 24.84% | 40.00% | | 10.16% | 0.00% |
| Air Austral | | | 26.30% | 37.72% | | | 35.98% |

Table 4.16: Airlines with largest closely-held shareholders in Asia

Three carriers have a significant block held by another airline, and fall into two categories. First are the start-ups at the behest of a parent airline, with Virgin's 25.26% share in Virgin Blue and All Nippon's nearly 15% of Skynet Asia. Second, and of course unique worldwide, is Cathay Pacific, with its cross-shareholding of 10.16% with Air China and the continuing controlling block held by the Swire Group providing consistent profit-driven management practices. Finally, EVA Air and Asiana are controlled by diversified holding companies ("Evergreen" for the former, and Korea's Kumho Construction for the latter). Airlines belonging to diversified groups are thus quite rare in the region. This suggests that the potential conflicts of interest identified later in this research in the diversified-group shareholding patterns many authors consider endemic to the region[11] would not logically be a significant problem in the Asian airline world.

Europe

In Europe, the closely-held pattern is very different, with 12 of the 31 closely-held airlines (39%) controlled by travel groups. These airlines are italicized in

[11] The most obvious examples are the Japanese Zaibatsu and the South Korean Chaebol groups, another being the Hong Kong conglomerate Hutchinson Whampoa.

Table 4.17. The aircraft utilisation pattern (highly seasonal) business model and investment priorities of travel groups are significantly different from those of scheduled carriers. All of the travel-group held airlines are 100% subsidiaries (save Tuifly in which Air Berlin holds a 19.9% stake), giving the owners complete control over all capital budgeting decisions.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| Air Europa | | | | 100,00% | | | 0,00% |
| Corsairfly | | | | 100,00% | | | 0,00% |
| Futura International Airways | | | | 100,00% | | | 0,00% |
| Hello | | | | 100,00% | | | 0,00% |
| Iberworld Airlines | | | | 100,00% | | | 0,00% |
| Livingston | | | | 100,00% | | | 0,00% |
| Monarch Airlines | | | | 100,00% | | | 0,00% |
| MyTravel Airways | | | | 100,00% | | | 0,00% |
| Novair | | | | 100,00% | | | 0,00% |
| Onur Air | | | | 100,00% | | | 0,00% |
| Silverjet | | | | 100,00% | | | 0,00% |
| Sterling Airlines | | | | 100,00% | | | 0,00% |
| Thomas Cook Airlines (UK) | | | | 100,00% | | | 0,00% |
| Thomsonfly | | | | 100,00% | | | 0,00% |
| XL Airways France | | | | 100,00% | | | 0,00% |
| XL Airways UK | | | | 100,00% | | | 0,00% |
| Air One | | | | 99,00% | | | 1,00% |
| Meridiana | | | | 84,00% | 16,00% | | 0,00% |
| TUIfly | | | | 80,10% | | 19,90% | 0,00% |
| Clickair | | | | 80,00% | | 20,00% | 0,00% |
| AeroSvit Airlines | 22,00% | | | 78,00% | | | 0,00% |
| Aegean Airlines | | 23,60% | | 76,00% | | | 0,40% |
| Virgin Blue | | | | 74,74% | | 25,26% | 0,00% |
| S7 Airlines | 25,50% | | | 74,50% | | | 0,00% |
| Ural Airlines | | 19,50% | 14,50% | 66,00% | | | 0,00% |
| Brussels Airlines | | | | 55,00% | | 45,00% | 0,00% |
| Eurowings | | | | 51,00% | | 49,00% | 0,00% |
| Virgin Atlantic Airways | | | | 51,00% | | 49,00% | 0,00% |
| Malév | | | 49,00% | 51,00% | | | 0,00% |
| easyJet | | 49,90% | | 50,10% | | | 0,00% |
| bmi | | | | 50,01% | | 49,99% | 0,00% |
| flybe | | | | 50,00% | | 15,00% | 35,00% |

Table 4.17 Airlines with largest closely-held shareholders in Europe

The second type of European closely-held carrier consists of seven airlines (including Tuifly) that have a substantial block of shares controlled by another airline, Iberia for ClickAir, Lufthansa for Brussels Airlines (a greatly pared-down Sabena) and for Eurowings, SIA for Virgin Atlantic, Lufthansa and SAS for bmi (soon to be 100% LH), and British Airways for Flybe. This pattern largely confirms the assertion in Chang and Williams (2001) that the moves have been intended to gain access (notably slots) in neighbouring countries, with a second group (flybe, Eurowings) part of the major carriers' on and off flirtation with new business models run separately from the mainline carrier.

There are entrepreneurial start-ups of the kind identified in Asia above, including easyJet, Aegean Airlines, AirOne (now merging with Alitalia), and Meridiana, and the late Silverjet. A significant difference from their Asian peers is that the majority of successful European start-ups were put into IPOs and are no longer closely-held after there start-up phase: this group includes Ryanair, SkyEurope (bankrupt in September 2009), Vueling, and Air Berlin. The start-up/IPO/listed western entrepreneurial pattern is more consistent with classical valuation (including corporate valuation) and hence closer to classical financial theory.

A final significant group comprises eastern European and Russian airlines, either started up or rescued from the wreckage of the Russian aviation meltdown after the collapse of the Soviet Union in 1989. Airlines such as AeroSvit, S7, Ural Airlines and Malev tend to have a rather murky disclosure of shareholdings, which include diverse groups including government, listed, and institutional investors. This governance pattern suggests rather tortuous capital budgeting procedures and attendant management practices.

North America

Closely-held airlines in North America produce only 9% of the regions RPKs. Among the group in Table 4.18, 84% of the group's RPKs are produce by four: Aeroméxico, Air Transat, Mexicana and Air Canada.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| Aeroméxico | | | | 100.00% | | | 0.00% |
| Air Transat | | | | 100.00% | | | 0.00% |
| Air Wisconsin | | | | 100.00% | | | 0.00% |
| Aviacsa | | | | 100.00% | | | 0.00% |
| Evergreen International Airlines | | | | 100.00% | | | 0.00% |
| GoJet | | | | 100.00% | | | 0.00% |
| Kalitta Air | | | | 100.00% | | | 0.00% |
| Mexicana | | | | 100.00% | | | 0.00% |
| Omni Air International | | | | 100.00% | | | 0.00% |
| Trans States Airlines | | | | 100.00% | | | 0.00% |
| USA 3000 Airlines | | | | 100.00% | | | 0.00% |
| Air Caraibes | | | | 85.00% | | | 15.00% |
| Air Canada | | 25.00% | | 75.00% | | | 0.00% |

Table 4.18: Airlines with largest closely-held shareholders in North America

Mexicana is since 2005 owned by travel group Posada after the failed "Cintra Group" combination with Aeroméxico, while the latter is now controlled by entrepreneur Jose Luis Barrazza. Air Transat is a North Atlantic charter carrier serving tourist markets. By far the largest of the four, Air Canada has been through a lengthy restructuring since the bankruptcy in the wake of 9/11, and is currently controlled by investor group BCE Holdings. The rest of these airlines are niche carriers, largely held by individuals or small groups of private investors.

South America

South America RPKs are 68% provided by closely held companies, making this governance pattern the dominant one in the region. Further, the closely held shareholdings are in most cases strongly dominant over other types of shareholders, as Table 4.19 shows.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline | N.S. |
|---|---|---|---|---|---|---|---|
| **Avianca** | | | | 100.00% | | | 0.00% |
| **Grupo TACA** | | | | 100.00% | | | 0.00% |
| **OceanAir** | | | | 100.00% | | | 0.00% |
| **TAM Linhas Aéreas** | | | | 100.00% | | | 0.00% |
| **BRA Transportes Aéreos** | | | 20.00% | 80.00% | | | 0.00% |
| **Aerolíneas Argentinas** | 20.00% | | | 77.00% | 3.00% | | 0.00% |
| **LAN Airlines** | | 26.80% | | 73.20% | | | 0.00% |
| **Copa Airlines** | | | | 51.00% | | 10.00% | 39.00% |

Table 4.19: Airlines with largest closely-held shareholders in South America

The largest airline in the group, TAM Linhas Aéreas, is controlled by Brazil's Amaro family (with 54%), while LAN Airlines, the second largest, is controlled by an informal consortium of the Piñera and Cueto families (28% and 27% respectively), and completed by the Eblen Group with 17%. LAN's free-float of 26.8%, listed on the Santiago and New York stock exchanges makes it the most transparent of these closely-held companies, with extensive annual reports providing insight into the company's management and accounts prepared under both Chilean and U.S. accounting standards. Panama's Copa is only major South American carrier with a significant share held by another airline, with 10% held by Continental of the U.S. The chronically unprofitable Aerolineas Argentinas was controlled in 2001 by Iberia, a stake then sold to Spanish travel company Grupo Marsans. By 2007, the Argentine government had re-taken a 20% shareholding, and subsequently announced in October 2008 its intention to re-nationalize the airline. Aérolineas is thus the exception in a South American region which shows a clear pattern toward closely-held ownership, and with the emergence of strong international players leading consolidation in the region.

Institutional investor-controlled airlines worldwide

This research distinguishes institutional investor control from other closely-held airlines. Institutional investors are defined as banks, mutual funds, insurance companies, which play no direct role in the airline management, while seeking investor returns valued in the classical manner. This is the most challenging group to identify among worldwide airlines, because the disclosure of such shareholding varies from region to region and country to country. Using ATI as a uniform source, the companies in Table 4.20 were clearly identified as majority owned by institutions, and the airlines' country and region are included.

| Airline | Country | Region | Governme nt | Listed | Institutional investors | Closely held | Employees | Other airline |
|---|---|---|---|---|---|---|---|---|
| **Air Do** | Japan | Asia-Pacific | | | 96,07% | 3,93% | | |
| **Air Nostrum (Iberia Regional)** | Spain | Europe | | | 97,50% | | | 3,00% |
| **Volga-Dnepr Airlines** | Russia | Europe | | | 84,00% | | | 16,00% |
| **UTair Aviation** | Russia | Europe | | 24,31% | 75,69% | | | |
| **VIM Airlines** | Russia | Europe | | 25,00% | 75,00% | | | |
| **Blue Panorama Airlines** | Italy | Europe | | | 66,60% | 33,40% | | |
| **Astraeus** | UK | Europe | | | 51,00% | | 49,00% | |
| **Hamburg International** | Germany | Europe | | | 50,01% | | 49,99% | |
| **Luxair** | Luxembourg | Europe | 23,10% | | 38,60% | | | 13,00% |
| **El Al** | Israel | Middle East | 21,97% | 31,36% | 39,50% | | | 8,12% |
| **North American Airlines** | USA | North America | | | 100,00% | | | |
| **Sun Country Airlines** | USA | North America | | | 100,00% | | | |
| **Spirit Airlines** | USA | North America | | | 51,00% | 49,00% | | |

Table 4.20: Airlines with largest institutional investors worldwide

The most striking feature of this group is that for the most part, the majority institutional shareholding is held by a single institution. Japan's Mizuho Asset Ltd., part of the Mizuho investment bank, owned the 96.07% share in Japanese start-up Air Do in 2007, making the airline a "pure" institutional investor play. The majority of the airlines disclosing institutional majority ownership are in Europe. Air Nostrum, a significant player in Iberia's strategic move to build a hub in Madrid, and also had a single dominant investor, NEFINSA S.A., which owned 75.5%. S

Similar patterns exist at Blue Panorama (Distal & Itr Group 66.6%), Astraeus (Northern Lights 51%), North American (part of Global Air Logistics in turn controlled by MaitlinPatterson), Sun Country (Petters Group, currently in Chapter 11 bankruptcy proceedings, and Spirit Airlines (Oaktree Capital, 51%).

The major exceptions to this single-institution pattern were largely in Russia, whose three airlines in Table 4.20 are controlled by a long list of institutional investors whose nature and shareholding are very difficult to determine through public-domain sources, another indication of the opacity of the Russian financing environment.

Another exception was El Al, in which investor group Knafaim-Aria Holdings only held 39.5%, making it the largest minority shareholder in one of the world's most politically-charged airlines.

In this research, privately-held airlines showed a tendency to use the classical financial valuation techniques consistent with the survey results as a whole. Gibson and Morrell (2005) found that the 13 airlines stating their majority shareholder as "private" (closely-held) exhibited strong tendency to use NPV and PBK, somewhat less pronounced than the listed carriers. The preference for NPV over IRR is similar to that found in airlines worldwide. Only slightly more than half of these 13 carriers used accounting measures of profitability (ARR), showing that these techniques were quite a bit less popular than among listed carriers. Similarly, they were less likely to use APV and ROA than their listed counterparts, and indeed, less likely to use these advanced techniques than the total sample of airlines responding to the survey.

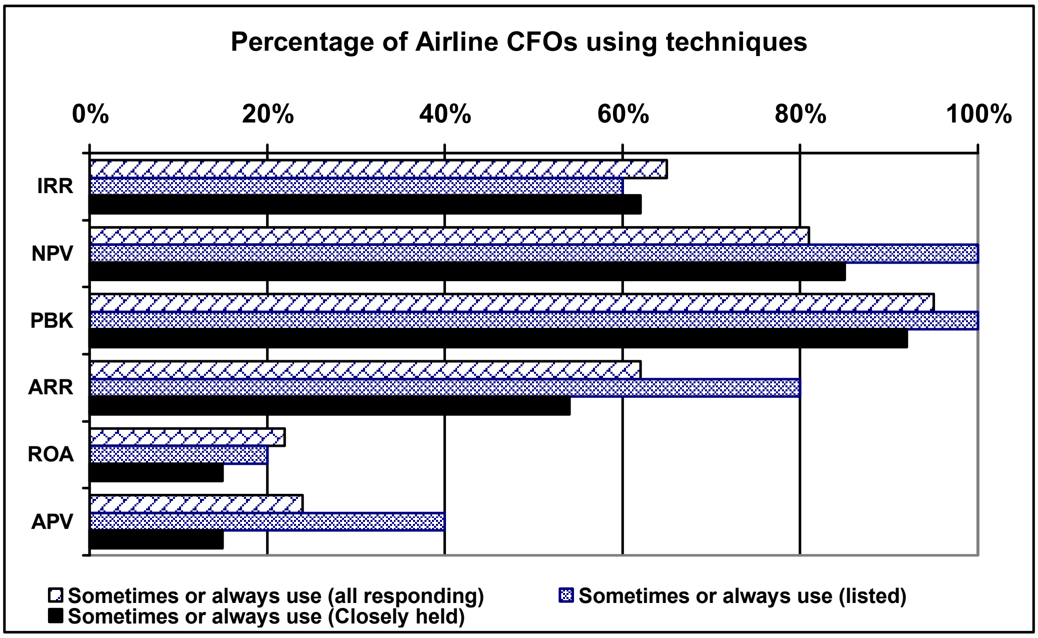



Figure 4.11: Frequency of valuation techniques used by all airlines, listed airlines & majority closely-held airlines

### 4.2.9. Other airline-owned carrier equity finance and investment analysis

The final type of equity ownership analysed in this research is large airlines owned by other airlines. This type of ownership is present in Asia, Europe, and North America, and quite distinctly absent in the Middle East, Africa and South America. This group is striking in two ways. First, airlines do not share ownership of subsidiaries: in all cases, there is a single airline parent of the majority share. Second, the ownership share of the parent airlines is near or at 100% in 40 of the 52 companies majority-owned by other airlines. These two features give the parent companies complete control over the management of these captive subsidiaries, which has major considerations regarding strategic management decisions, investment analysis, and the application of classical financial analysis techniques at the level of the subsidiary.

In Asia-Pacific, several patterns emerge.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline |
|---|---|---|---|---|---|---|
| China Eastern Airlines Wuhan | | | | | | 100,00% |
| Continental Micronesia | | | | | | 100,00% |
| Deccan | | | | | | 100,00% |
| Dragon Air | | | | | | 100,00% |
| JetLite | | | | | | 100,00% |
| Jetstar | | | | | | 100,00% |
| QantasLink | | | | | | 100,00% |
| SilkAir | | | | | | 100,00% |
| Japan TransOcean Air | 12,90% | | | 17,00% | | 70,10% |
| China Xinhua Airlines | | | | 40,00% | | 60,00% |
| Xiamen Airlines | 40,00% | | | | | 60,00% |
| Sichuan Airlines | | | | 41,00% | | 59,00% |

Table 4.21: Airlines with largest other-airline ownership in Asia-Pacific

Dragon Air and Silk Air are clear strategic plays by their parent companies, respectively Cathay Pacific and Singapore Airlines. The first was a successful attempt to open Hong-Kong-Beijing (and other mainland China) destinations, while Silk Air allowed Singapore Airlines to experiment with a lower-cost operating model to open extensive short and medium-range services in its immediate vicinity, primarily Malaysia and Indonesia. In a very similar vein, Jetstar was started by Qantas to serve regional markets using a low-cost business model, with management and labour agreements separate from that of the parent. The reasons behind this model – i.e., market access - are quite similar to those identified in Chang and Williams (2001) in a European context, with the difference that the parent control is absolute. The absolute control implies limitations of network patterns to the first four freedoms of the air, with fifth freedom rights dependent on the bilateral service agreements in place. The full advantages of point-to-point service to optimize aircraft utilisation are limited for these carriers.

A second group reflects the ongoing consolidation in the fast-growing and highly dynamic Indian market, comprising Deccan (taken over by Kingfisher) and JetLite (formerly Sahara, taken over by Jet). Again, the airlines are 100% subsidiaries of the parent companies.

The third and largest group of four airline subsidiaries is in China, which once again shows equity financing pattern distinct from the other countries of the world. First of all, the ownership is less than 100%, except for the anomaly of China Eastern Wuhan Airlines: though the airline continues to report results separately, the airline should be consolidated under China Eastern following the consolidation of Chinese airlines into the "big three." China Xinhua is 60% owned by Hainan Airlines, the first privately-owned airline in the P.R.C. The China Xinhua brand will probably "swallow" the parent airline brand, reflecting the ambition to go beyond the traditional Hainan/tourist-based operations of the airlines.

Xiamen Airlines is 60% owned by China Southern, while Sichuan is the only airline showing a mixed ownership (China Southern 39%, Shanghai and Shandong 10% each). Neither Xiamen nor Sichuan was started by its current parent airline, with identities and operations closely affiliated with their regional governments. Operations and the brands are currently completely separate from that of China Southern, though one must assume that growth, air services and frequency decisions are strongly influenced by the Guangzhou-based carrier. In both cases, the airline parent shares are complemented by closely held blocks associated with their regional roots.

The remaining airlines (Continental Micronesia, Qantaslink, Japan TransOcean Air are far less significant than the others, fundamentally representing air service connections to thinly-populated islands in the respective catchment areas.

Europe

The ongoing European airline consolidation, as described in Chang and Williams (2001 & 2004), is fully reflected in the other-airline owned category in the region.

| Airline operation | Government share | Listed share | Institutional investors share | Closely held share | Employees share | Other airline share |
|---|---|---|---|---|---|---|
| **Austrian Arrows** | | | | | | 100.00% |
| **Blue1** | | | | | | 100.00% |
| **bmibaby** | | | | | | 100.00% |
| **Brit Air** | | | | | | 100.00% |
| **CityJet** | | | | | | 100.00% |
| **Condor Flugdienst** | | | | | | 100.00% |
| **Edelweiss Air** | | | | | | 100.00% |
| **GB Airways** | | | | | | 100.00% |
| **germanwings** | | | | | | 100.00% |
| **Martinair** | | | | | | 100.00% |
| **Monarch Scheduled** | | | | | | 100.00% |
| **Régional** | | | | | | 100.00% |
| **SunExpress** | | | | | | 100.00% |
| **Swiss** | | | | | | 100.00% |
| **Swiss European Air Lines** | | | | | | 100.00% |
| **Thomas Cook Airlines Belgium** | | | | | | 100.00% |
| **Transavia Airlines** | | | | | | 100.00% |
| **Spanair** | | | | 5.10% | | 94.90% |
| **Travel Service Airlines** | | | | 34.00% | | 66.00% |
| **Eurofly** | | | 15.74% | 38.16% | | 46.10% |
| **Cargolux Airlines International** | | 34.00% | 31.10% | | | 34.90% |

Table 4.22: Airlines with largest other-airline ownership in Europe

The tendency toward 100% equity ownership of these airlines heralds a new approach compared to the minority-share strategy which led to the SAir Group debacle of 2001. These more clear ownership patterns have been made possible by internal European open skies policies and Europe-wide ownership rules codified in the 2008 “Open Skies” agreement with the U.S.

Of the 21 airlines in this group, fully eight involve Lufthansa’s extensive subsidiary strategy recent airline acquisitions: Austrian Arrows, bmibaby, Condor, Edelweiss, germanwings, SunExpress, Swiss, and Swiss European are all either direct (Condor, SunExpress and Swiss) or indirect subsidiaries of

Lufthansa, a group of wholly-controlled subsidiaries soon to fully include Austrian, Brussels Airlines, and bmi.

An additional five wholly-owned subsidiaries – BritAir, CityJet, MartinAir, Regional, and Transavia – are part of Air France-KLM's European consolidation and regional expansion strategy. Regional Airlines has been part of the French group's hub development strategy for many years, BritAir and CityJet are inroads into the U.K. market, while Martin-Air and Transavia were inherited with the Air France KLM merger.

A third much smaller group of strategic plays includes' SAS' Blue1 and Spanair, bringing the total of major-owned airlines in this group to 15 of the 21. The other airlines are composed of indirect travel group control - Eurofly (46.1% owned by Meridiana), Thomas Cook Belgium, smaller airline subsidiaries - Travel Service Airlines (Icelandair), Cargolux (Luxair), and GB Airways (easyJet), and the anomaly "Monarch Scheduled", part of Monarch Airlines.

Wholly airline-owned equity in North America reflects trends strikingly similar to those in Europe.

| Airline | Government | Listed | Institutional investors | Closely held | Employees | Other airline |
|---|---|---|---|---|---|---|
| **Air Canada Jazz** | | | | | | 100.00% |
| **American Eagle Airlines** | | | | | | 100.00% |
| **ATA Airlines** | | | | | | 100.00% |
| **Atlantic Southeast Airlines** | | | | | | 100.00% |
| **Chautauqua Airlines** | | | | | | 100.00% |
| **Click Mexicana** | | | | | | 100.00% |
| **Comair** | | | | | | 100.00% |
| **Freedom Airlines** | | | | | | 100.00% |
| **Horizon Air** | | | | | | 100.00% |
| **Midwest Airlines** | | | | | | 100.00% |
| **Shuttle America** | | | | | | 100.00% |
| **SkyWest Airlines** | | | | | | 100.00% |
| ***US Airways Express*** | | | | | | 100.00% |
| **World Airways** | | | | | | 100.00% |
| **Varig** | | | | | | 100.00% |
| **AeroRepública** | | | | | | 99.90% |
| **Austral Lineas Aereas** | 5.00% | | | | | 95.00% |
| **SAM Colombia** | | | | 6.00% | | 94.00% |

Table 4.23: Airlines with largest other-airline ownership in the Americas

While consolidation is underway – one might say, *finally* underway - the reasons for holding airline subsidiaries are quite different than in Europe, since the U.S. never suffered from internal "bilateral" restrictions on domestic consolidation across the states. American Eagle, Comair and Midwest belong to American, Delta and Northwest (now Delta), and operate as hub feeders for their respective carriers.

Many of the point-to-point, low-fare airline ventures started by North American majors (including Delta Express and United's short-lived division ted, for example) have ceased operation over the years. Air Canada Jazz, US Airways Express, and Click Mexicana continued today to represent this model of subsidiary.

Airline consolidation in the U.S. is typified by the five relatively small airlines owned by larger, purely domestic U.S. carriers, including Atlantic Southeast (SkyWest), Chautauqua and Shuttle America (Republic), Freedom Airlines (Mesa Group), and Horizon Air (Alaska Air). ATA and World Airways have a mixed government-private transport business model, and are owned by Global Aero Logistics, which could justifiably be considered either an airline or a private investor group.

South America

In South America, other airline ownership is the exception rather than the rule[12]. As shown above, dominant and most successful ownership model in the region is closely-held (largely family) ownership and control. The exceptions prove the rule. Brazil's former second carrier Varig is now owned by GOL, an operation the very successful low-fare carrier has yet to turn around. The Colombian market has been in near-chaos since the collapse of ACES and Avianca in 2001. SAM Colombia, including what remains of these two merged in 2002 into SAM, is now the country's second producer of RPKs to AeroRepublica, owned by Panama's closely-held Copa. Finally Austral Lineas Aéreas, a domestic subsidiary of Aérolineas Argentinas, is bound up in the parent company's governance struggle between Grupo Marsans and the Argentine government.

Given the dominance of the parent company's strategy and the difficulties of consolidation, these airlines' managers have their "hands tied," to a large extent unable to apply the financial analysis techniques used by stand-alone carriers. The responses from the six airline CFOs from this group of airline subsidiaries definitely confirm this intuition.

[12] This may be changing with the recently-announced TACA/Avianca airline group, purported to encompass nine airlines in total

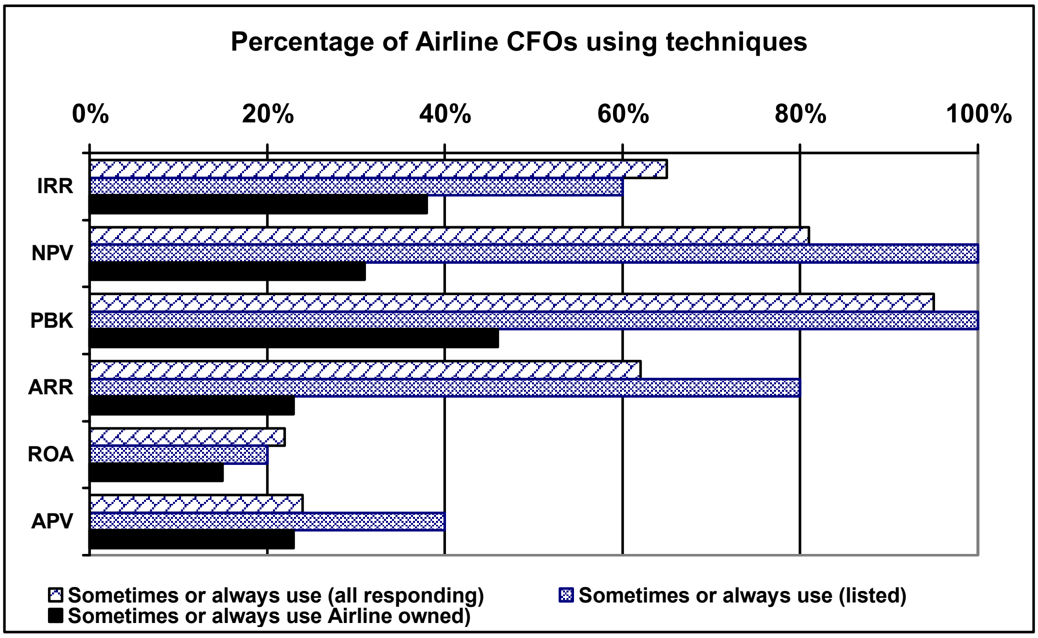



Figure 4.12: Frequency of valuation techniques used by all airlines, listed airlines & other airline-owned airlines

Of the analytical techniques in wide use elsewhere in the industry, none was stated as used even sometimes by a majority of CFOs. PBK was the most commonly used, while the classical techniques found use in fewer than three responding airlines. IRR was slightly more frequently used than NPV, as would be appropriate for a firm without its own cost of capital.

As a whole, this group of companies was found to be by far the least likely to use classical financial analysis techniques, less even than the government-owned carrier respondents, allowing the inference that their fleet decisions are largely made for them by parent companies.

### 4.2.10. Conclusions

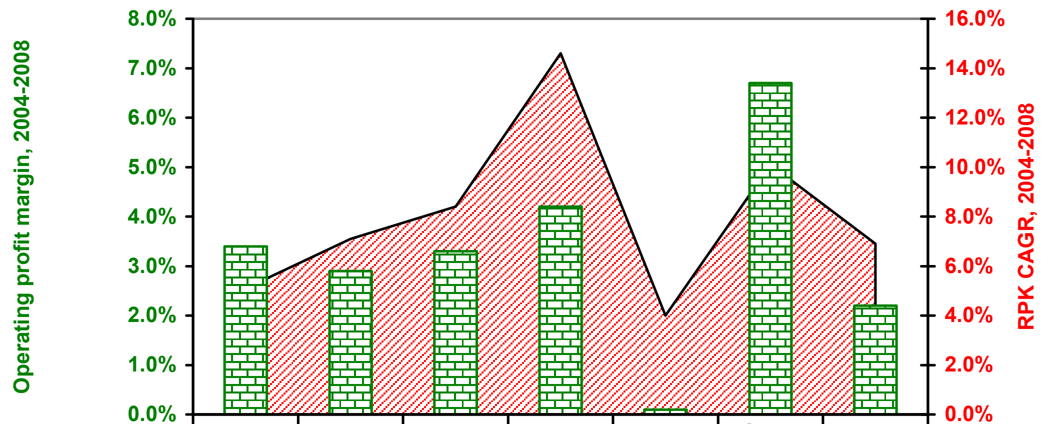
Due to the information revolution, historical financial market information is increasingly and readily available to airline managers worldwide. Banking and capital markets are similarly developing in most regions, and the existence listed airlines in all of the world's regions – with the notably exception of the Middle East - shows that capital-market equity is available for the airlines with investor-friendly business models. Regarding access to debt financing, aircraft deliveries worldwide show that airlines can access long-term funding for the acquisition of aircraft, even if many require Export Credit Agency-guaranteed finance to access long-term financing. The worldwide availability of aircraft finance is distinctly true in the aviation industry, even in countries where the predominant debt financing pattern may be short-term funding. The increasing availability of market information, and the accessibility of market-based financing that marks the airline industry, both indicate that there is no reason airlines worldwide cannot use classical financial valuation methods to justify aircraft investments, if managers are directed to do so.

On the other hand, the governance models displayed around the world are not uniformly based on the western-style diffuse ownership/capital market funding approach and management-ownership split that underpins classical financial theory. The detailed analysis of airline governance in this chapter reveals many different equity finance & governance patterns among the world's regions. These differences are summarized in Table 4.24 on the next page. The shaded square denotes the largest producer of the RPKs in the region. Listing is "only" dominant in Europe and North America. The majority of RPKs in Asia Pacific, Middle East and Africa are produced by government-owned airlines. Latin America production is strongly dominated by family groups. The text in each box summarizes the dominant airline business models with accompanying equity finance and governance characteristics.

| | Africa* | Asia Pacific | Europe | Middle East | North America | South America |
|---|---|---|---|---|---|---|
| **Listed on public share markets** | • Kenya Airways early alliance with KLM | • Majors<br>• Entrepreneurial start-ups<br>• Mixed ownership (China) | • All successful majors<br>• LCC start-up / IPO plays | • Start-ups only | • All majors<br>• LCC start-up / IPO plays | • Start-ups only |
| **Government owned** | • Traditional flag carriers | • Mature network carriers<br>• Emerging majors (China, Viet Nam) | • Growth economies in Southern and Eastern Europe<br>• "Remains" of the privatization wave | • Traditional flag carriers<br>• Sixth-freedom carriers | • None in large airline group | • None in large airline group |
| **Closely or institutionally owned** | • None in large airline group | • Families dominant<br>• Group control minor | • Travel groups dominant<br>• Entrepreneurial start-ups | • None in large airline group | • | • Families dominant |
| **Other airline owned** | • None in large airline group | • Market access plays<br>• Indian and Chinese consolidation | • Driven by consolidation<br>• Feeder airline control<br>• LCC start-ups | • None in large airline group | • Driven by consolidation<br>• Feeder airline control<br>• LCC start-ups | • None in large airline group |

Table 4.24: Summary of production-dominant governance model and equity investment patterns by region

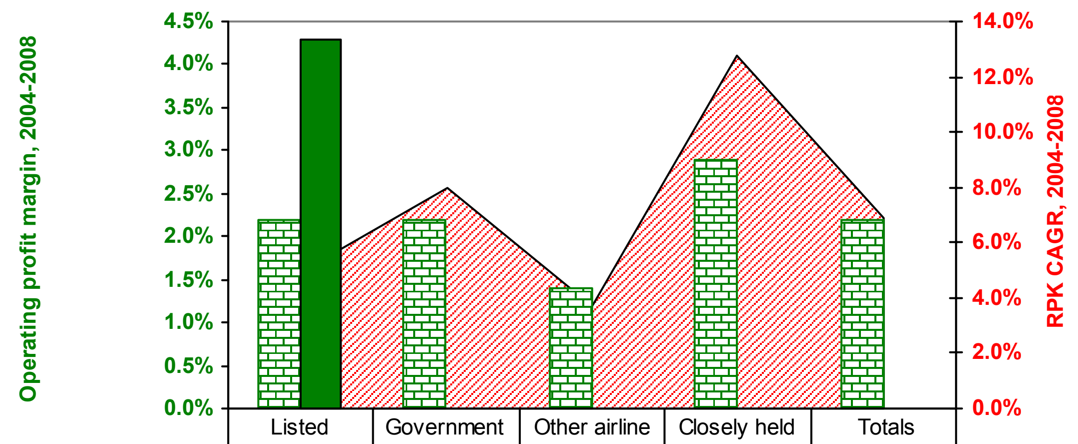
The analysis in this chapter shows that the world's airlines tend to have a strongly dominant type of governance (government, private, listed, other airline). Each region has a set of ownership patterns, as discussed and summarized above in Table 4.24. The airline business as a whole grew RPKs by 6.9% over the five year period, and produced an aggregate 2.2% operating profit margin, as depicted in 4.13. In aggregate over the 2004-2008 period, all save the largest North American regions exceeded these averages, in varying degrees. Both operating profit margins and the compound annual growth rate (CAGR) of RPKs have been highest in the Middle East (dominated by government ownership) and South America (dominated by family-owned airlines), compared with the larger and more mature markets of the northern hemisphere.




| | Africa | Asia-Pacific | Europe | Middle East | North America | South America | Totals |
|---|---|---|---|---|---|---|---|
| RPK CAGR | 5.1% | 7.1% | 8.4% | 14.6% | 4.0% | 10.1% | 6.9% |
| Margins | 3.4% | 2.9% | 3.3% | 4.2% | 0.1% | 6.7% | 2.2% |

Figure 4.13: Profits and growth in the world's aviation regions, 2004-2008

The ownership model selected or imposed by ASA agreements and national authorities, and the attendant incentives to management, have been shown to influence the adoption and use of classical financial valuation techniques worldwide. As 4.14 below shows, growth strategies have been pursued most strongly in growth markets by closely-held and government-owned airlines. The closely-held group (led by South American carriers) is the only ownership pattern showing above-average profit margins, while the government-owned airlines have equalled the industry average over the period.




| | Listed | Government | Other airline | Closely held | Totals |
|---|---|---|---|---|---|
| RPK CAGR | 4.9% | 8.0% | 3.7% | 12.8% | 6.9% |
| Listed ex-N.A. | 4.3% | | | | |
| Margins | 2.2% | 2.2% | 1.4% | 2.9% | 2.2% |

Figure 4.14: Profits, growth and largest share ownership, 2004-2008

Listed airlines in aggregate achieved the industry average profit levels, while growing at substantially lower rates. These aggregate figures are somewhat distorted by the disastrous performance of North American carriers, marked by Chapter 11 bankruptcies among three of the four largest airlines in the U.S. and the world (United, Delta, and Northwest). When the North American region is excluded, the listed carrier profit margins led the industry, with a 4.3% margin over the period. This performance has been led by the listed European carriers, which have opened a clear path toward airline consolidation and profit-oriented management, including the application of Value-Based Management techniques derived from classical financial theory. The lowest-growth/lowest-profit ‘other airline’-owned group has been shown in this chapter to be the least likely to employ classical valuation techniques.

The 37 Airline CFOs responding to the survey in this research – from airlines representing all ownership patterns - revealed substantial use of the “basic” NPV/PBK valuation methods. Estimation of the all-important discount rate parameter has shown to be challenging even for listed companies, implying that listing and statistical techniques such as CAPM are not in themselves sufficient to capture project risks. This research now turns to the questions of estimating these risks, most of which are embedded in the fleet planning assumptions and process, and the potential and practiced methods to value them in the investment appraisal.

# 5. Fleet planning and investment appraisal

Selection, acquisition and disposal the aircraft fleet are major strategic projects for airline managers: a robust investment valuation should fully incorporate the risk of such projects. This chapter aims to reveal the sources of uncertainty inherent in the planning process and the underlying assumptions about future economic conditions, as well as specific airline and aircraft performance.

First, the evolution of the fleet planning strategic drivers and techniques is reviewed, beginning in the regulated period of the 1970s and continuing to the present day. The key strategic decision parameters are identified, and contributions from the academic literature are reviewed.

Second, the influence of manufacturer product decisions and information provided to airlines worldwide is discussed in this chapter. Aircraft investment decisions commit the company to aircraft manufacturers and types over many years, and create a long-term and deep relationship between airlines and makers of aircraft, regarding deliveries, entry into service support including spare parts provisioning & crew training, product support over the time the aircraft is in operation, and potentially, disposal of the aircraft.

Common to all fleet planning processes is a set of assumptions concerning the economic environment, traffic patterns at the both market and airline levels, and aircraft characteristics. These uncertain assumptions are identified, and analysed with responses from a panel of fleet planning practitioners.

Finally, the interactions between fleet planning processes and decisions and the investment appraisal process are analysed beginning in this chapter. Each airline organizes the planning processes differently, even if the departments involved follow the general pattern outlined in Chapter One of this research. This research seeks to establish the positioning of the investment appraisal within the fleet planning process, the relevance of classical financial metrics such as NPV, and its importance (or irrelevance) in fleet decisions. The place and importance of investment appraisal are established by a series of interviews of fleet planning managers from airlines, and fleet finance experts from financial firms. The interviews revealed three distinct approaches to the fleet planning process, the first of which is discussed in this chapter.

The importance accorded to the investment valuation prepares and conditions the application of risk valuation methods to the airline investment problem are discussed in Chapters 6 and 7 of this research.

## 5.1. Strategic issues in fleet planning

### 5.1.1. Strategic drivers of long-haul route development

Underlying fleet decisions are company strategies for route development. Weber and Williams (2001) made a sweeping survey of the drivers of long-haul route development, citing five major areas of relevance to fleet planners and to this research. *Geography* favours economic development in concentrated urban areas, some of which become "gateway" cities and "world" cities for transportation. These cities are characterised by dominant economic positions in their own regions, strong economic connections to activities in other such hubs, and an inherent attractiveness to travellers. This last condition is very important for fleet development, because it implies a dual purpose for such gateways: as a hub for connecting traffic, and as a destination in its own right. Powerful examples of such cities are London and New York. To see the difference between hub and gateway, San Francisco or Miami can be compared to New York or Los Angeles: while both are very important hubs, with a combined total 75m passengers a year, they do not compare with the New York or Los Angeles total of 67m each. In Europe, the gateway of London with 97m passengers (LHR and LGW combined) dwarfs even major hubs such as Paris CDG with 48m and Frankfurt with 49m. The picture in Asia is more balanced, with Hong Kong's 30m passengers comparable to Singapore's 28m or Bangkok's 23m[13].

Weber and Williams discussed the geographic "inertia" or "lock-in" that tends to keep gateway cities in their dominant positions, in spite of subsequent economic movements in their regions. They suggest that with the current state of jet aircraft passenger load/range capabilities, intermediate stops are only a necessity in the rarest of circumstances (London to Auckland, for example), a fact that implies that these gateway cities now serve two distinct and dissociable functions, which can be isolated by planners: first is that of gathering 'behind' traffic and dispatching 'beyond' traffic through the hub, connecting and transporting that traffic over the long haul. The second is that of transporting passengers directly and only to or from the gateway city itself. Interviews with airline executives performed as part of this research show the importance of these two roles for airlines operating in such gateway cities.

[13] Airport traffic figures are from Oum and Yu (2004)

*Regulation* was cited by the authors as a second major driver, and rigidities created by the bilateral ASAs have been discussed in this research. For fleet planners, a further feature of the Chicago Convention (beyond landing rights) is the right of each ICAO state to control access to its own airspace. This creates a set of artificial requirements and economic consequences to route planning and aircraft evaluation. The most apparent example of this is the Russian airspace overflight fee which survived the collapse of the U.S.S.R. and remains in force today (despite a previous "commitment" to abandon the fee in 2012).

Another key driver is the *manufacturers* and their product strategies. Weber and Williams discussed and evaluated Boeing's view that the evolution toward more multilateral and/or less restricted air service agreements (the latest of which is the EU-US accord reached in 2008), held to encourage fragmentation of markets, reducing the role of the gateway cities and expanding point-to-point travel opportunities. The influence of manufacturer product decisions and forecasts on fleet planning information, and potential strategic uncertainties they induce, are discussed below.

Negative *passenger* reaction to long-haul direct service had been expected by many observers to limit the development of long-haul hub-to-hub. Weber and Williams discussed the negative medical and psychological effects of long-haul travel, both in the air (DVT, mild dehydration, boredom, anxiety) and on the ground (jet lag and temporal disorientation, especially on eastbound travel). However, they found that these effects have proven not to be deterrents to long haul direct service, particularly on business routes, where O-D time remains the predominant driver of itinerary choice. In support of this position, the authors cite the success of direct New York-Tokyo service enabled by the 747SP and later the 747-400's enabling of Los Angeles-Sydney services by United and Qantas.

Finally, *airline* choices of services were found to favour the strengthening of gateways such as Los Angeles, where traffic growth was found to be much greater than that of "primary hubs" such as Atlanta, and "secondary" hubs such as Denver. Analysing the London-Beijing route, Weber and Williams developed and calibrated a Competitiveness of Service Index (CSI) model, and found that weekly frequency, O-D travel time, stopovers (with or without aircraft changes), and additional "service-related factors" related to non-stop and direct service were highly predictive of observed market shares in this market.

Aircraft adoption is not of course limited to serving long-haul markets. The fundamental choices airlines must make prior to adopting fleet solutions were outlined by Maurice Pollack in 1982, in a framework he dubbed Route-Frequency (R-F) planning. Pollack argues that R-F planning is the necessary starting point for any coherent fleet plan. The heart of this approach is a set of service-level trade-offs to be resolved by management, each of which has profound implications for the airlines' fleet plan. Most of these trade-offs are still hotly debated in airline planning departments today:

1. Connecting flights vs. direct service
2. Frequency of service vs. aircraft size and layout
3. Frequency of service and premium pricing vs. achieved load factor
4. Longer-range vs. shorter-range aircraft requiring stops
5. Non-stop vs. one-stop vs. multi-stop as a service attribute

Common to all of these trade-offs is the need to arbitrate between the size of the aircraft operated vs. the number of flights required to offer competitive advantage in deregulated airline markets.

### 5.1.2. Aircraft size and service frequency

Fleet development in the wake of deregulation – and specifically the size of aircraft needed to serve deregulated markets – has been a constant source of debate from the 1970s to the present day. Douglas and Miller's 1974 book Economic Regulation of Domestic Air Transport (hereafter D&M 1974) was highly influential in the subsequent deregulation of U.S. aviation markets. In it, the authors developed the thesis that because prices were highly regulated by route, airlines were forced to compete by offering greater flight frequency.

In Brown's (1992) interpretation and test of D&M 1974 and subsequent fleet developments, the D&M model implied that airlines in a deregulated environment would drop this frequency-based strategy, adopt larger aircraft with lower seat costs, and compete based on fares, supported by the lower unit costs of larger shells. Airlines would drop thin routes, and concentrate capacity on the denser routes, served by larger aircraft. Success in the market would thus gravitate to the lowest-cost airlines, i.e., those with the most modern and lowest seat-cost aircraft. Brown (1992) carried this interpretation of D&M 1974 to an extreme, inferring that larger aircraft should serve dense routes, long-haul routes, and tourist routes where connection time is not an issue: in short, aircraft should get larger following the 1978 deregulation[14].

[14] Brown noted in his article that a referee criticized the "over-simplification" of D&M 1974, but defended his interpretation as a "simple extrapolation" of earlier work on the subject.

In his econometric test of the inference, Brown performed a multiple regression of pre- and post-deregulation of U.S. carrier fleet composition from 1970-1989, as a function of hub size (using the FAA's categorisation of large, medium and small hubs), number of passengers, and stage length, along with the conventional constant and error terms. In the first test, Brown found no significant relation of aircraft size to the regression variables ($R^2$ of 0.0444) in the post-regulation period. Aircraft utilisation defined as trips per aircraft in the fleet was shown to bear a weak 0.288 $R^2$ on the negative relationship to large and medium hubs and to stage length, as well as a very small positive relation to passenger numbers: frequency did decrease slightly at larger hubs, as the hub-and-spoke model took hold in the 1980s.

When Brown examined the relationships between the network size and shape and aircraft types, findings confirmed his earlier fleet-side analysis, but also revealed two flaws in his study. He finds airlines strongly adopting the 727, 737 and DC9 at large hubs, less strongly adopting the newer twins (A300, 757 and 767), moving away from the DC10 and L1011, with a moderate adoption of the 747. From this Brown concludes that airlines did not move to larger aircraft as deregulation proceeded, stating that "regulation did not distort airline choices of aircraft so much that airlines had to drastically alter their fleets in the deregulated environment."

During the early period of airline de-regulation, major changes in aircraft technology were introduced. For example, the introduction of the B737 in 1984 began its ascendancy as a workhorse, and 651 737s had been delivered by 1989. Douglas only delivered 42 DC-10s in the 1980s, compared to 236 A300s, and 283 B 757s[15]. These successes had more to do with technological advances, notably improvements in engine performance and the accompanying rejection of tri-jets, than with deregulation per se. Aircraft are not just about size.

Adrangi et al. (1999) attempted to deal with technological advances while using an econometric model very similar to Brown's. The authors tested the adoption of twin-engine wide-bodied aircraft (i.e., A300 and 767) by nine U.S. carriers from 1978 to 1990. The regression variables used to explain adoption of twins were airline profits, and the 8-firm concentration ratio (CR). This latter is the sum of the market shares of the largest eight airlines in the market. Adrangi et al. found that the CR in the U.S. moved up from 72% in 1978 to 91% in 1990, i.e., the industry was already concentrated pre-deregulation, and

[15] The delivery figures used throughout this chapter come from Airbus. A complete table of deliveries is provided in Appendix D.

became more so post-deregulation[16]. The regression analysis revealed an $R^2$ of 0.622, with both airline profits and the industry CR reliable predictors of the adoption of wide-body twins over the deregulated period. As always with econometric estimations (and regression more generally), one is left without certainty of cause and effect between the dependent and independent variables: do airlines adopt twins because they are profitable, or were they profitable because they adopted twins? The same conundrum clearly applies to airline industry concentration. Be that as it may, the authors concur with Brown (1992) that "adoption of technologically advanced aircraft has not changed significantly since deregulation." Airlines do adopt recent technology, but this was not found to be driven by deregulation.

These purely statistical studies do not provide much insight for practitioners of forward-looking fleet planning and investment appraisal, as they are based on historical data: more concrete context is needed. Of greater interest are a series of articles by Wei and Hansen (2003, 2005), in which the authors built demand and cost functions, to demonstrate how airlines may view the trade-off between aircraft size and frequency in strategic planning. They pointed out several times during the series of articles that previous research did not examine the aircraft sizing question central to airline fleet planning.

The market share model in Wei and Hansen (2005) is based on a two-level demand model. The upper level models the binary choice between air travel and alternative forms of travel in a utility framework, driven largely by income levels in the origin and destination. The lower level models the utility of travellers who choose to fly on airline j as $V_{jm}$, as an elasticity function of four attributes:

$$V_{jm} = \alpha \ln(Frequency_{jm}) + \beta \ln(Size_{jm}) + \eta \ln(Availability_{jm}) + \gamma \ln(Fare_{jm}) \quad \text{..... 5.1}$$

The log-linear form is used to allow linear regression of data from the U.S. market. The model was then adapted to a market-share form between two airlines, in order to test passenger choice as conditioned by flight frequency, aircraft size, the availability of seats for point-to-point travel, and the fare.

The authors tested the model on non-stop markets dominated by two carriers. To identify these markets, they used data from the U.S. Department of Transportation, including both market-level data reported by airlines and a 10% sample of boarding passes issued to passengers, in quarterly time increments. The authors analysed markets dominated by two carriers, where

[16] Airline concentration with its potential reduction of competitive pressures is a constant source of concern to U.S. aviation regulators, witness the persistent travails of airlines seeking antitrust immunity over the North Atlantic

both origination and destination was a hub airport for at least one of the competing carriers, and where each carrier offered at least one daily frequency.

The 13 markets chosen included just one mega-hub, Atlanta, with the other cities representing medium-sized continental U.S. hubs. Southwest was a competing airline in six of the 13 markets. The other carriers were Delta, TWA, Northwest, U.S. Airways, and now-defunct Hawaiian Pacific). The choice of markets and airlines implies a test of the service and demand dynamics of network carriers compared to point-to-point airlines such as Southwest. In this regard, the availability term in the model is interesting, as it measured the number of seats left empty at the passenger's origination, in the case of connecting service through a hub. After an initial test showed that passenger utility was not affected by different combinations of aircraft size and available seats on a flight-by-flight basis, a second model was run in which these variables were combined as the product of availability and size denoted Seats. This approach does capture one potentially disutility of choosing a connecting service, while at the same time clouds the issue of aircraft size slightly: the authors' definition of Seats is not the same attribute as the absolute size of the aircraft.

Wei and Hansen found the four service attributes to be highly predictive of market share between the pairs of airlines analysed, with an $R^2$ of 0.9582. They found strong confirmation of the positive effect on market share of offering additional frequency, with a market share coefficient for frequency over twice as large as the effect of offering more seats in a larger aircraft. The elasticity coefficient of 1.093 for frequency implies that market share gains from greater frequency are indeed disproportionate to share of flights offered. The authors were troubled by the weakness of the fare elasticity coefficient (-0.004). They speculated that this lack of elasticity could be due to the relatively crude measure of using overall fare levels rather than disaggregate fare data from RM systems, and service quality differences which can reduce fare sensitivity. The authors concluded that the competitive advantage of frequency means that "airlines have an incentive to use aircraft smaller than the least-cost aircraft."

These studies tended to confirm that (contrary to D&M 1974's expectations) deregulation encourages airlines to increase frequencies into hubs, while reducing the size of aircraft feeding these hubs. These trends in fleet developments have been observed in the major deregulated markets in North America and Europe.

One feature of Brown (1992), Adrangi et al (1999) and other studies of the impacts of aviation deregulation (see for example, Baltagi et al. 1995, Boresnstein (1989, 1990, 1992)), is that progress made in aircraft design, and the crucial aircraft programme decisions made by aircraft manufacturers are exogenous to fleet development in the U.S. aviation market. The second strain of literature on aircraft size and its relationship to network development comes via the manufacturers, notably Airbus and Boeing, who combine air transport demand forecasting with economic studies of current and future aircraft, to demonstrate the viability of new aircraft product strategies. These analyses are widely used (albeit with a substantial grain of salt) by airline managers, who are today faced with different visions of the future of air traffic development.

### 5.1.3. Manufacturer influence on fleet development strategies

Underlying the question of 21st century fleet development is a debate which has been growing in amplitude in recent years, as the manufacturers' product lines develop, airport congestion increases, fuel price volatility increases, and environment becomes a major concern.

Known in manufacturer jargon as consolidation (travel over hubs) vs. fragmentation (hub bypass), and more commonly in the trade press as the hub-and-spoke vs. point-to-point business model, there is a great deal of literature underlying this debate. For the individual airline, this is an important driver of the Route-Frequency (R-F) problem framed in Pollack (1982). And yet it is not an identical question: any airline must resolve the R-F trade-off as a basic element of its strategy; on the other hand, the hub-and-spoke vs. point-to-point question varies in its nature and importance between short-haul and long-haul carriers.

For short-haul airlines, "hubs" (simplistically defined as areas where a large proportion of an airline's flights originate) can simply be the locations where the aircraft are parked overnight, with no intention to concentrate connecting traffic in the hub airport or the local catchment area. For example, easyJet originates a great number of its point-to-point flights from Luton, Gatwick, and Stansted airports, but in no way is any of the three – nor is London more generally – a "hub" intended to concentrate connecting traffic. In this model, the network shape is *constrained* by the necessity of a base for parking and certain maintenance activities, but not *formed* by a connecting strategy.

When the hub definition is extended to include the strategic option to serve connecting traffic, the hub-and-spoke vs. point-to-point question is critical in strategic network design only to the largest carriers with the ambition to concentrate relatively nearby traffic and connect it onto a long-haul network. It is these “mega-carriers” to which the majority of the “consolidation vs. fragmentation” literature is addressed. There are very few countries with populations large enough to support true hub and spoke airlines in purely short- and medium-haul operations, and few airlines have been successful doing so.

This research suggests that when airlines have resolved both of these questions in their strategic outlook, the fleet planning process becomes to a great extent and exercise in aircraft evaluation. The most recent research in the consolidation-fragmentation debate is reviewed below.

Aircraft and engine manufacturers analyse passenger and freight traffic at a detailed level, and translates the impact into a 20-year forecast of the jet fleet in widely distributed tomes updated every year or two depending on conditions: particularly influential are the Boeing Current Market Outlook and the Airbus Global Market Forecast. Aviation executives interviewed as part of this research affirmed that these studies are quite influential in fleet planning circles.

The two current large jet manufacturers’ latest forecasts, both released in the second half of 2009, have as their basis a remarkably similar view of passenger demand growth: 4.9% from 2009-2028 for Boeing, 5.2% for Airbus. However, the consensus ends here, as the overall aircraft delivery forecasts produced by the two manufacturers in Figure 5.1 shows. The two fleet forecasts are notoriously difficult to compare, notably in the area of smaller planes due to the inclusion of propjet aircraft by Airbus, and different size categories used by each. For this research, we used the 100+ seat count for Airbus and 90+ for Boeing to make the single-aisle comparisons: other product segments are more easily comparable. The twin-aisle market is largely dominated by each manufacturer’s twinjets, while Very Large Aircraft (VLA) segment include only the 747-8 and the A380.

The Airbus forecast shows 10% fewer deliveries of aircraft overall, made up of 13% fewer deliveries in each of the Single- and Twin-aisle market, and a Very Large Aircraft (VLA) forecast 78% higher than that of Boeing, reflecting the manufacturer’s multi-billion dollar bet on the future of the A380.

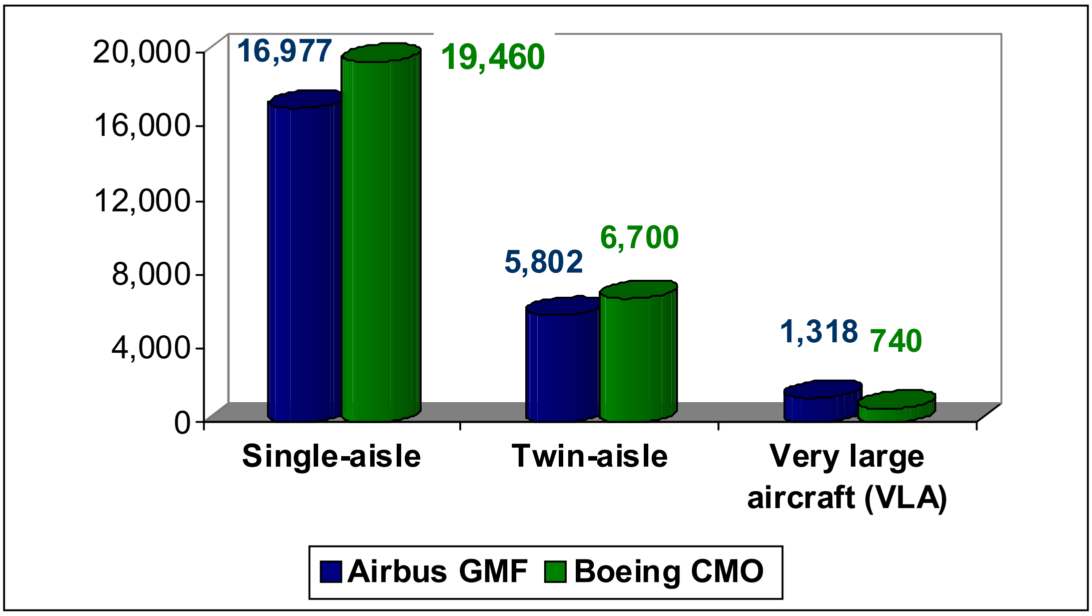



Figure 5.1: Forecasts of aircraft deliveries 2009 – 2028 from Airbus Global Market Forecast (GMF) & Boeing Current Market Outlook (CMO), 2009 editions from each manufacturer

In the long range market overall, Airbus delivery forecast is 4% lower than Boeing's, though on a seat-count basis the forecasts must be quite similar. This is difficult to verify as the companies don't reveal this level of detail; however, a rough calculation of the seats to be delivered reduces the difference between Airbus and Boeing to a mere 2% in the long-haul market: a very small difference indeed, over a 20 year forecasting horizon.

Such relatively small percentage differences belie the enormous stakes each manufacturer has in the forecasts being accepted by the audience of fleet planners. The differences between Airbus and Boeing forecast jet deliveries in the world's regions reveal strikingly different views of fleet development in the world's aircraft markets. Table 5.1 shows the divergence between the Airbus and Boeing view of fleet development region by region, in units of aircraft to be delivered over the next twenty years. Positive numbers indicate a greater need for types identified by Airbus, while negative figures indicate a greater unit delivery forecasted by Boeing. The GMF and CMO data used in this analysis is presented in Appendix C.

| Region | Single-aisle | Twin-aisle | VLA | Total Twin+VLA | Total Deliveries |
|---|---|---|---|---|---|
| Asia Pacific | -1 042 | -187 | 381 | 194 | -848 |
| North America | -1 066 | -307 | 24 | -283 | -1 349 |
| Europe | -729 | -274 | 81 | -193 | -922 |
| Middle East | -119 | -182 | 59 | -123 | -242 |
| Latin America | 80 | 9 | 9 | 18 | 98 |
| Russia & Central Asia | 123 | -16 | -6 | -22 | 101 |
| Africa | 270 | 59 | 30 | 89 | 359 |
| Totals | -2 483 | -898 | 578 | -320 | -2 803 |

Table 5.1: Delivery forecasts comparison: Airbus forecast higher (+) or lower (-) than Boeing

The disparity of these views can be inferred for each region:

- Asia Pacific is seen by Airbus to be both more long-haul and consolidated around hubs, requiring a large number of VLA to serve the "gateway" cities of Asia
- Airbus sees North America and Europe as lower-growth overall, and is particularly bearish on North American traffic development using large jets, probably due to the recent trend toward RJ use in fleet development.
- Airbus "concedes" that VLA growth in North America will be less than that in Europe with its very dense air traffic space, and the Middle East with its sixth-freedom hubs.
- Airbus is across-the-board more optimistic about Latin America and Africa, particularly as concerns intra-regional development.
- Internal and intra-regional growth in Russia and Central Asia requiring single-aisle aircraft is viewed with greater optimism, while the need for larger jets is significantly less, as development takes place in the shadow of mega-hubs located in Western Europe and the Middle East.

The Airbus view of fleet development strongly supports the consolidation (hub-and-spoke) view of the future for fleet planners' consumption. The 378 VLA delivery delta between the Airbus and Boeing fleet forecasts represents well over US$150billion in business for the manufacturers over the next 20 years. Putting this difference in opinion in commercial perspective, the difference in opinion represents over 20% of Airbus' total revenue in 2009. The commercial logic underlying the analysis is undeniable.

Since the advent and passing of the Sonic Cruiser and the phenomenally successful commercialization of the B787, Boeing has consistently promoted the fragmentation view of future network and fleet development. To demonstrate this, Chief Economics for Marketing William Swan (2007) used historic data to show that aircraft size has been in constant, gradual decline since 1990, as shown in Figure 5.2.

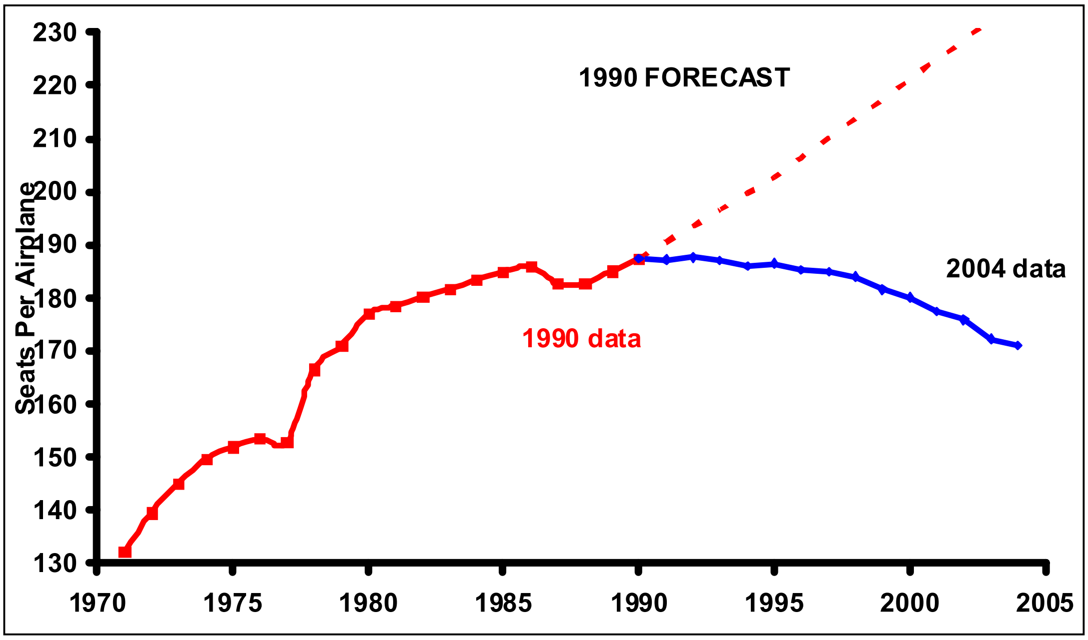


Figure 5.2: average seats per airplane from Swan (2007)

The reasons Swan gave for this major reversal of trend beginning in 1990 are related to negative characteristics of larger aircraft:

- Large aircraft turn around more slowly
- Value is created by new frequencies
- Reduced airport noise

The size argumentation has been accompanied by strong rhetoric advising airlines to embrace a high-frequency, fragmented view of market development, as illustrated by the table below, from a presentation by Dr. Swan.

- **Plan for growth:**
  70%-100% of it in added frequencies
- **Plan for flexibility:**
  Long-term commitments should not hang on one specific future
- **Plan to have more routes:**
  Growth will include new nonstop markets
- **Plan to have more frequencies:**
  Growth will include more flights at more times of day
- **Plan to face competition:**
  Competitors will by-pass your hub
- **Plan to discuss history:**
  Leaders may imagine growth patterns different from history

Table 5.2: Conclusions to Swan (2002), from Cyberswans.com, routenetworkhistory.ppt

The consistent commercial argumentation of decreasing aircraft size has bedevilled Boeing's competitors and impressed airline fleet planners for the ten years since Boeing adopted a smaller twinjet product strategy for the early 21st century. However, the use of simple average seats in the market masks two major trends in aircraft deliveries since 1985 (the year when, according to Swan, seat counts began their downward trend).

These trends become clear when a more forward-looking examination of aircraft deliveries (as opposed to aircraft in service, which reflects past choices). The first trend is toward greater numbers of short-haul aircraft deliveries in terms of seats, at the "expense" of long-haul machines, over the last 24 years. The second is the strong current trend toward increasing seat-counts in long-haul aircraft. The deliveries data for this analysis is provided in Appendix D.

To examine these two trends, aircraft seats delivered into the market are examined. The representative seat counts for in-production aircraft in Swan and Adler (2006) are used:

| Short-haul configurations | Nominal | Two-class |
|---|---|---|
| A318 | 117 | 107 |
| 737-600 | 122 | 110 |
| 737-700 | 140 | 126 |
| A319 | 138 | 126 |
| A320 | 160 | 150 |
| 737-800 | 175 | 162 |
| 737-900 | 189 | 177 |
| A321 | 202 | 183 |
| 757-200 | 217 | 200 |
| 757-300 | 258 | 243 |
| | | |
| Long-haul configurations | | |
| 767-200 | 238 | 163 |
| 767-300 | 280 | 200 |
| 767-400 | 315 | 229 |
| A330-2 | 355 | 233 |
| A330-3 | 379 | 268 |
| 777-200 | 415 | 308 |
| 777-300 | 510 | 385 |
| 747-400 | 553 | 429 |

Table 5.3: Aircraft seat counts used for cost estimation in Swan and Adler (2006)

To these data, the following representative seat counts from aircraft manufacturers are added:

| Short-haul configurations | Nominal | Two-class |
|---|---|---|
| 737 classic | 170 | 148 |
| MD80 series | 155 | 143 |
| | | |
| Long-haul configurations | | |
| DC-10 | 380 | 250 |
| MD-11 | 410 | 285 |
| L-1011 | 400 | 270 |
| A300 | 298 | 266 |
| A310 | 247 | 240 |
| 747-100/200/300 | 490 | 374 |
| 340-200 | 300 | 261 |
| 340-300 | 335 | 295 |
| 340-500 | 359 | 313 |
| 340-600 | 419 | 380 |

Table 5.3b: Aircraft seat counts used for delivery trend analysis (Source: Airbus, Boeing)

The non-shaded area of each table contains the seat counts used for the present analysis. The two-class seat counts are used for long-haul aircraft, because all-economy layouts are rare in newly-delivered long-haul planes, and second because as can be seen above, some of the "nominal" seat counts from Dr. Swan's earlier paper and from manufacturer commercial data seem rather high (553 seats in a 74-4!). Nominal or single-class seat counts are used for the short-haul, due to the strong trend toward either single-class or quick-change seat layouts in short-haul markets.

Multiplying these seat counts by the number of aircraft deliveries of each type tracked by Airbus, short-haul seat deliveries as a percentage of total seats delivered in each year is depicted in Figure 5.3.

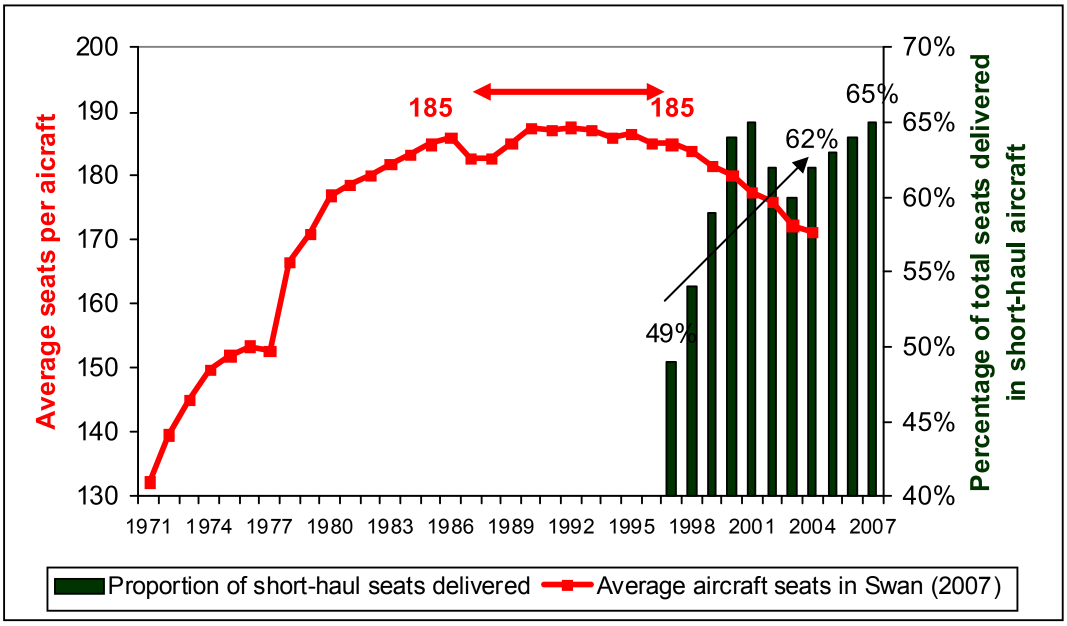



Figure 5.3: average seats per airplane from Swan (2007) and percentage of total seats delivered in short-haul aircraft

Average seat count in Swan (2007) was an identical 185 seats in 1985 and 1997, after which the decline in average seats was observed. 1997 saw the deliveries of the first three 737-700 aircraft. In an unprecedented ramp-up, Boeing delivered 165, 278, and 279 737NGs in the three succeeding years, while Airbus delivered an equally impressive 758 A320 family aircraft between 1997 and 2000. Both of these ascensions were driven by excellent products, ageing 737 classic and 757 fleets, strong lessor appetite for single-aisle aircraft, and the then-nascent globalization of the low cost airline business model. The capacity build-up left each manufacturer hungry for orders during the years after 9/11, leading to savage discounting and a continued climb of deliveries since. All of these factors drove short-haul aircraft seats (and of course, smaller aircraft) delivered from a low of 49% of all seats in 1997, to 62% in 2004. The trend has continued, as short-haul aircraft seat deliveries reached 65% of seats delivered in 2007.

The second major trend through the 1990s and 2000s is a substantial *increase* in long-haul aircraft seat counts in the 1990s. To illustrate this and compare the results with Swan (2007), seat count trends are depicted as indexes in Figure 5.4.

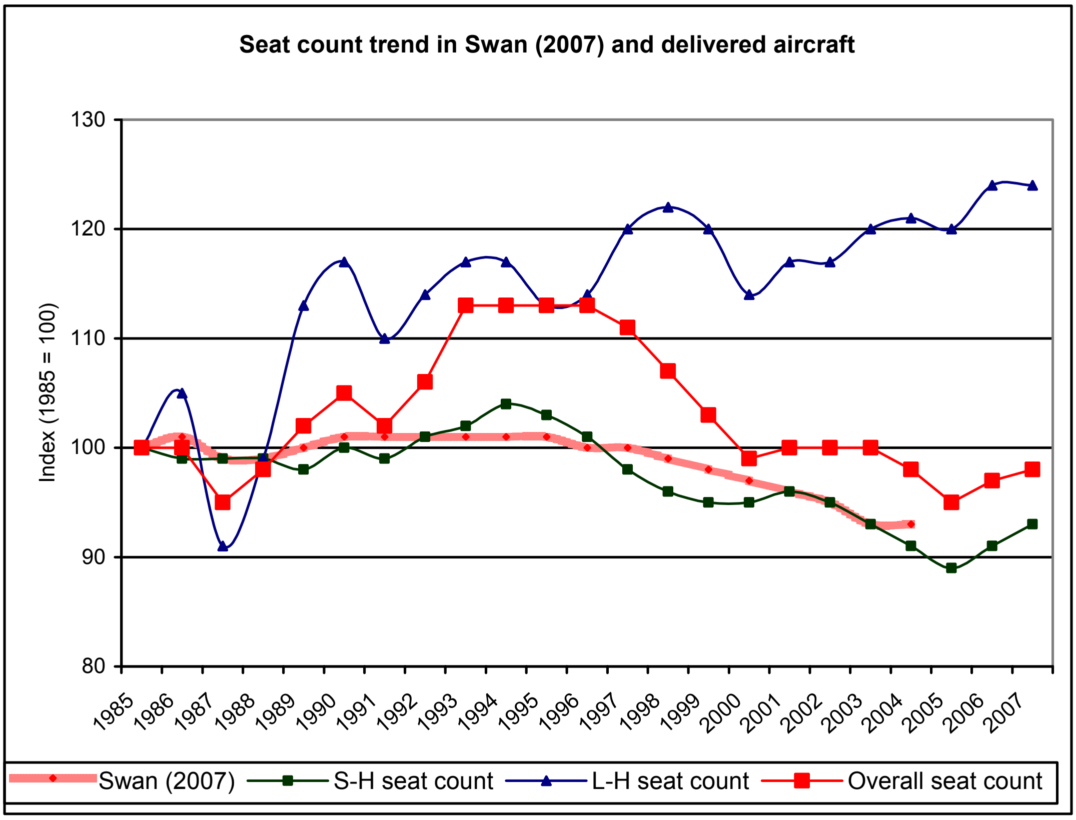



Figure 5.4: trend in average aircraft seat count, Swan (2007) and deliveries, 1985-2007

In broad terms, this analysis agrees with Swan (2007): the overall average size of aircraft delivered has decreased from 1985 to the present day.

However, the long-haul and short-haul segments show opposing trends: average seats in long-haul aircraft deliveries increased over 20% from 1985 to the peak size in 1998, from an average size of 251 seats to 307. In 1985 the long-range aircraft being delivered were the A300-600, A310-200, the 767-200 (joined by the 767-300 in 1986), and the remnants of the DC-10 and L-1011 programmes, with a simple average of 231 seats. The 374-seat 747-100/200/300 aircraft represented only one quarter of long-haul deliveries in 1985.

By the mid nineties, the picture had completely changed, with the introduction of the 777-200 (1995 introduction) and 340-300 (1993), each with around 300 seats, joined in 1998 by the 385-seat 777-300. Seat deliveries of these types dwarfed the 200-seat 767 series and 266-seat A300-600. Additionally, the 747-400 delivered 471 units in the 1990s. The programme's decline has accelerated since the commercial launch of the A380 in December 1999, but the size of long-haul aircraft delivered remains 24% over the 1985 size.

In the short-haul segment, the opposite phenomenon is observed, with the decline in average seat count delivered from 173 in 1985, to 157 in 2004 and 161 in 2007, a 7% seat count reduction. In the 1980s, the MD-80, 737 classic and especially the 757-200 with average nominal seat count of 181 seats were the aircraft being delivered. The success of the A320 family and 737NG has driven the decline in seat counts. There has been a small uptick in seat count since 2004, due to the increased success of larger A321 and the 737-800.

Thus, the decline in aircraft size in recent history has been driven by an increasing share of deliveries of smaller single-aisle jets. The two trends point up the fact that that *size* of aircraft is bundled with the *range* of the aircraft. The comparison of this analysis with the assertions about aircraft size in Swan (2007) is an example of the uncertainty fleet planners face when using academic and/or manufacturer data to establish their long-term fleet plans, as well as demonstrating the dangers of using simple averages as parameters for modelling. The analysis looks at larger jet deliveries from Airbus, Boeing, Lockheed, and McDonnell-Douglas: given the success of Embraer and Bombardier jets, the average seats delivered in short-haul aircraft would show an even more important decrease in recent years were seats delivered in their products included. This analysis tends to lend credence to a conclusion of Swan (2007), "a forecast (sic) is a trend where you know the reasons why things went the way they did."

The attractive power of frequency and total travel time have been revealed to be of lasting importance in air transport markets since the regulated period, notwithstanding the predictions of D&M 1974. The two forces are in many ways in tension with one another in long-haul fleet development: frequency implies smaller aircraft to serve gateways, such as the 767 and 330, while achieving direct service to distant gateways implies the use of larger aircraft, where range is coupled (or "bundled") with capacity in larger planes such as the 777-200LR and 340-500/600 offerings. This curious feature of long-haul markets has fuelled the fragmentation vs. consolidation debate.

The future visions of aircraft manufacturers cannot be taken lightly by fleet planners, if for no other reason than aircraft availability depends utterly on the viability of aircraft programmes promoted in their literature. The billion-dollar bets on the future of aviation made by airframers and engine manufacturers create substantial strategic uncertainty among planners. This research identified one strain of fleet development strategy that implicitly takes such uncertainty into account when valuing investments: this approach is discussed in Chapter Six.

### 5.1.4. Fleet development modelling literature

The literature on airline fleet planning techniques has evolved in several directions, the most prevalent of which are applications of Operations Research (OR) techniques, and initially, linear programming (LP) in particular. Operations researchers have long attempted to optimise fleet sizes using of linear programming optimisation techniques, although such attempts are fewer in recent years, notably due to the modelling problems discussed below. Early recommendations for LP fleet planning models are found in Miller (1963 - linear programming), Burger and Rice (1966 – integer linear programming), Larson (1968 - dynamic programming). Another approach was to establish heuristic schemes, a set of descriptive rules about fleet sizes which can be applied to expected market conditions (Gunn 1964, Howard and Eberhardt 1967, Jessiman et al., 1970).

Aircraft manufacturers joined in the search for optimal fleet plans using LP. The most complete application was provided by Douglas Aircraft's Schick and Stroup (1981), who tested a set of models developed at the company to optimise fleets. The core "Multi-Year" model was built to optimise based on one of three planning objectives:

1. Minimization of direct operating cost
2. Minimization of amount spent for new equipment
3. Minimization of the sum of (1) and (2), above.

The authors ran the model over a six year horizon, for a European airline initially operating 46 aircraft in international markets, incorporating existing fleet as well as already-made decisions on future fleet disposals, 6% traffic growth and a 61.5% planning load factor. Overall, the LP model reduced the number of aircraft to 43 while meeting the demand growth, however, the pattern of sales and purchases showed a rather unrealistic pattern (eg.,10.5 DC-9S sold in year 3, and 11.55 of the same type purchased the following year). The authors recognize several problems with using such models in airline fleet planning processes, the most serious of which is the fact that schedule development and fleet planning were "manual processes" that did not use linear programming as an underlying tool, and associated "philosophical differences" from the "bottom-up" (route-by-route) approach used at airlines.

A comprehensive statement of the problems encountered using this type of optimisation model for fleet planning was provided in Pollack (1976). Linear programming runs into problems with faced with one or more market realities. The first is the airline requirement that aircraft schedule frequencies be expressed as integers rather than fractional figures, although this can be solved at the expense of more complex computation using the integer linear programming: computing power was a concern at the time that has largely dissipated today. A second more serious problem is the assumption of constant traffic flows, when demand airline traffic is both highly seasonal and time-bound (day of week, time of day). The linear programming options would be to plan capacity for peak demand (generating excess fleet), or for average demand as in Schick and Stroup (generating capacity insufficient to meet the airline schedule at peak). Similarly, such models did not follow the physical location of aircraft in the system, and hence, do not consider isolated aircraft, which can be unavailable for maintenance or even for service requirements.

The most serious problems identified by Pollack concern passenger preference, notably regarding fare level and flight schedule. Linear programming models do not do well when faced with market-level service requirements such as minimum weekly frequency, non-stop service between city-pairs, or the potential passenger preference for aircraft sizes. The problem of passenger preference and city-pair flow was absent from the models reviewed. Station constraints such as slots and curfews are well-handled as LP, but since they vary around the airline's service area, they create a need to model the system in a substantial level of detail, making general-purpose models fit for all airlines elusive in practice.

Another problem with LP models concerns the nature of the output: given the need for continuity in cabin product offering and fleet plans (see the rapid-fire DC-9S sell-buy, above). Selection of aircraft for a given objective(s) is by definition based on current period conditions (traffic, growth, fleet availability). Such models are to a great extent "memory-less," without regard for continuity in fleet development beyond the constraints manually entered into the model, i.e., current fleet, already-planned acquisition and disposal dates.

The final challenge to LP usage for fleet planning concerns modelling revenue streams. As in Schick and Stroup (1981), linear programming solutions at this time focused primarily on cost optimization, with little consideration for passenger utility and resultant revenue characteristics. Pollack pointed up the problem by stating "at best, revenues can be approximated with piece-wise linear functions," including a constant and intercept to estimate fare based on distance. Any such general function for revenue could only be used on an average-fare basis, ignoring differences in competitive levels, potential fare subsidies, and open-jaw type routing where the distance travelled is greater than the passenger's origination-destination (O-D) fare would imply. The magnitude of such problems have only grown since the period following fare deregulation, as airline pricing has become increasingly non-linear, following the implementation of O-D pricing, fare classes and accompanying revenue management systems intended to maximise overall system revenue, as well as the low cost carrier business model with its dramatic disruption of legacy carrier pricing schemes.

Costs can also behave in non-linear or inconsistent fashion: fuel prices vary, cycle-driven maintenance (engine, landing gear) do not vary with distance, station fees, spares requirements, special maintenance arrangements between airlines (pooling) and engineering labour rates all vary internationally, making linear modelling problematic.

LP has found far greater acceptance in the area of airline network design and fleet assignment to routes (as noted above, both BA and Air France place Network and Fleet Planning within the same organisational units).

Network design in the R-F approach is one of the "manual" processes mentioned by Schick and Stroup, using both commercial and technical considerations to define the proper service mix to serve the airlines' markets.

Etschmaier and Rothstein (1974) identified six international airlines (Japan Airlines, Air France, Air Canada, Lufthansa, Qantas, United) that tried or used linear programming to define the airlines' route-frequency (R-F) plans. All of these attempts were documented in proceedings of the Airline Group of International Federation of Operational Research Societies (AGIFORS).

The Air Canada method cited is illustrative of the use of LP in network design:

1. Identify a flyable network of city-pair connections
2. Estimate passenger demand between each city pair
3. Use an LP model to assign *frequencies* to each leg of the network
4. Low weekly frequencies are eliminated from the schedule as undesirable
5. Round the non-integer frequencies

Successful use of the LP model in step 3 requires that both the available fleet and the service-level constraints identified in Pollack (1982) be entered as constraints to the LP model, which then produces a frequency programme to maximize the expected profits. For this research, it must be noted that the problems of estimating cost and revenue as linear functions are not eliminated by this more modest use of LP. While these models apparently produced insightful approximations of potential service propositions, the financial projections of such models are limited at best. In order to go from a frequency plan to a reasonable accurate financial projection, at least a rudimentary flight schedule would be very useful.

In a second paper from 1974, Maurice Pollack concluded that scheduling is indeed a largely heuristic and "manual" process. Beginning from a daily (time-of-day) or weekly (day of week) set of frequencies, the scheduler attempting to use LP finds that "no optimal solution to this problem [i.e., the problem scheduling and determining the minimum number of aircraft for a given set of frequencies] is known; the solution procedure presented is heuristic in nature."

He proposes setting flight departures at desirable times for service quality, and linking departures to arrivals at each city on a first-in-first-out basis. Since no flight departure can be re-timed, a significant number of unlinked flights will remain after this first step. An iterative process in which the desired departure times are allowed to shift within acceptable ranges to suit prior and subsequent aircraft movements allows the linking of all flights, at the expense of schedule convenience for connecting passengers on some flights. When all flights are linked in acceptable ways, the schedule is validated using a cycle diagram, with aircraft tail numbers on one axis, and the 24-hour day on the other. Each city-pair flight is charted with its flight time between origin and destination and the related ground time. The cycle diagram allows a clear view of the aircraft utilization, and naturally allows both a clear check on utilisation and viability of the schedule, and, for the financial projection, a clear set of fleet assignments for each route, necessary for revenue and cost calculations.

One can imagine the time and complexity of producing a cycle diagram with 300 aircraft on its vertical axis. Clearly, this view of schedule definition owes as much to art as to science, and is indeed highly "manual": in this view, the potential use of modelling is limited to the strategic definition of a frequency programme, which is itself subject to many qualitative heuristics needed to define an R-F strategy based as much on experience and intuition as hard data.

Since these seminal investigations, the academic literature has evolved on the one hand to provide *integer* LP solutions to fleet planning problems, and on the other, to account for uncertainty in operators' environments. Abara (1989) developed a workable integer LP model for aircraft fleet assignment to a fixed schedule, which was extended by Hane et al. (1995) relaxing the fixed scheduling constraints. This work was in turn extended by Clarke et al. (1996), who added maintenance and crew scheduling constraints to the model. Further strains of fleet assignment modelling were proposed by Desaulnier et al (1997) and Barnhart et al. (2002), complemented by Lohatepanont and Barnhart (2004).

The introduction of uncertainty in the form of stochastic fleet assignment modelling for air transport was first introduced by Mulevy and Ruszczynski (1995), followed by List et al (2002) and Yan et al (2008). The models attempt to achieve “robust optimization,” defined as a fleet assignment solution that meets objectives (cost and service quality) under a variety of as-yet unknown situations. The uncertain situation analysed in List et al. (2002) concerns a three-node transportation network served by a single vehicle type. Demand is uncertain, with a coefficient of variability (standard deviation divided by sample mean, aka “K Factor”) of 0.4, a figure often used for airline spill modelling. In List et al., there is a cost due to delayed shipments caused by spill due to demand fluctuations. List et al.’s approach uses a semi-variance calculation to estimate the effect of peaks in demand, putting aside the effect of troughs, in order to capture the (negative) effects of spill. Their stochastic model generates required fleet size in order to minimise cost and penalties that is nearly twice as large as the fleet requirement estimated without uncertainty (!). Of course, the model may be calibrated to account for a lower aversion to risk (e.g., using a lower delayed shipment penalty cost) than in the base case. The complexity of calculations (especially given the very simple network and fleet) is rather daunting, and the article leaves the reader with a “black box” feel, a typical reaction to stochastic modelling among business managers. Finally, one seriously doubts that this model would be scalable to reflect the complexity of real-world aircraft operations.

In summary, the OR/LP approach to fleet planning achieved moderate success helping airlines to define frequency programmes in combination with heuristic methods such as Pollack’s R-F design trade-offs cited above. Further elaborations and evolutions have solved certain technical problems and more recently, introduced the problem of demand uncertainty on very simple networks and fleets.

Increasingly, the literature applications of LP-type techniques concerns scheduling and demand allocation rather than fleet or investment planning per se. As Etschmaier and Rothstein point out, LP has found more lasting applications in critical areas such as crew scheduling, spares provisioning, maintenance planning. As easily-accessible computing power and programming tools have evolved, more detailed and mathematically advanced models have been developed as proprietary tools by the network carriers, but the process remains a complex mix of management judgement and modelling, witness the academic and practitioners’ literature, and the executive interviews performed during this research and discussed in subsequent sections. This research does show that LP techniques are strongly influential in what will be called the “neo-classical” fleet planning and valuation approach. On the other hand, stochastic modelling is found to be used only in the valuation phase, and then only under specific circumstances.

## 5.2. Fleet planning and airline planning processes

While there are numerous books on airline and aircraft *economics* to guide planners, the literature on fleet planning and its place in airline planning *processes* is far more limited. Generalization on planning processes is difficult, for at least three reasons. First, airline planning is distinctly related to organization structure and objectives, which vary by governance, business model, and geography. Boumrene and Flavell (1980) suggest a "typical" airline organisation structure in their article on airline corporate planning, with all functions reporting the General Manager:

- Flight operations
- Engineering and maintenance
- Programme and scheduling
- Marketing
- Finance
- Personnel and General Administration

While this type of organization is found in many airlines today, exceptions are as common. For example, Clark (2007) presents the British Airways organization with the classical Engineering/Flight Operations departments, but with Network and Fleet Planning, as well as Revenue Management within a "Commercial Planning" directorate. This reflects an organizational philosophy which network and fleet planning are within a single commercially-oriented directorate, separate from the operational divisions: this tight interrelation of network development and fleet planning characterizes the literature on the subject of fleet selection as well.

Secondly, fleet planning in particular is considered highly strategic and confidential, often the domain of the highest-level strategies and negotiations between airline and manufacturer executives [17]. This lends an air of uniqueness to many fleet development campaigns, characterized by ego-driven bargaining and brinksmanship that defies easy categorization. Lastly, fleet planning it is inherently multi-disciplinary, giving it a company-wide importance which defies simple positioning in one or the other phases of company planning. The complexity of the airline business necessitates strong cross-functional cooperation.

Bouamrene and Flavell (1980) posited a 10-stage planning process for airlines. The first five stages are focussed on two areas: establishing the airline's objectives and resources on the one hand, and analysing the market

[17] Many colourful and well-documented examples of this can be found in John Newhouse's The Sporty Game (1982)and Boeing vs. Airbus (2008)

and operating environment on the other. Stages five and six involve what most would refer to as fleet planning, and again evidence the proximity of network and fleet planning in airline development:

- Identification of competitive aircraft
- Network structure and development
- Procurement / retirement policies
- Aircraft/route performance analysis
- Economic analysis (including cost, revenue, economies of scale and benefits of fleet standardization)

The investment plan preparation and appraisal form the next two processes, which in turn give way to what the authors refer to as "Corporate Plans", essentially short and long term budgets. Fleet planning is positioned after the company's determination of market and strategic goals, while the investment appraisal is in turn positioned at the end of the fleet planning process.

An example of the importance of the airline network shape and development to airline business plans was the save-the-company plan developed by Alitalia in 2004 and 2005, and posted on the company web site. The network shape was depicted graphically by Alitalia as presented in Figure 5.5

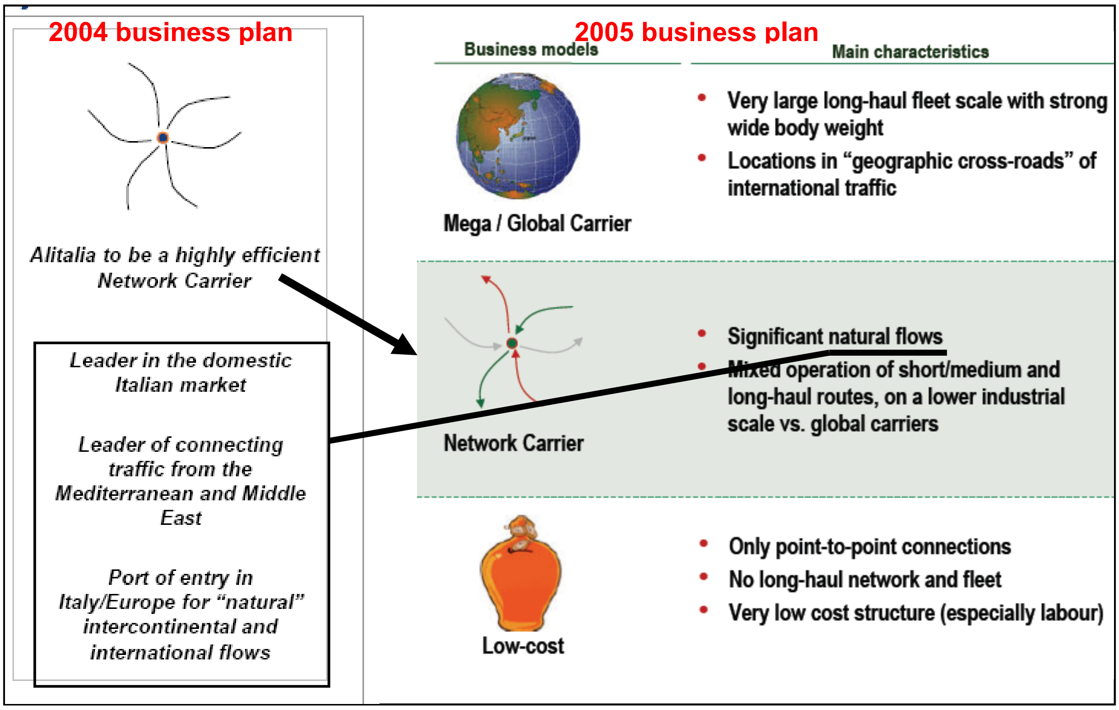



Figure 5.5: Alitalia network shape from Business Plan (source: Alitalia.com)

In this plan, the company's new business model turns away from the "global mega-carrier" network shape, positioning the network and resultant future fleet requirements as a hub-and-spoke operator serving "natural" flows centred around Europe and the Mediterranean. This obviously has profound implications for the company's fleet requirements, and as such, is precedes both the fleet plan and the investment appraisal.

In lectures given at AirBusiness Academy and elsewhere between 2003 and 2006, Paul Clark suggested a quite similar view of planning processes, with rather more detail on the fleet plan. In Clark's view, the fleet plan is directed by and subsidiary to the company's business plan. The investment appraisal is positioned at the end of the fleet planning process, and is a monetary quantification of the fleet plan. The investment appraisal has the highest-level consideration, as the primary document which goes to the CEO and eventually to the Board of Directors for consideration and approval, following the flow chart depicted in Figure 5.6.

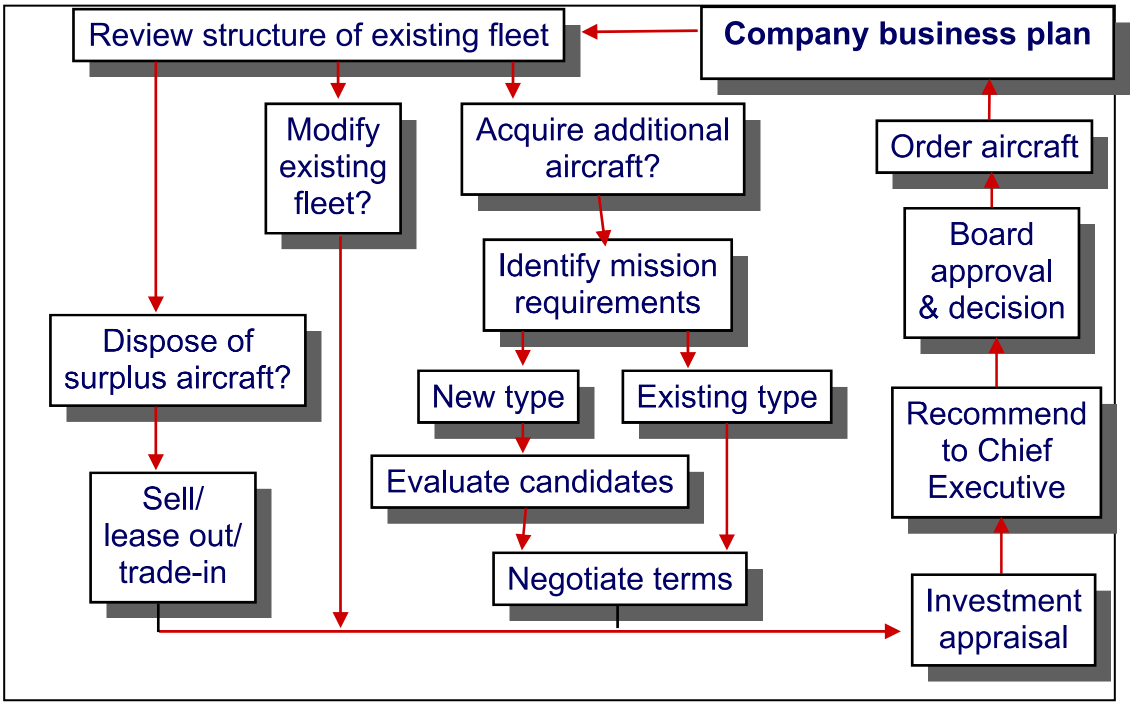



Figure 5.6: Position of fleet planning and investment appraisal, lectures by Professor Paul Clark

This view positions the investment appraisal and valuation as the 'arbiter' of the fleet plan's validity.

For the analytical phase of the fleet plan, Clark (2007) suggests that airlines should combine a top-down approach to defining capacity requirements at a market-by-market level, with a micro analysis. The top-down approach is simpler and useful for the long range picture, giving planners an overall feel for the market dynamics expected over the planning horizon, and has the added potential advantage of benefiting from historic data for demand projections.

The micro analysis is of course far more complex, although still not carried out on a flight-by-flight basis. In Clark's view, a detailed schedule is not feasible or needed for long-term fleet planning: the R-F plan with its overall allocation of aircraft to markets is sufficient in his view. His recommended steps for the micro analysis includes the following

1. Market segmentation and underlying demand and yield forecast for each cabin class
2. Demand allocation to aircraft types based on the overall demand forecast, supplemented by S-curve modelling and/or, Quality of Service Index (QSI) modelling to account for competitive conditions
3. Spill analysis taking into account variations in demand by reason for travel, by season, by day of week, and by time of day
4. Network simulation which generates capacity, traffic and load factors for each type of aircraft on an annual basis

Step four serves as a pivot to an iterative process until supply and demand are properly matched. This micro analysis provides the capacity and traffic inputs to the investment appraisal, defined in a very classical way in Clark's work, which is more focussed on the performance and cost aspects of aircraft comparison than on revenue or cost forecasting at the fleet level. Once again, the investment appraisal itself is seen as a translation of all preceding analysis, including the fleet sizing and network simulation.

Another example of the positioning of the investment appraisal is provided in Weber and Williams (2001), where the authors use a diagram from J.P. Morgan Securities graphic as an illustration of airlines' "product development" process, including both the steps in the process and the departments involved.

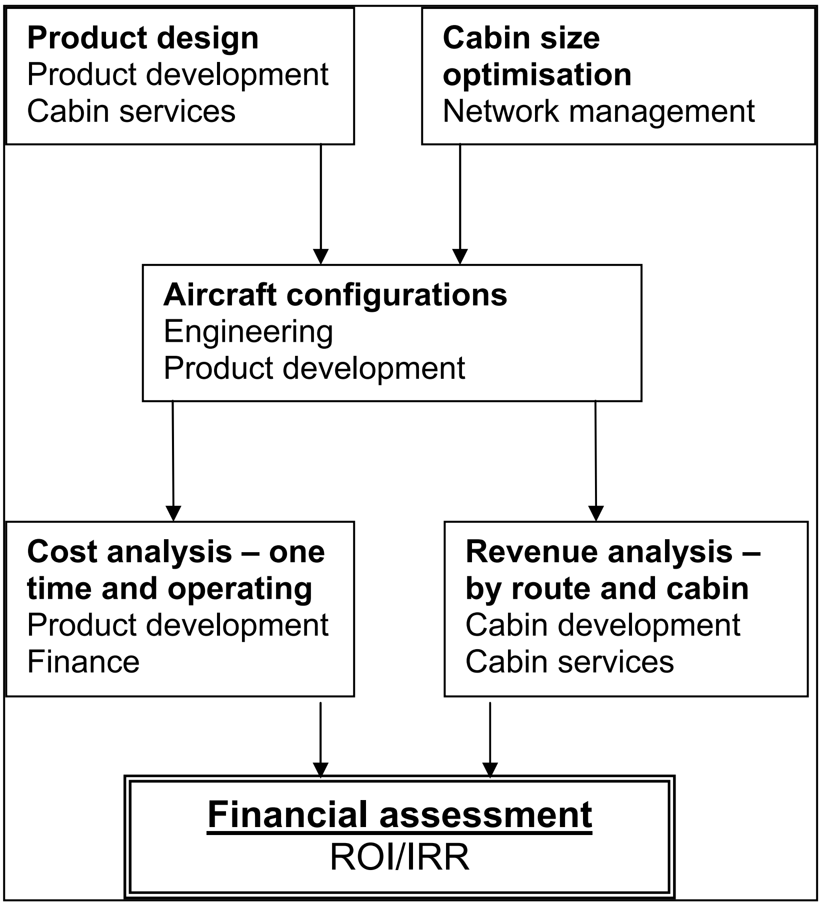



Figure 5.7: The product development process, adapted from Weber and Williams (2001)

This process is focussed on planning the airline's cabin product rather than corporate planning, but the positioning of the financial analysis is identical to the views expressed by Bouamrene and Flavell and Clark: the financial assessment or investment appraisal positioned at the end of the process, as a quantification of the project's market, revenue and cost characteristics, its output a sort of arbiter of the project's viability.

In the third edition of his definitive text on airline finance, Morrell (2007) discussed the investment appraisal process as part of airline *financial* processes. His emphasis is on the cash flow forecasting and evaluation, focussing on discounted cash flow techniques using classical methodologies discussed in this research. No overall scheme of airline planning is presented here, rather, investment appraisal is positioned as a central part of financial planning, and discussed as a means of comparing aircraft and assessing the risk of alternative projects, a subject addressed in Chapter Six of this research.

The low cost airline revolution has spawned many recent offerings on start-up airline business planning. Boeing created Start-up Boeing in 2006, proposing a "roadmap" for planning:

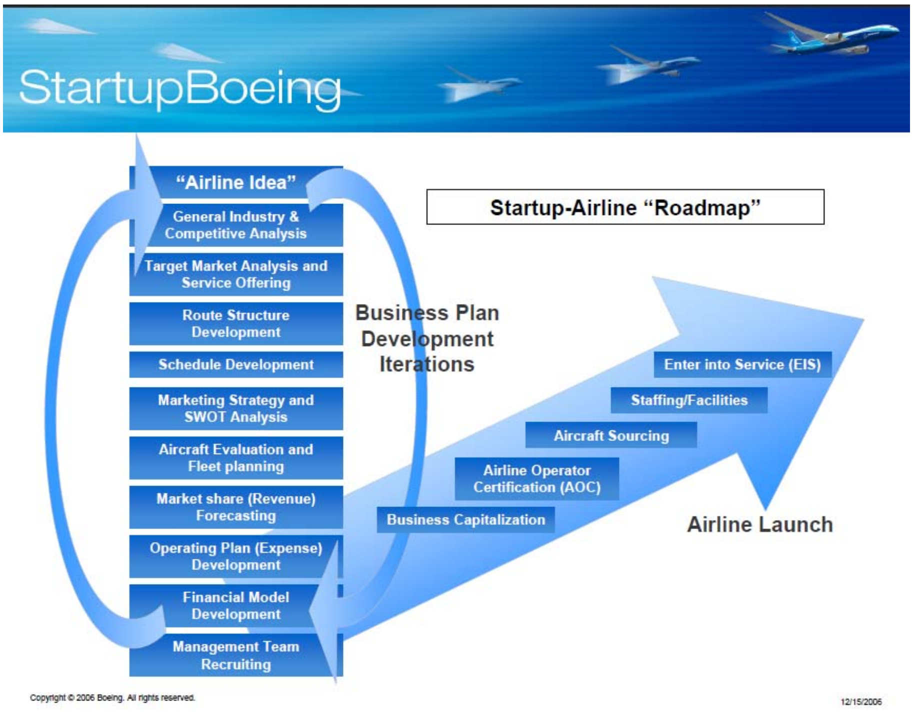



Figure 5.8: The Boeing's business planning "roadmap" (2006)

The steps in Boeing's roadmap are strikingly consistent with Bouamrene and Flavell (1980), and again show the financial model development near the end of the process. In both views, business planning is an iterative process, with the financial analysis serving as a pivot point, its calculations giving rise to successive revisions of the plan.

These views of airline planning processes are largely consistent with business planning practices in other industries. The interest for this research is the clear positioning of the financial plan, specifying investment appraisal as a quantification of the plan's consequences in financial terms. This positioning implies that uncertainties in fleet and network development assumptions could flow from deterministic fleet planning models into the financial figures, and the results presented with undue certitude regarding the projected outcome. This problem is exacerbated by the fact that finance departments and skills are quite distinct from those of network and fleet planning: for example, one would be hard-pressed to find a finance manager expert in LP techniques, where OR professionals are commonly found in fleet planning departments. Airline practice regarding the treatment of such uncertainties in assumptions is discussed in Chapter Six of this research.

A second implication is that the use of the investment appraisal as a final rationale or *justification* of the project for the company's top-level governance bodies is subject to the strategic goals of a company, which in turn is conditioned by the ownership structure and resulting governance, as examined in Chapter Four.

## 5.3. Executive views on fleet planning & investment appraisal

Twelve senior managers were interviewed for this research, in order to identify common practices in fleet planning and investment appraisal. These managers are working in European airlines, aircraft manufacturers, and financial institutions, using broadly the same set of questions for each manager, to allow comparison and contrast of views on the topics raised.

The airline managers represented both network and point-to-point low-fare carriers. The selection of the managers was based on three criteria. The first was broad industry coverage – from operators and manufacturers to financiers - in order to discuss the issues from a variety of perspectives. This was done in order to give a comprehensive view of the issues raised, given the fact (discussed in Chapter 1) that airline fleet planning and investment analysis entails extensive collaboration with a wide variety of players, each having a significant influence on the investment valuation.

The second criteria was a pragmatic approach to identifying senior managers who would both have sufficient knowledge of company strategy, and be willing to discuss these sensitive issues with the author: indeed, all of the managers were known to the author and most had worked with him on various projects prior to this research. The third criterion was again pragmatic, and related to the second: this research has been carried out without external funding, and the face-to-face interviews were conducted with managers known to the author, and were based in Europe.

Therefore, as with the CFO survey, the sample is clearly biased toward European perspectives, whether they be in operators or suppliers. All of the company managers were working for companies with shares listed, either their own or a parent companies. This bias reflects both the predominance of listed airlines in Europe and the clear propensity toward use of classical financial valuation techniques among such listed airlines, as discussed in the previous chapter. All of the managers were very experienced with the use, and the difficulties, of classical valuation techniques.

These interviews are best seen as representing the most current views on the application and extension of classical financial valuation theory in today's aviation market. The executives were quite willing to discuss valuation methods, in spite of the confidentiality of many topics raised. Senior airline managers in particular expressed the wish to see more rational valuation methods adopted worldwide in an industry many see as lacking financial discipline. Based on the forthcoming attitude, this research has been able to identify three modern “paradigms” for aircraft investment appraisal and treatment of uncertainty.

The interviews covered a list of 40 questions, in three broad areas:

1) Positioning and use of financial evaluation in the fleet planning process
2) Parameter estimation and decision-making processes
3) Treatment of uncertainty in the analysis

An additional set of questions, specifically posed to the financial managers from airlines and financial institutions, explored the interactions between investing and financing decisions.

### 5.3.1. Three paradigms of economic valuation

Through the interviews and the author’s field experience, three very distinct approaches to fleet investment valuation have been identified. The first is a highly quantified, OR-influenced approach to modelling operations, combined with a classical use of NPV for project justification. The revenue and cost estimation methods are based on company records and (to a much lesser extent) data provided by manufacturers. This approach is called the neo-classical method. A second approach, dubbed risk-quantitative, places risk assessment and cash-flow volatility at the heart of the analysis. Finally, we discovered a revolutionary approach to investment appraisal, in which aircraft are viewed as a commodity-like variable input to operations, embedding financing into airline strategy to obviate the need for classical valuation.

Adhesion to these paradigms was not necessarily specific to individual airlines: rather, we found aspects of each paradigm expressed by managers of the different airlines and financial institutions interviewed. This suggests that the valuation approaches are not immutable doctrines within companies, but rather form the basis for an on-going debate informing strategic and tactical choices among the various valuation options available,, depending on the company’s situation and evolving business strategy. In this section, we review the neo-classical method, which clearly reflects the methodologies – both for fleet planning and for investment valuation - identified in this chapter. The other two approaches integrate risk as a fundamental element of the valuation, and will be discussed in Chapter Six.

### 5.3.2. Neo-classical fleet planning: NPV as project justification

Central to this paradigm is a broad strategic view of market segments in terms of O-D traffic: are passengers coming to our hub, or travelling over it to some final destination? The fragmentation-consolidation debate is central to fleet planning under this paradigm.

In the neo-classical model, the network is segmented by specific origin and destination, and each segment is analysed in terms of the profit potential for the airline:

- Short haul to short haul (SH:SH): passengers connecting from one short flight of around three hours to another
- Short haul to long haul (SH:LH): locally originating passengers travelling over our hub to a more distant area
- Long haul to short haul (LH:SH): distant travellers seeking a destination within around three hours of our hub
- Finally, the two segments of long-haul (LH) and short-haul (SH) passengers originating or completing their passage at our hub

This is clearly the model of a network carrier. The specific insight here is that that the desirability of the airlines service depends essentially on the *specific* origin and destination of the traveller. That is, short-haul to long haul is viewed as a segment distinct from long haul to short-haul. A further segmentation is made according to cabin class, and in the most detailed case, to fare class under a revenue management policy. The neo-classic paradigm thus selects the most desirable traffic to capture, based on market strategy.

| | Luxury (First) | Corporate (Business) | Small business/ upscale leisure (Premium economy) | Leisure / VFR (Economy ) |
|---|---|---|---|---|
| SH:SH | | | | |
| SH:LH | Profit potential of each segment determined on a strategic (long-term) basis | | | |
| LH:SH | | | | |
| LH | | | | |
| SH | | | | |

Figure 5.9: Market segmentation by specific origination and destination

This concept has been extended in recent years by “sixth freedom” carriers such as Emirates, which add LH:LH traffic over the local hub, re-directing traditional traffic flows (notably Europe-Asia, but also North America-Asia) through small home-market hubs in a rather dramatic way. Implicitly then, fleet planners take a market by market approach in modelling the network.

Once profitable markets have been selected, the competitiveness of our airline and thus the traffic we capture is seen as a function of the QSI, similar to that used by Weber and Williams (2001). A recent study of Asian carriers was published on the web by Karvy Global Services (2006). Each target market is quantitatively analysed in terms of competing airlines' attributes, according to the familiar QSI equation. The Karvy Formulation is:

$$QSI_i = \frac{Index_i}{\sum_{i=1}^{n} Index_i}$$

Where

$$index_i = Freq^{k1} \times Cap^{k2} \times Rank^{k3} \times Time^{k4} \times Dist^{k5} \times Fare^{k6} \times CT^{k7} \times DT^{k8} \quad ..................................\ 5.9$$

In this formulation, competitive advantages are captured in individual indices

n = Total number of O-D services offered on the route
Freq = Frequency offered on each route
Cap = Capacity offered
Rank = a service quality rating such as SkyTrax (airlinequality.com)
Time = total O-D travel time
Dist = Trip distance
Fare = O-D passenger fare
CT = Connection type: direct or connecting
DT = Desirability of departure time

This competitive model is remarkably comprehensive, capturing connection and total distance variables as well as the standard frequency, capacity and quality measures. The neo-classical model is characterized by a highly quantitative approach to competitive performance on the routes selected for analysis. In mature markets, a portion of the network can be modelled and the model's parameters calibrated using historical traffic patterns available from reservations systems providers such as Sabre, or from the IATA PaxIS system. [18]

The output of such a study is projected O-D market share over the network under consideration, an extremely useful set of data points which then can be applied to traffic estimates to generate revenue for the cash flow study. However, the calculation is fraught with complexity and potential errors. In addition to tremendous complexity of such a market-by-market analysis and the challenges of estimating the QSI market parameters, the Garvy (2006) calculation requires a specific schedule and capacity (i.e. fleet assignment to

[18] As the Karvy study points out, in many of the world's markets, such data is either scarce or non-existent today. This kind of number-crunching requires data only available in advanced markets such as Europe.

routes) as an input. This leads to an iterative process matching various fleet alternatives to projected airline schedule, with the twin objectives of minimising spill of the most desirable segment of passengers, and minimising the number and cost of fleet in operation for the study. To reduce the complexity, firms often study one portion of the network at a time, but today the more ambitious are using programmes capable of modelling the entire network, including the SH&E Network and Share Analysis (NSA) system, and Sabre's Fleet Assignment Model in the iterative framework depicted in Figure 5.10.

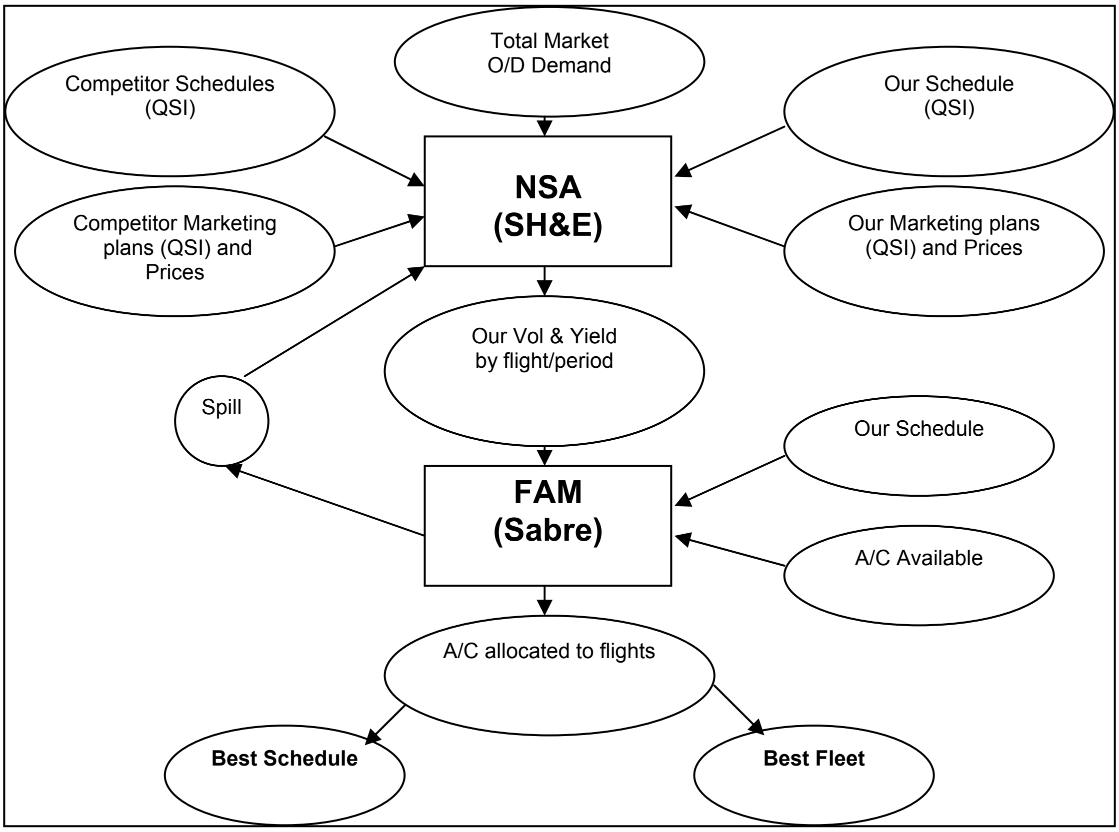



Figure 5.10: Modelling in the neo-classical paradigm. Source: Richard Wyatt

The bulk of the analytical effort in the neo-classical approach is applied to this competitive market and fleet assignment analysis. When the complex iterations have reached a satisfactory balance of capture, spill and investment requirements, the fleet and schedule are used to generate cash flows for the years under consideration. The analysis is a point-in-time, rather than time series, view. The model is run for several years over the investment horizon, and the resulting cash flows interpolated for the in-between years to form a time-series view of revenue, costs, and cash flow.

Estimation of valuation parameters

The QSI market share calculation requires estimation of many competitive parameters. One key uncertainty concerns the evolution of services to be offered over the investment horizon by competitors on each route: do we use current conditions, and if not, how to estimate service offerings from new entrants to the market? Managers interviewed tend to use current conditions, for the very good reason that hard data can be used to validate the parameters. This methodology, however, may not perform well predicting competitive positions with the emergence of new business models, such as point-to-point or sixth-freedom carriers. These airlines have dramatically changed the shape of air traffic networks over the last few years. Their continued success, as well as the emergence of single-class point-to-point long haul carriers appears set to further alter the game in the near future.

Costs tend to be estimated using internal historical data, where available. For new aircraft types, most managers "listen politely" to the claims of aircraft and engine manufacturers regarding cost behaviour, and then develop their own view of the expected unit costs, extrapolating from current performance and manufacturer performance data such as block time and fuel burn.

In the neo-classical paradigm, aircraft residual value (RV) estimates come from third-party providers such as appraisal firms. A common approach of appraisers is to develop "hard" and "soft" values using statistical estimates of historical second-hand aircraft price volatility. Prudent managers include the soft values in sensitivity analysis, to avoid excessively optimistic views.

The up-front investment requirements (aircraft price and entry into service (EIS) costs) are the great equaliser: as the cost is borne at the outset of a project, an unsatisfactory NPV can be made possible with a suitably reduced aircraft price. The initial price offer from manufacturers is often used as the input to the cash flow, and represents a starting point for negotiations.

<u>Policy issues</u>

Selection of an appropriate investment horizon strongly conditions the attractiveness of investments under NPV rules; the horizon also dramatically affects the importance of the RV assumption in the overall valuation. Large civil aircraft design lives are around 25 years, but the market values of used aircraft show dramatically different patterns, depending on the success of the aircraft type around the world. As Figure 5.11 illustrates, in a stylized valuation for a European single aisle operation, the present value of aircraft RV can represent nearly 45% of the total value creation for a 7-year study, decreasing to 18% if the horizon is extended to 15 years.

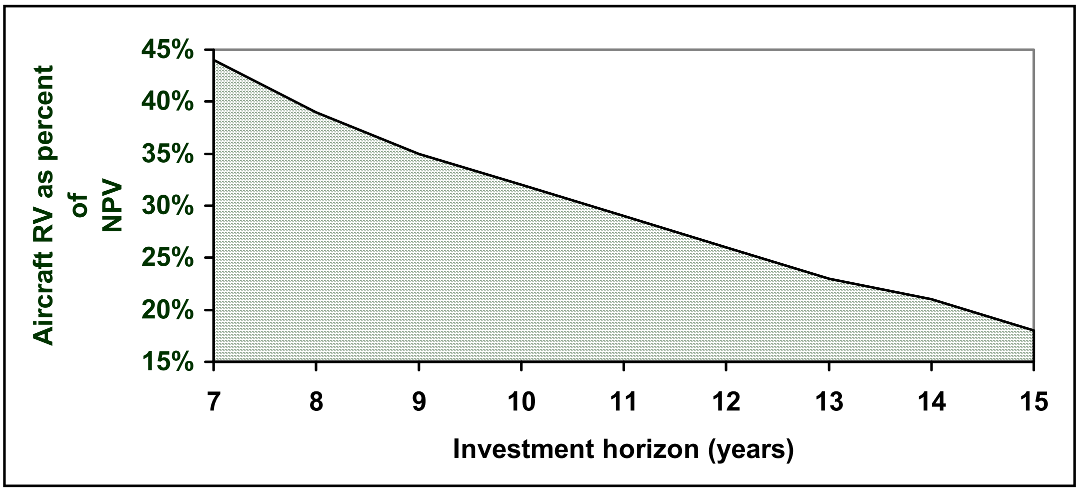



Figure 5.11: Impact of Residual Value on Net Present Value for differing investment horizons: analysis of a typical short-range project bv author

Airlines using very short investment horizons might ask themselves whether they are primarily in the business of operating aircraft, or trading them. Depending on the fleet under consideration, companies using the neo-classical paradigm tend to adopt 10-15 year investment horizons, implying that the airline will renew its fleet sometime toward the end of this horizon. For an airline using a 10 year investment horizon, the RV assumption can "make or break" an investment justification.

The other major policy input to the decision is the discount rate or cost of capital. Very much in line with traditional valuation theory, the neo-classical paradigm uses the weighted-average cost of capital (WACC) as the cost of capital. Managers interviewed stressed the importance of using target (presumably lower than current) debt ratios to avoid under-estimating the cost of capital by over-weighting the cheaper cost of debt in the calculation, relevant advice to the highly-leveraged airline industry. Secondly, they tend to look to other industries' shareholder returns to estimate equity investors' expected returns, rather than use historic, often low or negative, airline returns. Finally, the WACC is adjusted upward to reflect the specific risk of the project, based on a subjective estimate. These practices imply that there is a great deal of subjectivity in the WACC estimation, confirming the analysis in Chapter Four of this research.

<u>Decision-making</u>

In this paradigm, various fleet alternatives are always compared with the "do-nothing" scenario of continuing with the current fleet. This has the advantage of using hard revenue and cost data from existing operations as a benchmark to which alternatives can be compared. Preliminary decisions are made by committee made up of Commercial, Network Planning, Operations Planning, and Engineering departments.

The final calculation of cash flow and NPV is often done by a group of financial analysts embedded in the Fleet Planning department, raising interesting questions about asymmetries of information between Fleet Planning and Finance. Several managers stated that they often discovered errors in this analysis. The analysis is then typically reviewed and discussed with Finance, whose primary concerns include the marketability and thus the “bankability” of the aircraft. The details of the analysis are rarely examined by the Finance group, which is mainly responsible for treasury, business planning, and financing of the aircraft. A board paper is prepared, including a business rationale and key investment analysis results including both NPV and payback, and presented to the board of directors.

Financing arrangements for the aircraft eventually approved for acquisition are kept strictly separate in this paradigm, consistent with classical finance theory. Managers expressed the opinion that fleet financing is rather tactical and pragmatic than strategic, based on concrete concerns such as availability and cost of financing alternatives, which may change dramatically based on market conditions and airline performance as deliveries approach. Further, fleet financing decisions combine quantification (comparing NPV of term sheets) with qualitative judgement and intuition. The judgement and experience comes into play particularly in the area of choosing between fixed and floating-rate debt, because interest-rate movements are rarely amenable to quantitative forecasting techniques in the medium-term.

In sum, the neo-classical paradigm is a reflection of analytical methods developed and recommended in the fleet planning and financial literature. All of the airline executives interviewed use some form of these methods. The positioning of the investment appraisal is found to be at the end of the analytical phase, and it does serve as a justification of the projects to the highest levels of the airline’s governance structures.

The ‘engineering’ models used are sophisticated, and they are deterministic rather than stochastic. A key methodological question planners face is the level of detail for analysis, and the most sophisticated airline is found to go to the O-D city pair level, to look at individual markets for air travel.

In the interview of executives practicing this paradigm, the cash flow calculation itself appears almost an afterthought: the heart of the approach is in the network model. Uncertainties in the assumptions underlying these models will inevitably impact the investment valuation, and because the Fleet

Planning and Finance functions are separate both organizationally and in terms of expertise, these uncertainties may be missed, and their quantification ignored. The variety and extent of such fleet planning uncertainties are identified with an expert panel in the next section.

## 5.4. Uncertainties in fleet planning assumptions

### 5.4.1. Panel composition and overall results

A panel of nine fleet planning experts was queried in four areas of potential uncertainty in fleet planning assumptions. The sampling objective was again a mix of global coverage and pragmatism. Three experts were fleet planning managers from European legacy airlines, in order to establish expert opinion with specific carriers in mind. The other six were independent (non airline-employee) advisors with worldwide experience helping airlines to develop fleet plans, and validate the investment analysis with the airlines' top management. This dual panel has a broad range of fleet planning project experience, including concrete, single-carrier experience for the airline planners, as well as independent perspectives over a large geographical range of advisory projects for specific airlines, predominantly in North America, Europe, and the Middle East, with a lesser experience in Asia.

The sample was a fortiori limited to experts known to the author, and as in the earlier studies, is biased toward legacy carriers and is somewhat Eurocentric. Geographically biased similar to the CFO survey and the executive interviews, the panel was broader in the range of experience, due to the predominance of independent analysts.

This breadth was borne out in the results of the panel, where marked differences were found between the opinions of the European airline managers, and the independent experts. Consultants tend to be used by companies rather smaller than the legacy carriers interviewed, due to these airlines lack of internal resources and expertise. Their work is also focused on emerging aviation markets. This sampling bias, and dual population goes a long way to explaining the broad range of opinions resulting from the panel.

The panel was proposed a list of 35 assumptions that may be subject to uncertainty. These assumptions were grouped within five broad areas:

- Corporate strategy (3 assumptions)
- Network and demand evolution (12)
- Aircraft performance: reliability of manufacturer data (6)
- Operating cost evolutions (10)
- Environmental cost evolution (3)

For each assumption underlying airline fleet plans, experts were asked to think about the degree of uncertainty fleet planners face, when planning over a horizon of 7-10 years. For each assumptions, the experts gave their assessments first of the degree of uncertainty over 7-10 years, and secondly, of the impact of uncertainty on the project's viability. They were asked to assess these two questions independently: as far as possible, keeping the impact independent of the degree of uncertainty when assessing the assumptions.

The experts used a scale of 1 (low) to 10 (high), and were invited to provide comments for each assumption in the space provided, and nearly all did so. Additionally, the experts were invited to add assumptions they believe are important, and subject to uncertainty. The range of individual assessments are provided in the form of radar charts in Appendix E. These charts reveal that there is substantial variety of opinions regarding fleet planning uncertainties, more or less depending on the specific assumption analysed.

The overall results for the panel (using average responses) are presented in a classic 'risk map' framework in Figure 5.12. In this framework, the lower left quadrant is considered inconsequential, the top-left and bottom-right quadrants are of moderate risk, while items in the top-right quadrant are considered to be the focus for risk management measures, as the present above-normal probabilities and impacts on the project.

To get a sense of the overall results from the nine fleet planning experts, five assumptions areas are further divided into 12 individual categories, and plotted on an X-Y chart. The degree of uncertainty is plotted on the X axis, and the impact on project profitability on the Y axis.

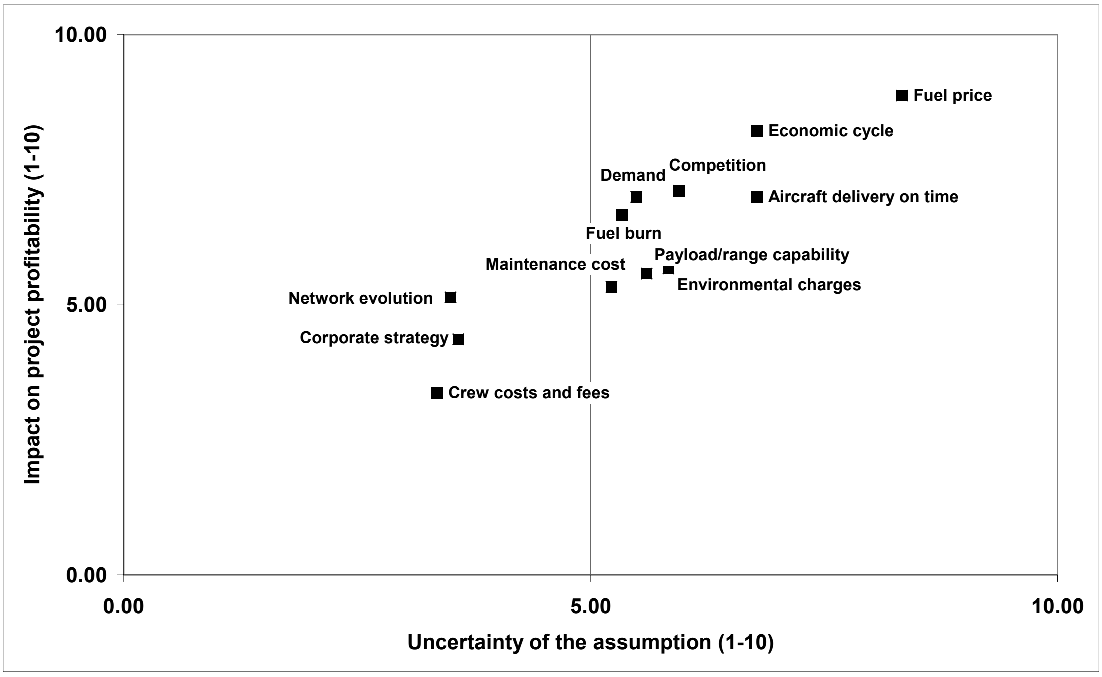



Figure 5.12: Expert panel on fleet planning uncertainties: risk map

Corporate strategy and crew costs are largely internal to the company, and with fees (handling, landing, ATC), are considered of only moderate uncertainty and impact on fleet planning projects. These two categories are considered by the experts to be in the “safe” area where assumptions are ranked less than 5.0 for both uncertainty and impact. Comments reveal that crew and fee costs are largely predictable, and some considering them non-issues in fleet planning, as they are outputs of other planning exercises such as medium-term budgeting. In any case, the uncertainty and impact of these cost items are deemed low.

Network evolution is similarly to a great extent a question of airline choice, particularly in the increasingly open Europe/North Atlantic service areas: the experts rank it just above the impact-neutral 5.00 line, with low uncertainty, not of overriding concern to fleet planners.

On the other hand, there was a major divergence regarding potential uncertainty in the strategic and governance areas between the airline managers and the advisors. The assumptions questioned were:

- Company governance and senior management
- Evolution of shareholder objectives
- Political involvement in aircraft selection process

As befits a panel survey approach without large numbers of respondents, this research analyses the overall tendencies and divergence of opinions among the experts, rather than seeking statistical validity. Clear differences were discovered between the airline planners and the advisors, and these form part of the analysis in this section, depicted in graphic form. The vertical lines in the figures below show the overall divergence between the minimum and maximum uncertainties and impacts estimated among the expert panel, irrespective of whether they be advisors or airline planners. The column in the middle of each line indicates the range of simple average opinions of airline planners and advisors. The *size* of each column shows the degree of divergence between the two groups, while the *colour* shows its direction: **red** columns indicate that the advisors believed uncertainty or impact to be greater, while **black** columns indicate the reverse, that is, that the airline executives believe the uncertainties to be greater.

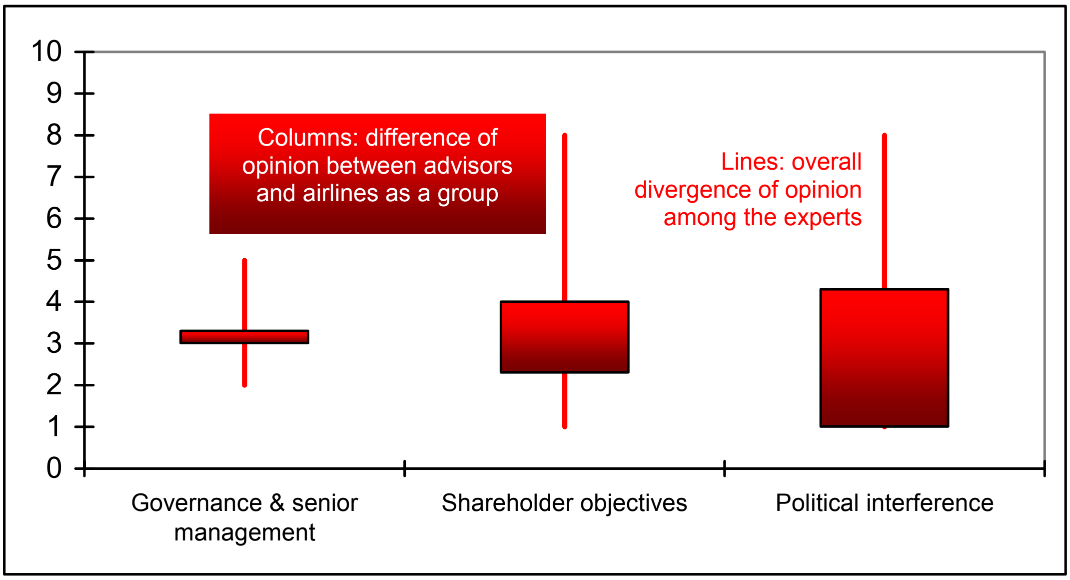



Figure 5.13: Range of expert opinions regarding strategic uncertainty: O = Low, 10 = High

There was a small divergence regarding changes in governance and senior management directions over the fleet planning period. The range of opinions was larger concerning shareholder objectives, with the airlines assessing the uncertainty as low, and the advisors uniformly higher. The greatest divergence between the groups concerned political interference in fleet planning: the European legacy carriers queried are wholly privatized, which tends to preclude direct government interference in company strategy. The advisors' wealth of experience in other regions of the world points up the well-known fact that mixed missions and political winds can have a very powerful influence on fleet plans and aircraft acquisition decisions. This highlights the importance of airline ownership to its planning and valuation practices, as discussed in Chapter Four.

The range of opinions regarding the impact of strategic assumptions shows a similar pattern between airline managers' and advisors' opinions, with the differences that impact assessments are higher than uncertainty for all the experts, and that the impact of political interference on profitability is deemed to be seven on a scale of ten by the group of six advisors.

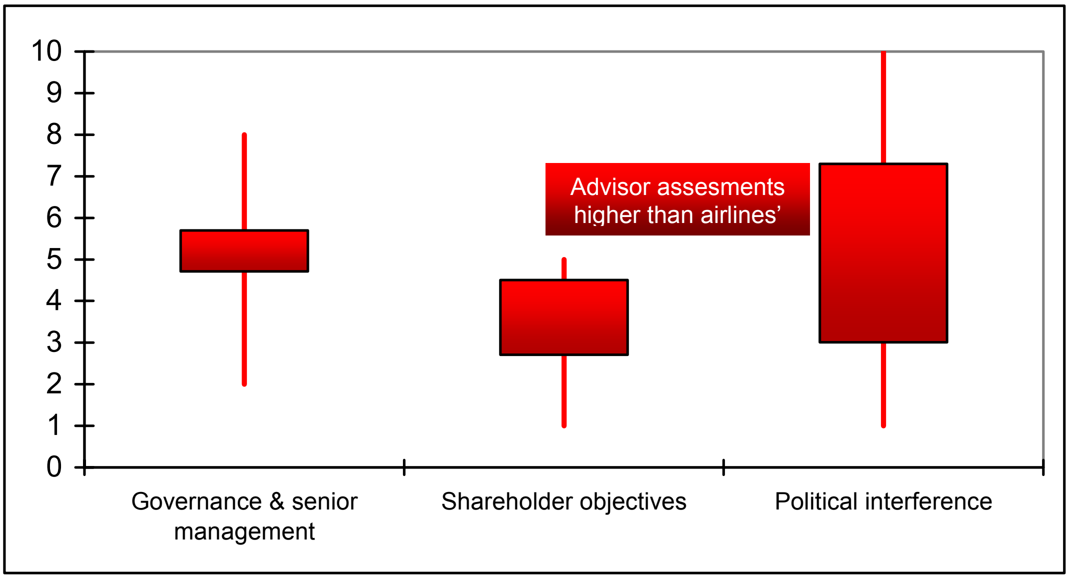



Figure 5.14: Range of expert opinions regarding strategic impacts

Two experts spontaneously mentioned the importance of airline alliances on fleet plans over a 10-15 year horizon, with major impacts cited by one airline expert.

All nine additional assumption categories all lie within the high-uncertainty + high-impact zone of Figure 5.12. The detail of expert assessment of assumptions within each category of risk is discussed below, from most critical to least.

There is little disagreement that jet fuel price is the greatest uncertainty facing fleet planners today. Assessments of the uncertainty surrounding fuel price evolution over 10-15 years ranged from moderate (five to seven), to a more frequent eight-to-ten range, while none of the impact assessments was less than eight on the scale of ten. The panel recognize that the fleet planning horizon stretches substantially beyond any potential to keep the long-term price down through fuel hedging, whatever the condition of the derivatives markets in coming years. Advisors cited the "crystal ball" or casino nature of fuel markets, and one expert estimating low uncertainty stated "the only way is up." This view reflects recent trends in fuel prices.

Average daily FOB jet fuel prices increased 92% from 2000 to 2009, from 88US¢ per US Gallon to $1.68[19]. Over the same period, the volatility of fuel

[19] The analysis in this section is derived from historic data from the U.S. Energy Information Administration of the Department of Energy, and its web site eia.doe.gov. Much of the

has more than doubled, from a standard deviation (SD) of 11.6¢in 2000 to 26.2¢ in 2009. These changes are driving in turn an increase of the coefficient of variability (SD / mean) from 13% of the average price to 16%, a small numeric difference which, when measured in absolute dollar terms implies that the potential upward *variation* in fuel prices (3SD above the mean given a normal distribution) is nearly the same dollar amount as the fuel *price* was ten years earlier. In addition to the underlying commodity fluctuations, uncertainty resides in the crack spread premium of jet fuel prices over crude oil, which reached a maximum of 28% in the aftermath of Hurricane Katrina in 2005, subsiding amid the financial crisis in 2009 to an annual average of 13%. This market turbulence adds up to a fuel price distribution that still bears its traditional resemblance to a lognormal distribution with its positively skewed shape, but with the central tendency higher than previously, and an extremely long tail of values on the high side of the distribution, with 24% of all observed values 2000-2009 were over US$2.00 per gallon, a percentage that rises to 64% in the period from 2007 to 2009.

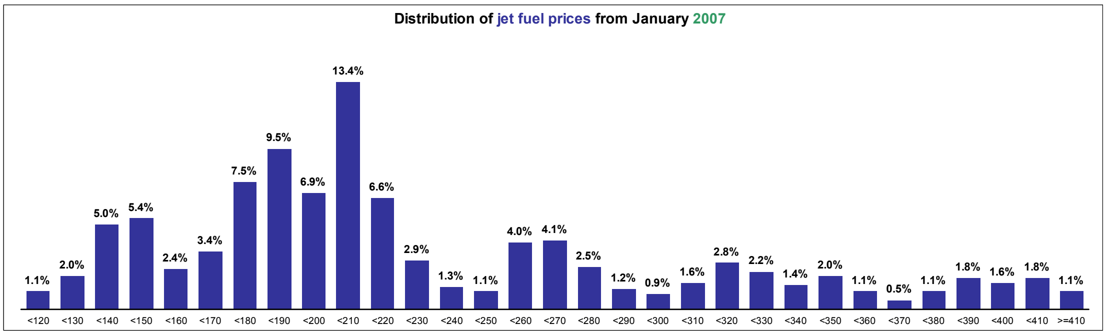


Figure 5.14: Distribution of jet fuel prices 2007-2009 in US¢, courtesy of Claude Pluzanski, Airbus

In addition to the price valuations in U.S.$, there has been a very strong correlation between fuel prices and the declining international value of the U.S. dollar, in the context of deficit spending of successive U.S. administrations since 2001, continuing well into 2010. Figure 5.15, courtesy of Mr. Pluzanski, shows a correlation coefficient of +0.839 between crude oil prices and the value of the euro, from the euro's creation in 1999 through October 2009, an $R^2$ that rises to 0.905 when considering the period from 2007 – 2009.

analysis has resulted from discussions with and prior work done by Claude Pluzanski, Head of Economic Analysis in Airbus Marketing.

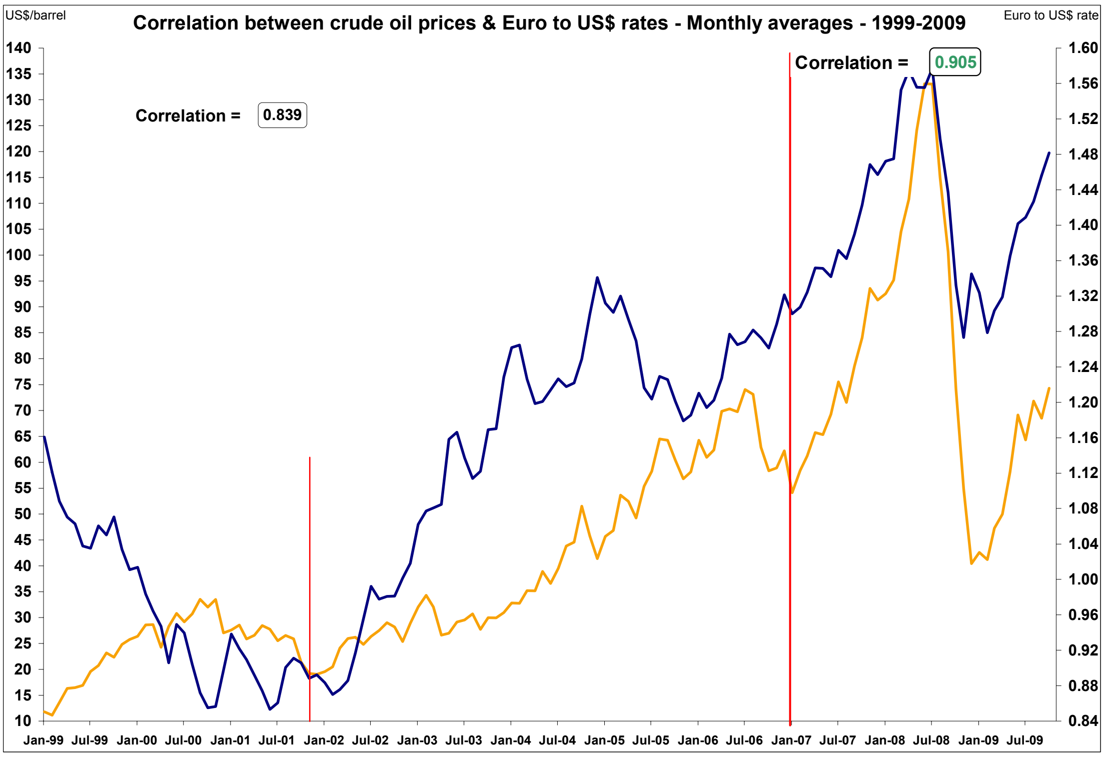



Figure 5.15: Correlation of crude oil prices with the euro:$ rate, courtesy of Claude Pluzanski, Airbus

Oil has become 'two prices' for international airlines, the base price of the commodity, and the exchange rate of an unstable U.S. dollar. Its movements are statistically, though not necessarily causally, related to movements in other world reserve currencies such as the euro. Amid all this recent history, it is no surprise that the expert panel put fuel price very near the maximum levels of risk for fleet planners.

The economic cycle was the next most critical uncertainty cited by the expert panel, particularly strong in terms of impact on profitability. The airline expert assessments averaged higher values than the advisor group regarding both the uncertainty and the impact on projects: this is indicated in the Figures throughout this section by the black colour of the column, as opposed to red when the advisors' assessments are higher on average. The two groups substantially concur that the impact of the cycle is profound, while opinions vary as to its predictability.

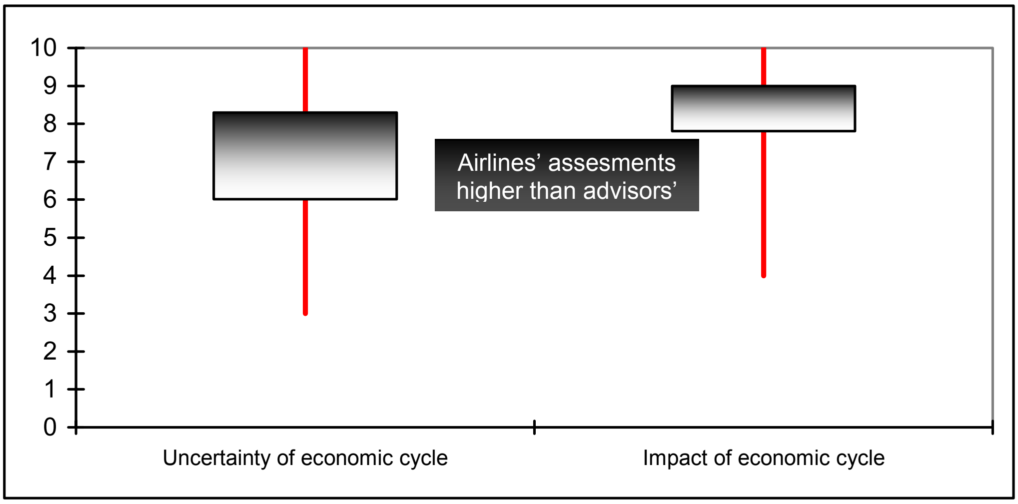



Figure 5.16: expert assessments of the economic cycle risks

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The cycle for aircraft was superimposed on the large airline profit cycle in Figures 1.1 and 1.2 of this research. The market has moved on from the traditional logic practiced in the 1990s. In this model, the relationship between airline profits and orders was fairly clear. Orders bottomed out near zero in 1993 after the then-worst profit performance on record during 1992, in the wake of the first Gulf War and attendant drops in traffic. As profits began to recover, so did orders. This relationship between profits and orders has become less pronounced over the last ten years. From 2001-2004, unprecedented low-cost airline orders (e.g. 140 for Ryanair in 2002, 120 for easyJet), the incipient air travel boom in the Middle East, and legacy carrier "bottom-feeding" (strategic ordering during the downturn to extract maximum manufacturer concessions), kept orders at the 500-unit level during the entire period including the invasions of Iraq and Afghanistan, and the initial SARS epidemic in 2003.

Since 2005 aircraft ordering has exceeded all historical records, fuelled by enthusiasm for the B787, a major replacement wave for the 1980s era jets such as the B767, B747 and A300/310, the continuing booms in the Middle East and China, and the more fragile boom in India. Aside from the continuing low-fare airline boom with its proposal of truly new service proposition generating new demand, ordering took an unprecedented strategic and geopolitical turn in the mid-2000s, with B787 delivery dates stretching out through 2019 (and given the delays, potentially further), and large orders for current-generation twins (B777 and A330) continuing very strong in the so-called emerging markets cited above.

Aircraft deliveries are traditionally out of sync with airline profits due to manufacturer lead times and the difficulty of reducing production rates, which tend to bottom out between 400 and 500 jets at the bottom of the cycle. Again, the 1990s cycle was more “classical,” with production increases lagging the airline profit cycle, while in the current cycle production rose even as major airline profits remained low in the early years of this decade. In the most recent downturn, the manufacturers managed to deliver 800-1,000 jets in spite of the new-record losses in 2008 and continuing airline losses in 2009, and expect to continue doing so in 2010. Again, the experts’ opinions regarding the cycle are borne out by medium and short-term historical experience in the aircraft market, and as they indicated, the *amplitude* of cyclical patterns has increased, even if the cycle’s frequency is more or less consistent at eight-ten years.

The third major risky assumption concerning the reliability of announced manufacturer entry into service (EIS) dates for new aircraft hardly needs comment. Clearly, this problem is strictly related to new aircraft types, as several of the experts pointed out that delivery date uncertainty for in-service aircraft is very low. The A380’s scheduled EIS of March 2006 slipped to December 2008, while the B787 is two years behind schedule as the manufacturer struggles with supply chain and engineering problems linked to the choice to dramatically increase composite use in primary structures, notably the wing. The expert panel placed this risk high on their lists, with the airline executives somewhat more confident than the advisors that such risks can be mitigated using contractual provisions in aircraft contracts, short-term capacity compensations such as operating leases, or a combination of these two.

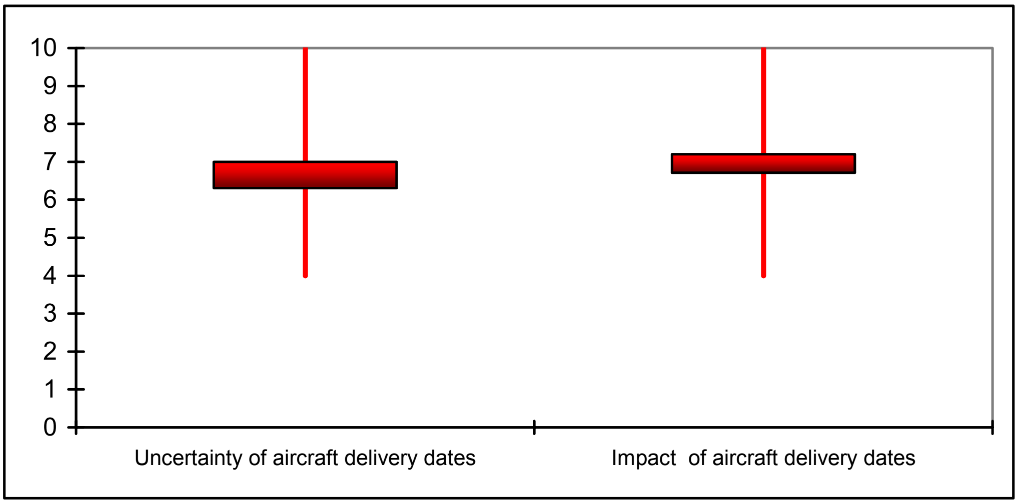



Figure 5.17: expert assessments of aircraft manufacturer EIS and delivery date reliability

Thus, the top three risks faced by airline fleet planners – fuel price, economic cycle, and EIS dates for new aircraft types – are largely outside the airlines' control, and they have very few ways to mitigate these risks over the fleet planning horizon.

The next highest risk fleet planning assumption according to the expert panel regards competition. They were asked to assess the risk of competitive response to fleet plans from existing competitors, and separately to evaluate the risks from new entrants to their markets. The two groups had differing views of this issue, with the airline executives more assessing the uncertainty and the impact of existing competitors higher than the threat of new entrants, and advisors the opposite.

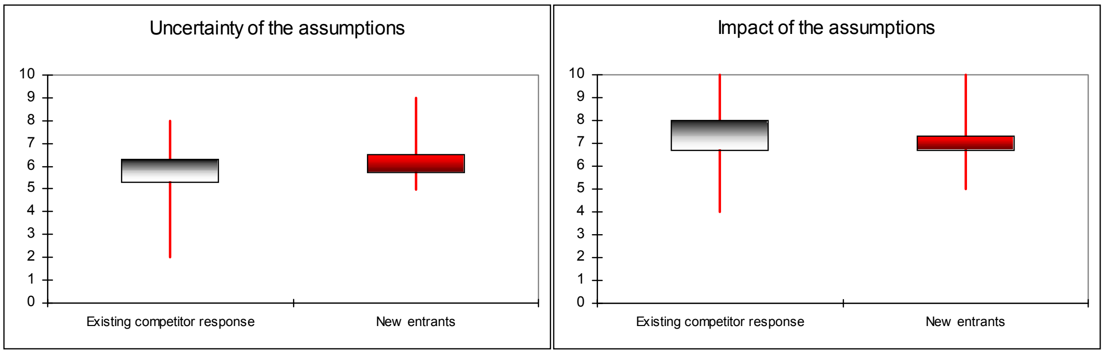



Figure 5.18: expert panel assessments of competitive uncertainties

The airline group placed the uncertainty surrounding existing competitors between five to seven, and the impact between seven and nine. The European legacy carriers have borne new and continuing assaults on both long-haul and short/medium-haul markets over the last ten years. On the long-haul markets between Europe and Asia, the emergence of Emirates and other sixth-freedom Gulf carriers has created a new set of traffic flows between Europe and Asia through high-capacity hubs in the United Arab Emirates and Qatar. The 23% compound annual ATK growth rate of Emirates in particular placed the airline slightly above BA in terms of Available Tonne Kilometres (ATK) in 2008/2009, and very near equal in terms of overall Revenue Tonne Kilometres (including both passengers and freight), as shown in Figures 5.19 and 5.20. The spectacular rise of these carriers is a major long-term threat to European airline development, but also, the extent to which they can continue to grow in one of the world's geopolitically volatile region is a substantial source of uncertainty for planners.

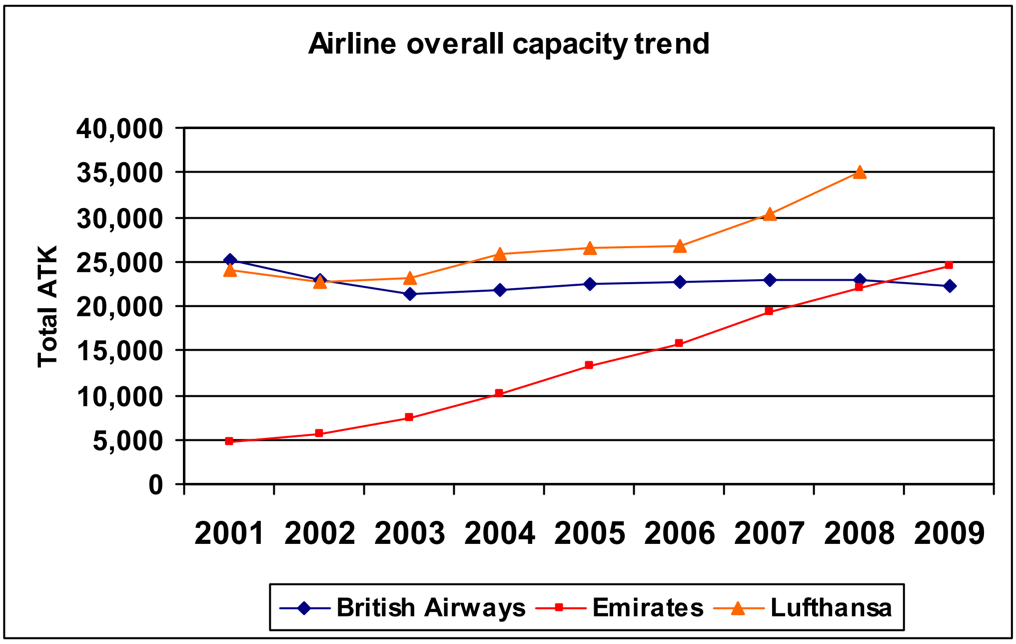



Figure 5.19: British Airways (BA), Emirates (EK), Lufthansa (LH) total capacity 2001 – 2009. Source: company reports

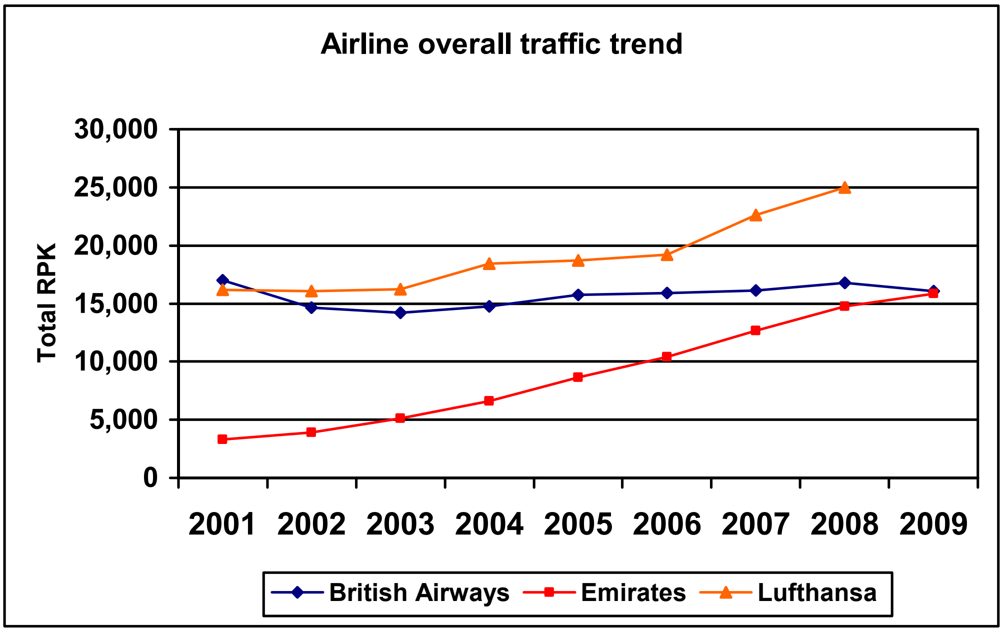



Figure 5.20: British Airways (BA), Emirates (EK), Lufthansa (LH) total traffic, 2001 – 2009. Source: company reports

In European markets, low-fare airlines led by Ryanair and easyJet have had the created new potential for travel by air. As Figure 5.21 shows, the early part of the 2000s saw these carriers increasing overall traffic between the London and Barcelona catchment areas over fourfold, with fairly limited impact on such incumbents as BA and Iberia (IB). As the low-fare carriers continue to expand fleet and services at a rapid rate, the potential impact on the legacy carriers' hub-based strategies remains to be seen. At least one, Iberia, has followed a strategy of investing in arms-length low-fare carriers of its own, while reducing the mainline airline's capacity on competing routes and focusing on feeding the Madrid hub: the creation of Clickair in Barcelona, and its subsequent merger with Vueling, a major component of the network restructuring underway at IB.

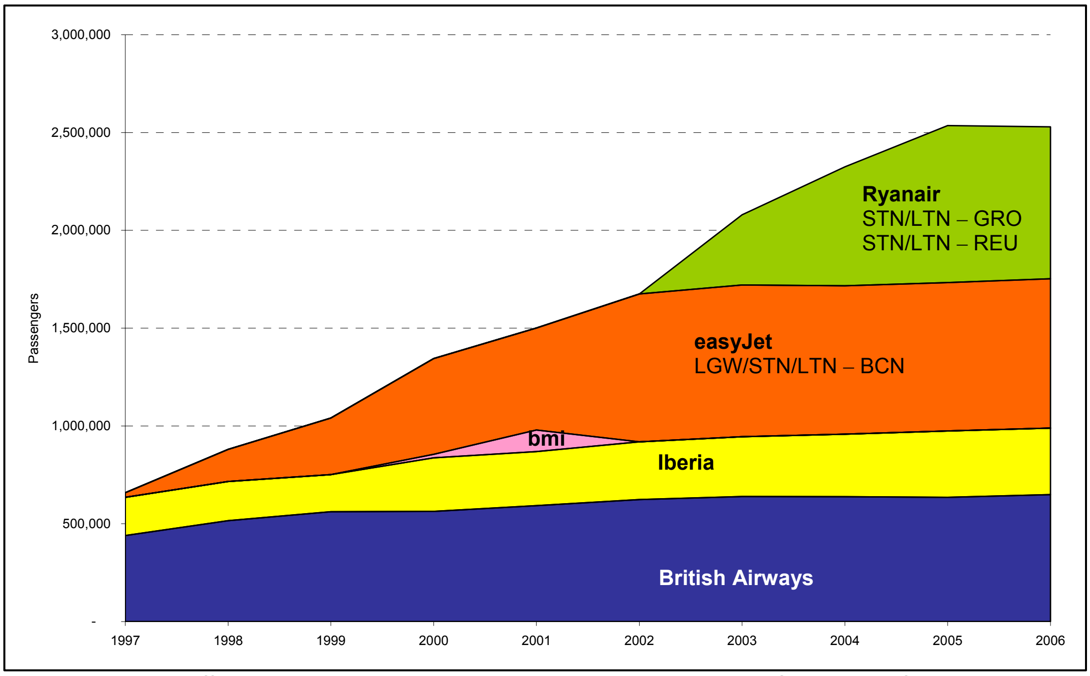


Figure 5.21: traffic between London and Barcelona catchment areas: Source: Prof. Rigas Doganis

The advisors consistently rated the impact of new entrants the same as or higher than that of existing competitors, as the new business models continue to spread around the globe. Concerning the uncertainty of the twin threats, there was no consensus among the experts, whose assessments ranged from two to nine. This again reflects the geographical diversity of their experience, since there remain many markets where entrance and competition are strictly controlled, for example, India and mainland China. The European airlines have in many ways led the way toward privatization, financial transparency and accompanying valuation techniques, and most recently, consolidation, just as their markets become increasingly deregulated.

The next category of assumptions queried concerns prospective demand for air travel on individual airlines. The expert panel was asked to assess these risks in four areas:

- Pure origin-destination (O-D) demand
- Behind/beyond demand feeding the airlines' trunk routes
- Demand mix: First, Business, Economy
- Trends and evolution in yields

The responses are summarized in Figure 5.22.

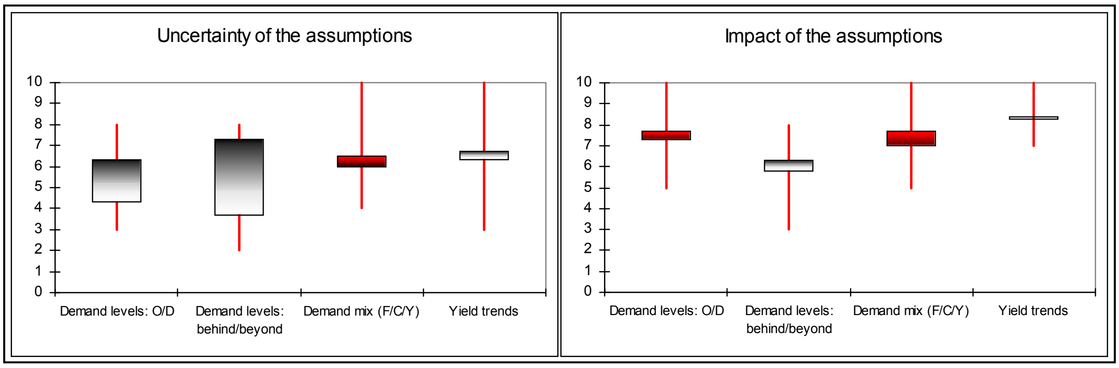



Figure 5.22: expert assessments of demand evolutions over the fleet planning horizon

As the black columns indicate, the uncertainty of overall demand levels is considered substantially higher by the group of airline fleet planning executives than by the advisors, giving rise to a wide range of responses on these two items.  Regarding uncertainty, advisors stated that such considerations can be estimated reliably in their experience and lie within the airline's overall business plan.  One advisor drew a sharp distinction between behind (feeding) and beyond (de-feeding) traffic, with the latter being far more uncertain than the former.

On the other hand, the groups agreed regarding the high impact of these assumptions on the viability of fleet plans, with responses centring around 7.5 for the core O-D demand, and 6.0 for behind/beyond traffic demand.  When the two dimensions are combined in a risk map framework, the airline executives see demand levels as substantially more risky that the advisors, mostly on the uncertainty dimension.  Once again, the broader geographical range of the advisors' experience can partially explain this divergence, with many of the world's more highly-regulated aviation regions offering more stability than today's volatile European/North- and South-Atlantic service areas.  Many of the state-owned carriers soliciting professional advice on fleet plans have a stronger grip on their markets than Northern European carriers.

The assumptions regarding demand by cabin class and yield trends reveal greater uncertainty and impact across the board, with a strong consensus around 6.0-6.5 on the uncertainty dimension for both groups overall, and a near-complete consensus around 8.5 for their impacts.  Several experts pointed out that the two assumptions are deeply intertwined and difficult to separate by analysis.  The divergence of opinion regarding yields arises from the frequently-stated notion - held by the advisors - that yield trends across the industry are well-known to be decreasing year on year, with greater prospective uncertainty regarding air service and cabin class propositions and pricing, in the wake of the advent of new business models (including e.g., low-fare carriers and the rapid-growing 6th-freedom airlines in the Persian Gulf). The overall result of the expert opinions places demand-related risks firmly in the high-risk quadrant of the map, with the impact substantially higher than the perceived uncertainty.

In the section on the reliability of manufacturers' aircraft performance data, the experts as a group assessed fuel burn in the high-risk quadrant of the risk map: however, there was an extraordinary diversity of opinions regarding the fleet planning risks of such data.

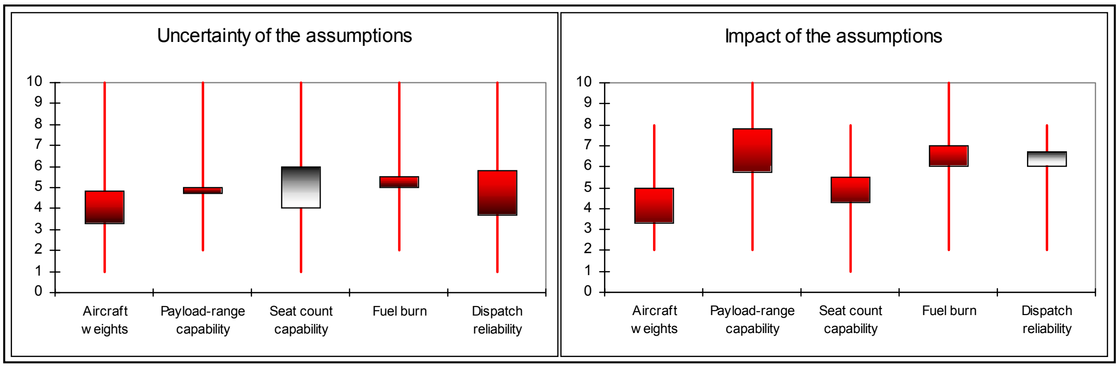


Figure 5.23: expert assessments of aircraft performance uncertainties over the fleet planning horizon

In general, the advisors' group expressed more scepticism about the manufacturers' data, with the airline managers frequently stating that such uncertainties can be mitigated by contractual means such as manufacturer guarantees. The exception to this rule was uncertainties on announced seat counts, which one airline executive considered "pure marketing," while another stated that they use their own layout tools to establish seat counts, disregarding manufacturer layouts entirely. The airline managers considered the much-discussed dispatch reliability data to be of slightly higher impact than the advisors, again stating that guarantees can minimize the impact on the project. The fuel burn risk present in the high-risk section of the risk map is considered more critical in its impact than the uncertainty.

The operating cost assumptions were considered to be relatively low uncertainty and impact, although certain assumptions were considered quite a bit more risky than others.

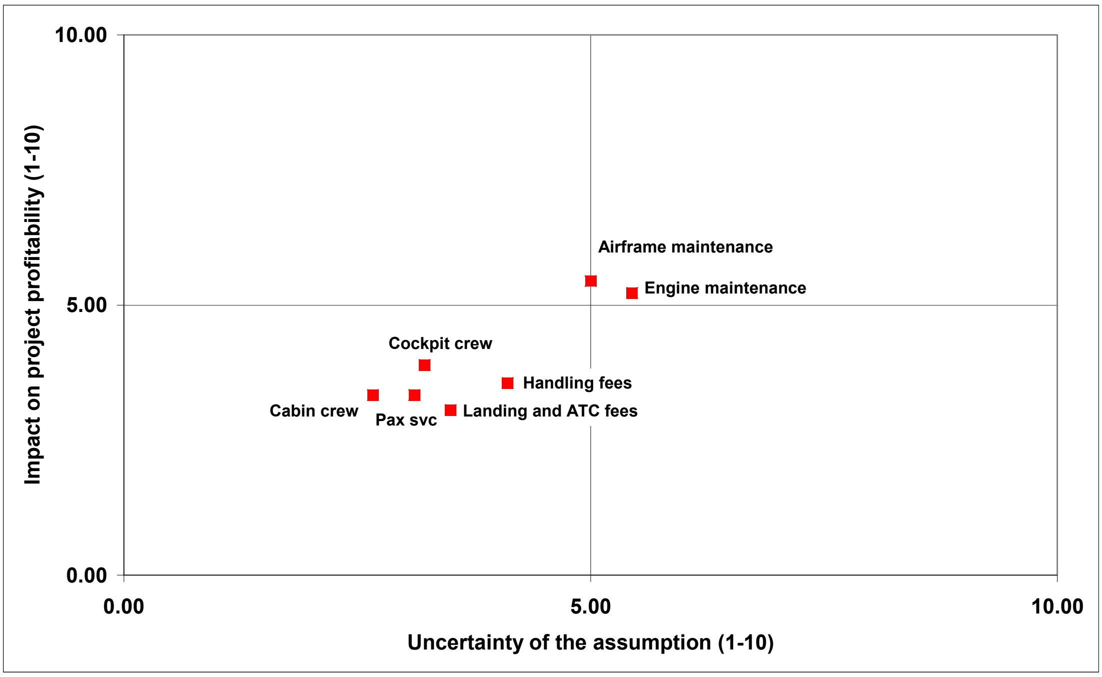



Figure 5.24: Expert panel assessment of aircraft operating cost uncertainties: risk map

Two significant risky assumptions emerge: airframe and particularly engine maintenance. Risk mitigation of these two items has followed three distinct trends in recent years. Following the engine manufacturers' lead, aircraft OEMs have begun to offer flight-hour based 'total care' packages covering scheduled maintenance events, smoothing the stream of maintenance cash flows and rendering them quite a bit more certain. When such packages are not available, airlines have sought manufacturer guarantees but often find them very difficult and costly to administer operationally. The third trend developed by the low-fare airlines has been to outsource maintenance to third parties, reducing variability of maintenance costs over the contract period. This approach tends to dramatically reduce the direct maintenance costs, but also contributes to low-fare emphasis on reducing overhead costs by rendering extensive tooling, training, engineering and management staff superfluous.

The experience of the airline and advisor experts lead them to assess the other cash operating costs of aircraft operation to be relatively low risk from a fleet planning perspective.

The final risky assumptions analyzed in this section concern present and future emissions charges levied by airports and governments. Several experts stated that this area is rather predictable in the near term, but far less so – with strong political influence – in the longer term.

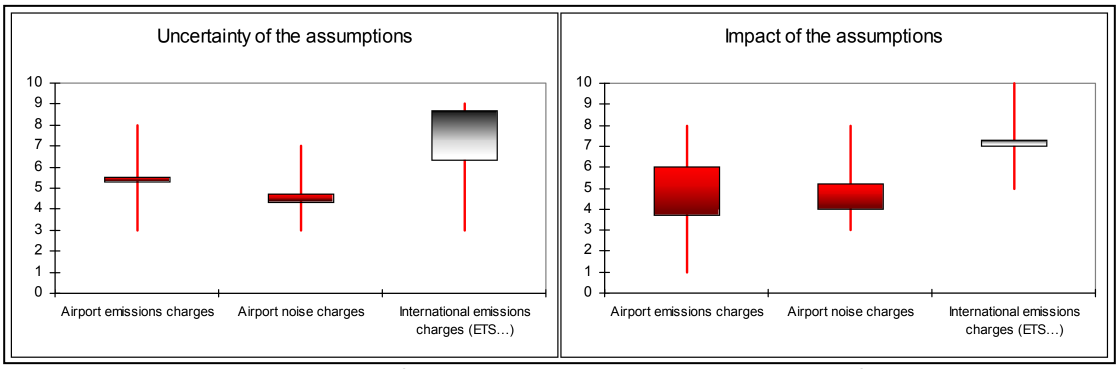



Figure 5.25: expert assessments of environmental cost uncertainties over the fleet planning horizon

There is a reasonably strong consensus on the airport charge question, with the near-term impacts well-known following imposition of such charges at Heathrow, as well as in Switzerland and Sweden early in this decade. Still the divergence regarding both uncertainty and impacts of airport charges among experts working in different regions of the world is substantial, running from one to eight on the scale of ten. The perceived threat to aviation from international emissions scheme such as the E.U.'s Emissions Trading Scheme (ETS) is greatest among the airline practitioners, who assess both dimensions at higher levels than the advisors. On airline executive considers international emissions charges "the greatest threat to airline growth."

## 5.5. Conclusions

The fleet planning process and its attendant uncertainties are strategic for the world's airlines. Fleet development decisions require airlines to make fundamental choices regarding network shape, and carefully arbitrate between aircraft size vs. frequency. Frequency has been shown by the literature and practice to be a key competitive feature to gain market share in deregulated environments.

The deep relationship with and influence of aircraft manufacturers and their choice of aircraft programmes gives the manufacturers' market analysis strong influence in the fleet development decisions at the strategic level. Argumentation and rhetoric by today's two large manufacturers inevitably add to the uncertainties faced by fleet planners, particularly since the airframers' choices of aircraft programmes define the range of choices available to fleet planners. Today, aircraft manufacturers have dramatically different views of the potential for fleet development in the future, particularly in the "21st Century" markets of Asia-Pacific and the recently-developed sixth-freedom hubs of the Middle East.

Airline fleet planning processes tend to place the investment valuation at the end of an iterative loop, as a justification and arbiter of the fleet plans' validity.

This is particularly pronounced in the neo-classical paradigm of fleet development, which is entirely consistent with classical financial theory. The fleet planning methodology typical in this paradigm seeks to align the airline's development with expected evolutions in the economic environment and competitive arenas.

The expert panel assessed nine out of 12 broad assumption areas in neo-classical fleet planning in the high-uncertainty / high-risk quadrant of the risk map. The divergence of opinions among the experts suggests that the methods and uncertainties faced in fleet planning vary depending on the region of the world, and the airline's ownership, governance, and fleet planning process definition.

The positioning of the investment valuation as arbiter at the end of the fleet development process, and the high level of uncertainty regarding economic assumptions identified in this research, lend particular weight to the valuation policy and risk assessment methods discussed in the next chapter. In light of the risks, the neo-classical approach has been found to be complemented by newer and distinctly different approaches to managing risks in aircraft investment planning and project valuation.

# 6. Airline practices in risk valuation and management

This chapter examines how airlines estimate and value the risks in the investment appraisal process, in light of available techniques and research in risk valuation methodologies. In the purest interpretation of classical financial theory, adjustments to project valuations are not necessary, as all relevant company-specific risks are captured in the company's beta and hence in its cost of capital. Chapter Four of this research revealed that in the airline business classical, market-based financial valuation techniques are problematic, given the difficulties of estimating cost of capital parameters, as well as the variety of airline ownership and governance patterns around the world.

As this research discovered to be the case concerning estimates of cost of capital, the literature review and field research shows a variety of objective and subjective methods in use to estimate the level of risk in a project's assumptions. Once the risks are estimated, there are essentially two methods to adjust the valuation for risk. The first is to vary the assumptions or inputs to the investment valuation to determine whether the project is robust under adverse conditions: a more sophisticated variant of this approach is to weight various parameter values with a priori probabilities, an expected-value approach familiar in OR. Alternatively, risk is dealt with by 'raising the bar' for investment approval by requiring a higher forecast rate of return, a shorter payback period, or both. In this chapter the literature and airline practice are compared, using both the airline CFO survey and the executive interviews performed as part of this research.

Secondly, this chapter seeks to ascertain the degree of interaction between fleet decisions and financing alternatives available. While classical theory holds that these decisions should be held strictly separate, our field research reveals significant interactions, notably in the evaluation of operating leasing as an alternative to purchasing the aircraft. The theory and practice of lease evaluation is reviewed, and practice from the airline survey and executive interviews performed is identified and discussed. The potential use of operating leases to mitigate airline risks is then discussed in a real options framework in Chapter Seven.

## 6.1. Risk valuation field research

### 6.1.1. Evolution of risk valuation methods in the general business community

In the general business community[20], risk estimation is found to be largely subjective, though more sophisticated statistical techniques have increased in popularity in recent years. Surprisingly, a relatively small number of executives surveyed report performing 'best/most likely/worst case' sensitivity analysis. The most popular method for adjusting the valuation for risk in the financial community is to raise the required rate of return for investment approval. In spite of the ready availability of modern risk management techniques such as Monte Carlo simulation and Real Options Analysis, these appear to be marginally applied in practice.

Schall et al. found that in 1978, a clear majority of the 189 firms responding to their survey assess risk "only subjectively." A slight weakness of their survey design is that the authors do not clearly distinguish between methods to estimate risk and methods to adjust the valuation for risk.

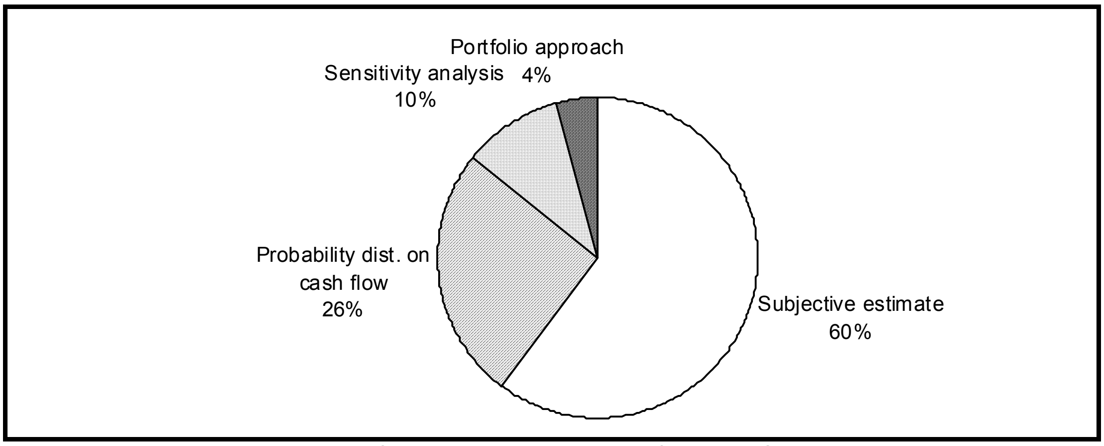



Figure 6.1: methods of estimating and adjusting for risk in Schall et al. (1978)

Estimating probability distributions for cash flows was found to be used by a significant number of firms to adjust the valuation, while sensitivity analysis and the portfolio approach were far less used. Another clear majority of 78% 'raised the bar' by shortening PBK period, raising the required ARR, or raising the discount rate in NPV, to account for risk in the project. The authors found that one tenth of all firms shorten the PBK period to compensate for risk, while a full 31% of respondents combine shortened PBK with raising the cost of

[20] Given the preponderance of field research performed by academics in the United States, it is important to keep in mind that the "general" business community largely reflects practice in that country.

capital or the required ARR. Twenty-three percent of firms were found to use different techniques for different risk classes.

Oblak and Helm (1980) queried executives on risk assessment in light of offshore operations, which present currency and sovereign political risks not present in domestic operations. The authors found that only 7% of firms surveyed use sensitivity analysis to quantify the risks. Instead, they tended to raise the cost of capital for the NPV calculation, based either on the local (offshore) cost of capital, or a subjective estimate similar to Schall et al. (1978). The nearly even split between these two methods is shown in Figure 6.2. The article confirmed both the persistence of "seat-of-the-pants", subjective estimates of risk, and the preference for raising the estimated WACC to adjust for this risk.

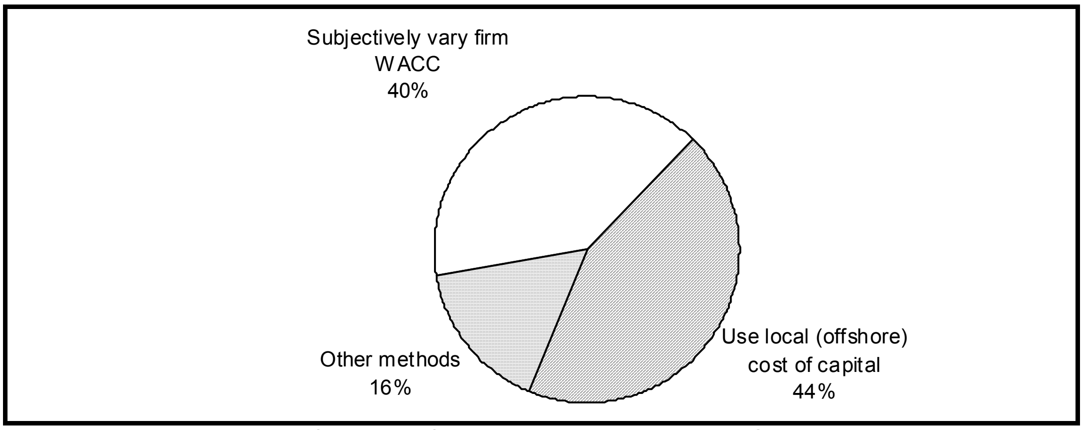



Figure 6.2: methods of adjusting for international project risk in Oblak and Helm. (1980)

Two more recent and comprehensive surveys updated and completed the picture of risk assessment practice. Trahan and Gitman (1995) treat the risk assessment question exhaustively, measuring both the extent to which the various risk assessment methods were understood, and the extent to which they were used. The authors queried financial managers from a population of 700 Fortune 500 and Forbes 200 U.S. companies, and received 84 responses, a 12% response rate. The results regarding risk assessment are presented in Figure 6.3.

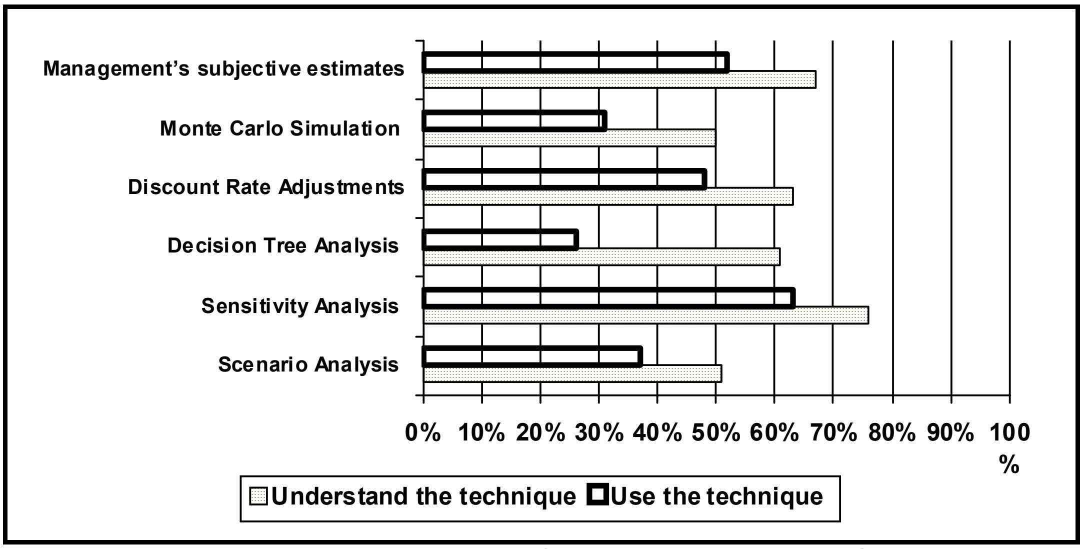



Figure 6.3: Methods in adjusting valuations for project risk in Trahan and Gitman (1995)

Responses revealed that sensitivity analysis was the most commonly used technique, with over 60% of managers using it. By 1995 (in contrast to 1980), spreadsheet software had become ubiquitous, greatly facilitating such analysis. The familiar subjective estimates and discount rate adjustments followed, with around 50% adoption each. More advanced techniques such as Monte Carlo, and Decision Tree analysis lagged behind, but not because the managers didn't understand them. The Scenario analysis technique is a variant of sensitivity analysis, where assumptions are clustered into groups and used to stress test the project model: a simple airline example would be to grouping high fares and reduced load factors (or in today's environment, a high US$ fuel price with a low US$ currency value) into comprehensive scenarios for analysis. The more quantitative techniques and the seeming stubborn resistance to their adoption are discussed below and in Chapter 7 of this research.

Graham and Harvey (2001) went more into detail, proposing a set of potentially risky parameters and ask how companies account for them in the project valuation. They found that in the of the 392 U.S. firms responding, 71% make adjustments for the market risk (beta value) of a project, confirming heavy use of the CAPM methodology and the so-called "project Beta" approach to estimating cost of capital. The project beta is derived by calculating a leveraged beta taking financing requirements into consideration, and/or adopting the betas of "pure-play" firms engaged in businesses with risk characteristics similar to those of the project in question as a proxy for the project beta. Adjusting the beta upwards to reflect increased risk to shareholders goes beyond simple subjective increases of WACC in that it is derived objectively: that said, it remains a method for adjusting for risk by raising the required cost of capital.

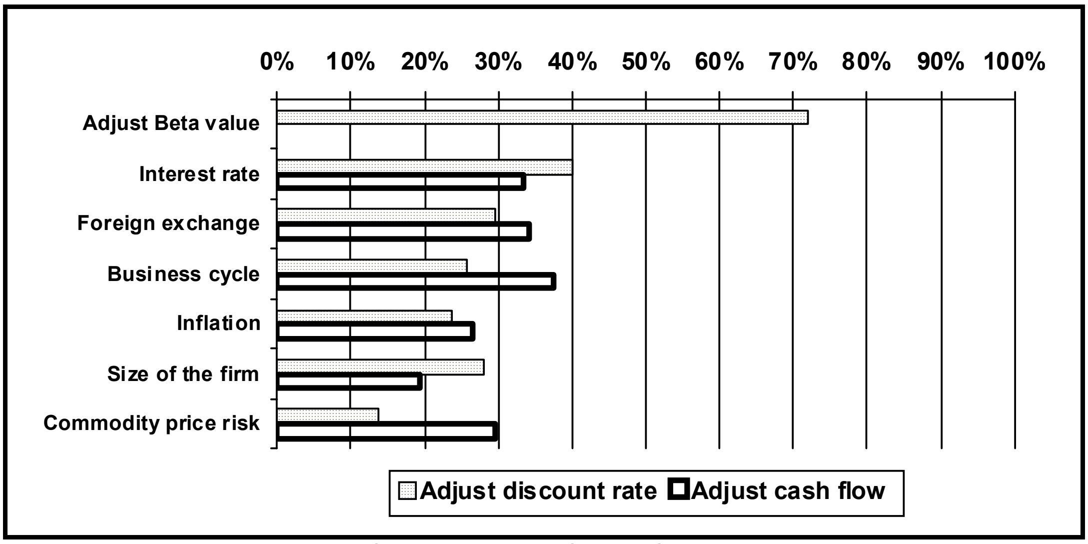


Figure 6.4: adjusting for various types of risk in Graham and Harvey (2001)

Graham and Harvey further queried their respondents about their treatment of specific risks in the project valuation, including both financial risks (interest rate, currency rates, inflation) and economic risks (business cycle, commodity prices, firm size). Financial managers were found to be most likely to adjust cash flows (and somewhat less likely to adjust the discount rate) in assessing the risk of three parameters that are strongly relevant for the airline business: commodity prices (jet fuel), business cycle (due to traffic fluctuations), and foreign exchange (for international carriers). The authors found that a relative majority of firms more commonly adjust the cash flows for these specific risks, rather than raising the discount rate.

The field research performed recently in the general business community thus shows continuity and change: discount rate adjustments remain the favoured technique to adjust valuations, however, with an evolution from largely subjective adjustments toward more scientific approaches. The Trahan and Gitman and Graham and Harvey surveys, the most comprehensive in the recent literature, produced slightly contradictory findings: the former revealed that sensitivity analysis for key uncertain parameters is more commonly used than raising the discount rate in the U.S. business community, while Graham and Harvey found a more "pure" CAPM approach, where firms tend to estimate project betas and thus adjust the discount rate in this way.

### 6.1.2. Risk valuation methods in aircraft projects

In the aviation literature, this research has found extensive use of stochastic methods in fleet assignment and scheduling problems: however, at least in the neo-classical approach to fleet planning, forecasting models are largely deterministic, producing "point estimates" of cash flows. Two recent approaches in the aviation literature suggest ways of using deterministic models to capture uncertainty.

Morrell (2007) discusses a very practical method for looking at project risk, by calculating the project NPV against potential cost of capital of hurdle rates for investments.

The techniques discussed in the remaining chapters of this research use the example of a single-aisle aircraft operating under typical European economic conditions, under the high aircraft utilization that characterizes low-fare airlines such as Ryanair and easyJet. Throughout, the scenario concerns valuation in 2010 for prospective delivery of the aircraft at the beginning of 2012, with a 15-year investment horizon. The model inputs and results are presented in Appendix F. For confidentiality reasons, the figures are somewhat stylized, but remain representative of typical data used in such an analysis.

This research has shown that discount rate estimation is fraught with many uncertainties and methodological challenges, but has also revealed that discounted cash flow techniques are preferred by airline CFO respondents, largely representing European airlines. Given this paradox, the approach discussed in Morrell (2007) is a method of estimating project risk, while implicitly capturing the revealed tendency of finance executives to increase estimated WACC for risky projects.

The stylized example below compares investment in the smaller 156-seat aircraft with a 180-seat model from the same manufacturer, an aircraft sizing question is a common decision for fleet planners. The method discussed in Morrell (2007) is applied to the risk assessment/discount-rate problem in Figure 6.5.

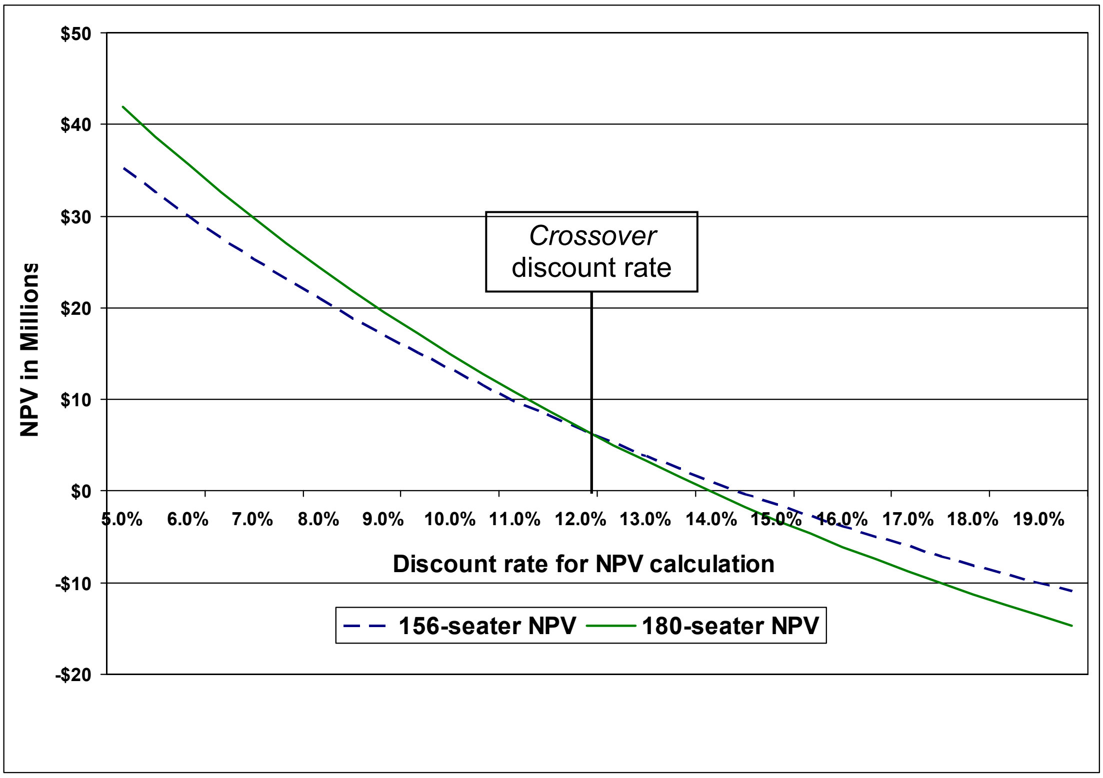



Figure 6.5: Project NPV as a function of Discount Rate

As a larger plane, the 180-seater has more potential to allow for growth in demand for passenger and cargo transport. On the other hand, the aircraft is more expensive, and traffic growth fills the airplane further out in the future than the 156-seater. At low discount rates, the larger plane's future benefits produce higher NPV than those of the smaller, while the reverse is true for higher discount rates. At the "crossover" rate of just under 12% in the example, the projects produce equivalent NPVs, and the valuation is thus indifferent to the choice of aircraft. If the firm's WACC is over 14%, both the larger then the smaller aircraft projects become problematic from a valuation standpoint. With its steeper curve of NPV against discount rate, the larger plane can be seen as a riskier project, and can allow managers to view preferences under a variety of discount rate scenarios: this is a pragmatic combination of risk assessment and sensitivity analysis.

Of paramount concern to fleet planners today, fuel prices and related uncertainties will have a major impact on fleet evolutions in the 21st century. To measure possible impacts of fuel-price uncertainty on fleet choices, Hansen and Smirti (2009) propose a deterministic model that can be used to determine "contour" indifference curves between aircraft types operated over a variety of stage lengths, depending on fuel price. The authors included crew and maintenance cost as variables, in addition to fuel consumption, for regional jets (RJ), turbo-props (PR) and narrow-body (NB) jets, derived through regression analysis of U.S. DOT data. By applying different fuel prices per U.S. Gallon to these equations, they establish the indifference point where each of the three aircraft types produce equivalent costs at various stage lengths. The analysis was then extended to include a charge for passenger travel time ($47.75/hr) and turboprop disutility ($29.17/passenger/flight). Not surprisingly, RJs fare poorly when compared to turbo-props on a per-passenger basis even when travel time and turboprop disutility is taken into account, as shown in Figure 6.6. The red curve represents the frontier where operating cost is the same between the two technologies.

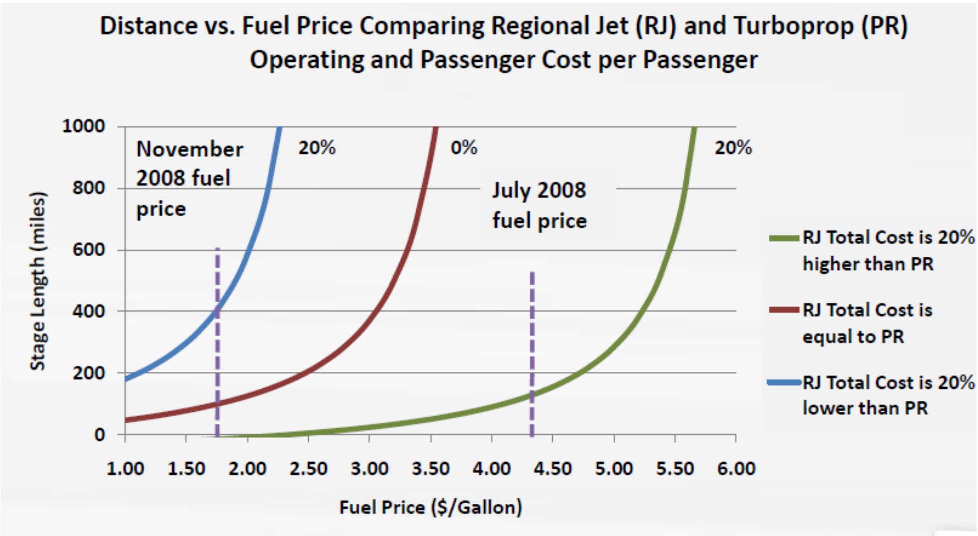



Figure 6.6: “Contour” indifference curves showing RJ cost compared to PR, from Smirti and Hansen (2009)

At any fuel price above $3.50 per gallon, turbo-props present a lower cost per passenger than RJs, a state of affairs which certainly hasn’t escaped turbo-prop manufacturers such as ATR, who have seen a dramatic revival of demand as fuel prices have climbed over recent years.

On the other hand, narrow-body jets, with larger seat counts and lower maintenance and crew costs per seat, fare better in the comparison. They remain cheaper to operate per passenger until fuel prices reach rather extreme levels, as shown in Figure 6.7.

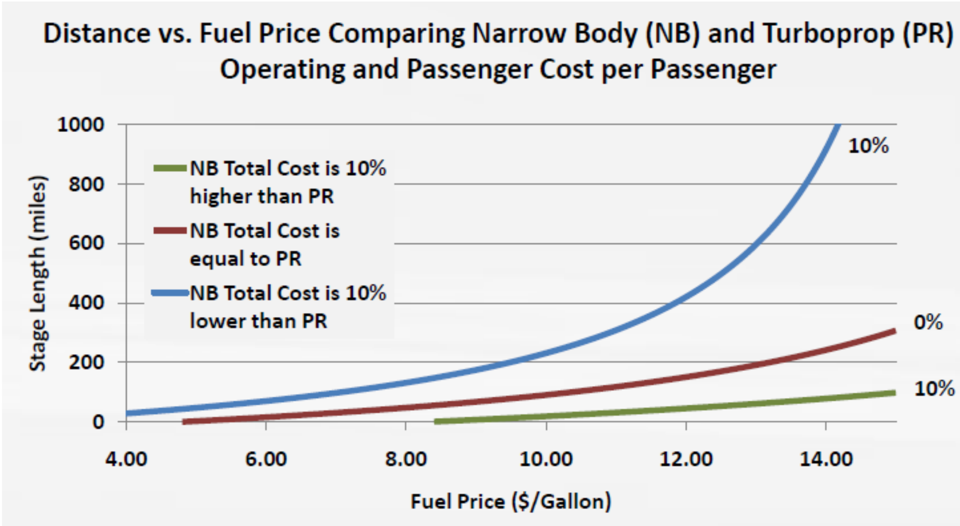



Figure 6.7: "Contour" indifference curves showing NB cost compared to PR, from Smirti and Hansen (2009)

Higher-capacity narrow-body aircraft are shown to be a more robust solution to rising fuel costs than either turboprops or RJs, in U.S. market. These two recent examples from the literature demonstrate sensitivity analysis techniques available to airline planners in assessing project risks, within a deterministic modelling framework.

## 6.2. Airline approaches to fleet investment risk

### 6.2.1. Risk assessment methods in airlines

The airline CFO survey performed for this research addressed separately the methods used for risk estimation (or assessment), and those used for the subsequent adjustment of the valuation to reflect project risks. In terms of risk assessment, the survey revealed substantial consistency with prior research. Airline CFOs were asked to indicate one or more techniques used, among the following list:

- **Subjective estimate**: a rough adjustment made based on prior experience
- **Monte Carlo**: assigning probability distributions to variables and measuring the statistical range of project outcomes
- **Beta method**: identifying a "project Beta" reflecting the project cash flow variances and market Betas of companies in similar businesses
- **Value at risk**: a technique used in banking, which measures the potential loss at a very high level of certainty (typically, 95% or 99% probability. This method is a rule for quantifying the results of Monte Carlo analysis

- **Sensitivity**: varying sensitive parameters in a limited number of scenarios, similar to the approach in Smirti and Hansen (2009)
- **Don't analyse**: self-explanatory

Nearly half of the Airline CFOs responding indicated that they use a single technique to assess risk: of these, 12 CFOs use Subjective estimates only. The remaining respondents use more than one technique to assess risk, a similar approach to the use of more than one valuation technique identified in Chapter Three of this research.

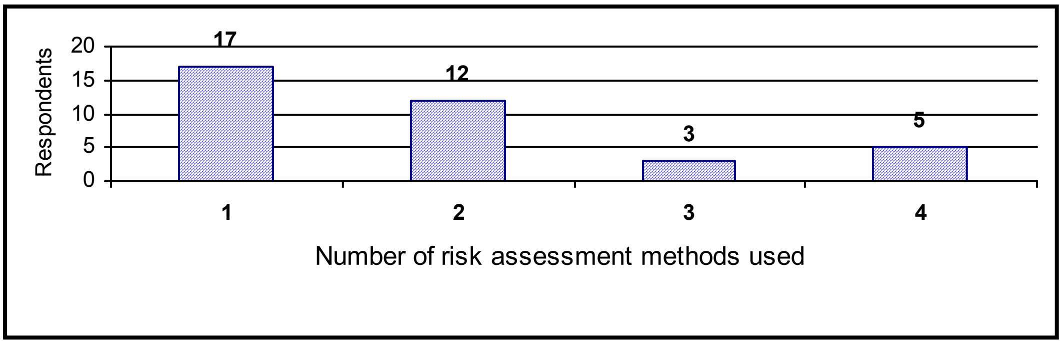



Figure 6.8: Number of different valuation techniques used to evaluate airline investments

The full range of responses is presented in Figure 6.9. A large majority of airline CFO respondents used subjective estimates to assess risk, while nearly one third use Monte Carlo analysis. Use of this statistical technique by a prominent start-up low-fare airline in Europe was confirmed in the executive interviews discussed in the next section. The other methods showed lower levels of use, and were found to be used along with other techniques.

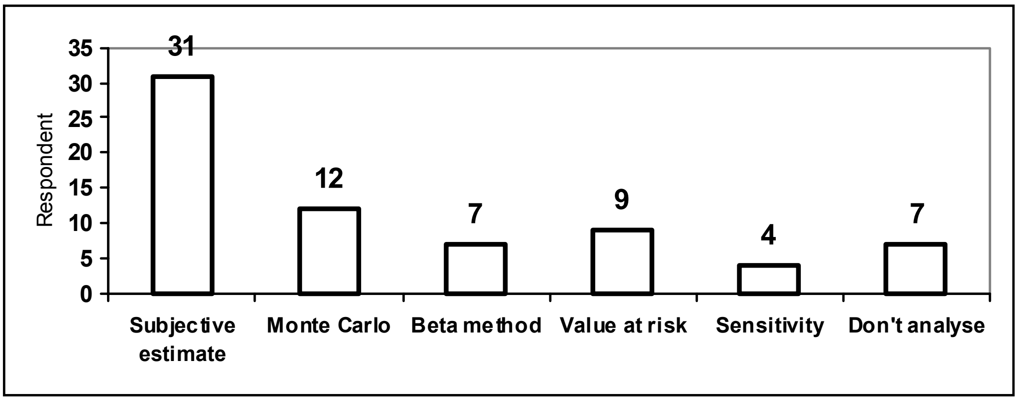



Figure 6.9: Methods used to assess risk among Airline CFO respondents

The survey also tested strength of preference among managers using the techniques, asking whether the CFOs used the techniques sometimes (1), or always (2), as shown in Figure 6.10.

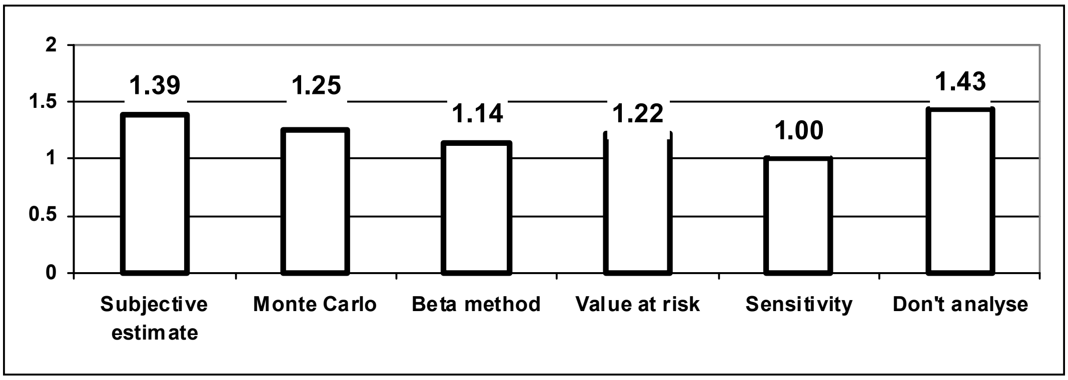


Figure 6.10: Strength of preference for risk assessment methods among Airline CFO respondents

CFOs using sensitivity analysis do so only sometimes, while preferences for all other methods showed that they are used more than anecdotally.

Comparing the overall frequency of positive airline responses on the subject of risk methods to Schall et al. (1978) reveals similarities and evolutions, as shown in Figure 6.11. Subjective estimate is still and more strongly the favourite method to capture risk. Statistical methods such as Monte Carlo and cash flow covariance have gained ground, while the number of companies who use sensitivity analysis is stable: the executive interviews revealed that “simple” sensitivity analysis has given way to more comprehensive and sophisticated techniques in Europe.

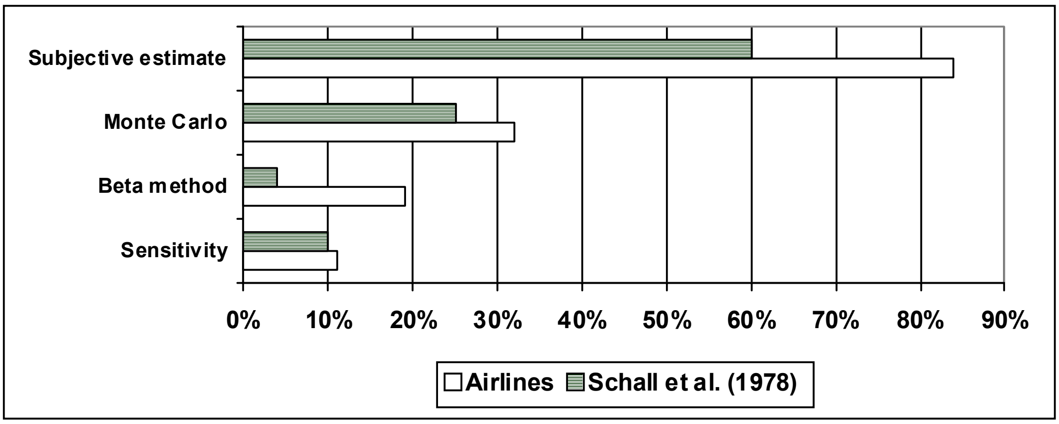


Figure 6.11: frequency of use of risk estimation techniques “sometimes” or “all the time”

Airline financial managers are clearly taking risk into account, and substantial numbers are using sophisticated techniques at least some of the time. Still, though, management judgement is more common than quantitative techniques among airline respondents.

This is in strong contrast to Graham and Harvey’s finding that 71% of U.S. financial managers use the quantitative “Beta” technique from classical finance to assess risk. This technique is only applicable to firms with listed shares. Since airline shares are very commonly unlisted, managers are in any case unable to apply classical financial theory to risk assessment: 10 of the 12 Government-owned airlines responding to the CFO survey used subjective estimates to assess the risk of projects.

### 6.2.2. Adjusting investment valuation for project risks

Once the risk of a project is estimated, the valuation can be adjusted either by varying the cash flows, or by increasing the discount rate. In the area of compensating or adjusting the analysis for risk there are clear tendencies among airline managers, as shown in Figure 6.12. The common approaches of 'raising the bar' by increasing the discount rate, requiring earlier payback, or raising the acceptable IRR are clearly used by airlines.

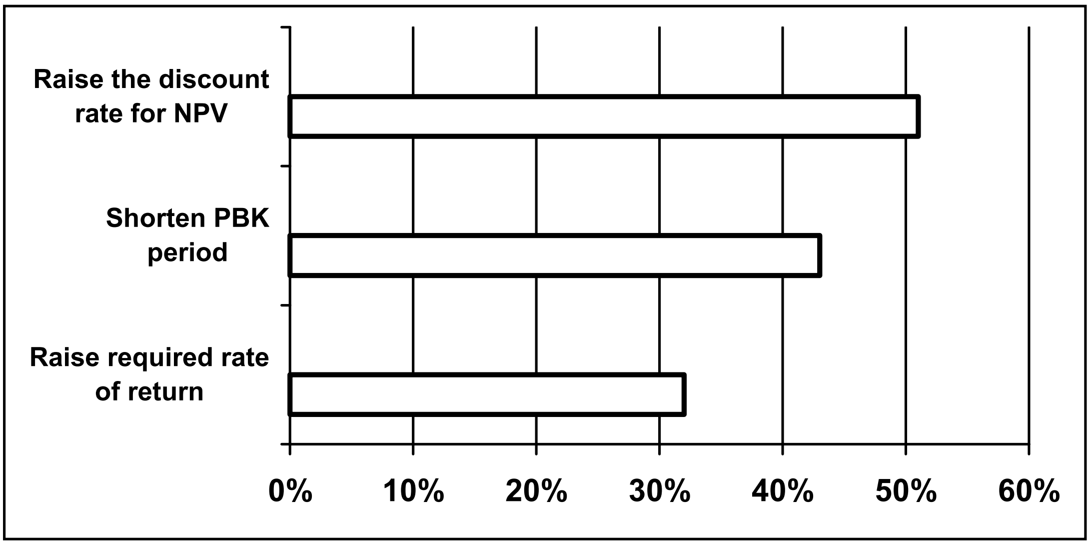



Figure 6.12: Airline methods to adjust investment valuations for project risk

Keeping in mind that 81% of the CFOs interviewed – regardless of ownership – used the NPV technique to value investments, Table 6.1 shows the percentage of airline executives who both used the relevant technique (NPV or PBK) and 'raised the bar' to adjust the valuation. In all cases the survey revealed a pronounced tendency to raise the bar for the CFOs who used the relevant technique. The strongest tendency to increase the discount rate was found among the practitioners that always use NPV to value investments: 64% responded that they raise the discount rate in the analysis to compensate for risk, compared to only 38% of "occasional" NPV users. There was a less prominent tendency to tighten payback criteria in light of project risks.

| Preference for the techniques / Raise the bar? | Adjust discount rate | Shorten payback period |
|---|---|---|
| ***Always* use NPV/PBK to analyse investments** | 64% | 47% |
| ***Sometimes* use NPV/PBK to analyse investments** | 38% | 38% |

Table 6.1: Tendency of airline CFOs using NPV to adjust valuations by raising the bar

This again stands in contrast to Graham and Harvey (2001), which revealed a more balanced approach between adjusting discount rates and varying cash flows among U.S. CFOs.

The survey shows that the most common way to account for risk in aircraft investment analysis is to "artificially" raise the discount rate, making investment projects more difficult to justify. The adjustment is in turn often based on subjective estimates of the risk of projects. The two practices add up to experience-based risk management, as opposed to objective and quantified valuation adjustments. The popularity of "raising the bar" for valuation purposes begs the question of how much it should be raised, adding an additional dimension to the airline dilemma regarding cost of capital estimation discussed in Chapter Four.

### 6.2.3. Risk quantification in the neo-classical paradigm

In the neo-classical approach, sensitivity analysis of critical parameters such as yield, fuel price, and maintenance cost is performed. The parameters are identified for sensitivity analysis by testing the impact each has on the result. The analysis is then subjected to two types of tests. The first is "stress testing," that is, application of worst-case values to the model, each parameter in turn. The project will be rejected if the NPV does not hold up under worst case values for various parameters. Second, in some cases, parameter "stress tests" are grouped into scenarios of concomitant parameter values, with the acceptance criterion remaining a positive NPV.

The discount rate used for NPV in this paradigm is very much based on a classical WACC calculation, using a target (i.e., lower than current) debt ratio. In the highly-geared airline industry, this is one mechanical way of raising the project discount rate, as the higher cost of equity is substituted for the lower cost of debt, to avoid "cheap money from excessive debt." Managers stated that there was a margin then added over the WACC, about which they were "sworn to secrecy", without knowing the source or nature of the margin over WACC. This approach is largely consistent with the results of the airline CFO survey.

None of the managers interviewed took an explicit view of the impact of the economic cycle on traffic, nor modelled the cycle's effect on cash flow or aircraft values. Rather, they assume a mean-reverting cycle with a clear central tendency or average growth rate, and model such growth at a constant rate over the investment horizon. This approach is very much at odds with current practices in the financial community (particularly among operating lessors), who have cyclical trends and market timing as a central aspect of their business models.

When asked about the use of Monte Carlo analysis to quantify risk, managers expressed a clear preference for an approach which allowed them to build a "mental model" of the potential outcomes. This is usually done by running the model with a number of intermediate data points between the extreme high and low values for the sensitive parameters, generate a scatter diagram or radar graph to represent the risk visually in a scatter plot to show the outcomes graphically. No central tendency is used to create these charts, that is, each data point is considered equally probable. Assumptions of positive or negative correlations are often used in the analysis, the most common being to consider demand as negatively correlated with fare or yield.

The claim was consistently made that this type of sensitivity approach was less of a black box than Monte Carlo, and easier to explain and to grasp than such probabilistic techniques. Several managers in various airlines expressed a pronounced hostility to Monte Carlo, saying that using it was akin to abdicating responsibility for the analysis and resulting recommendations.

The neo-classical approach to modelling risk is thus a sort of intuitive statistical approach, where dispersion and correlations are applied to potential outcomes, which are used to capture visually the risks of the project, as opposed to a quantitative, Monte Carlo-type approach.

Real Options Analysis is similarly only used in a limited and intuitive way under this paradigm. These managers often use decision trees, for example, to value aircraft family conversion options under different market growth and traffic scenarios. Each market scenario is weighted with probabilities and matched with various aircraft choices: the result is an expected NPV for each aircraft choice, used to guide the process of final aircraft type selection among narrow body aircraft families. This approach is certainly close to valuing flexibility using real options, although flexibility is valued implicitly by comparing expected NPV under various fleet scenarios, rather than assigning a specific dollar figure as in real options analysis, which is discussed in Chapter Seven of this research.

Consensus among the executives in various airlines is that risk analysis is primarily used to build understanding and the dynamics and "get a mental sense of the trade-offs" a benefit many find absent in statistical and options pricing approaches. The intensive quantification of the market analysis phase is absent in the valuation. One manager made the comment that simplicity of analysis can be an advantage "in a world of imponderables" that characterizes today's airline business.

## 6.3. New perspectives on risk management in aircraft projects

### 6.3.1. Risk quantification as a negotiating strategy

The second paradigm identified is dramatically different from the neo-classical approach in three ways. First, there is a far higher level of information-sharing between the airline and its potential suppliers regarding the valuation. Second, there is no detailed market analysis or route-by-route build-up of revenue and cost. Rather, an assumed average stage length is used throughout the cash flow model. Finally, statistical risk modelling is placed at the centre of the analysis. This paradigm is often associated with start-up airlines, whose initial operating strategy is based on a business plan rather than historical data and previous company experience. It is noted in passing that airlines of this sort in every region of the world form an important part of new orders for jet aircraft every year, particularly in the booming market for short to medium-range aircraft of 125-175 seats.

<u>Positioning of the economic evaluation</u>

In this paradigm, the fleet plan and valuation is one aspect of the company's business plan, which follows the steps outlined in Chapter Five of this research. The fleet plan is an element of the overall business plan, and economic performance of the fleet is reflected in the company financial forecast, rather than being a separate analysis as in the neo-classical paradigm.

Many recent airline start-ups have applied a rigorous "commoditization" of the airline product, offering dramatically simpler services and unbundled pricing, charging all ancillary services to those who are willing to pay for them. This type of business model is best suited to an aircraft which is also a "commodity," well-proven and available in large quantities in relatively standardised configurations. The selection of potential aircraft to suit the strategy is often one of the first steps for these airlines, with a narrow range of potential aircraft and specific configurations identified (maximum seat count, no hot galley for example) forming part of the business model itself.

Europe's low fare airlines can be seen as applying an analytical logic directly opposite to mainline carriers: rather than develop a model of the company's network and then find a set of aircraft which "optimally" serves the demand through OR techniques and iterations, these carriers start by analysing aircraft types and their capabilities, and build the projected network around these capabilities, with the overall objective of maximizing utilization of the aircraft on a daily basis.

In this type of operation, the evaluation of the aircraft (resulting in an NPV) is not used primarily for financial justification of the acquisition inside the airline. Rather, its essential use as a bargaining tool to obtain the lowest possible investment needed to fulfil the business model requirements. The risk assessment is used to demonstrate the variability of project returns to the manufacturers, and to extract concessions (in price and performance guarantees) aimed at limiting the downside risk for the airline investors.

Managers adopting the risk quantification paradigm emphasise the need to level the playing field between different aircraft, that is, to get to operational figures at a sufficient level of detail to correctly assess the risks. To prepare the negotiation, these managers work closely with manufacturers in order to gain agreement (more or less grudging) on the fundamental parameters driving the cash flow, and establish a base case NPV for the project, as well as a set of "sensitivity NPVs", which are used as bargaining chips with the manufacturers.

A stochastic sensitivity analysis is at the heart of this paradigm. One manager cited an example where 11 risk factors were identified and quantified one by one, with the impact and probability of each high and low scenario estimated by the airline's management. In analysing the potential switch from an single-type fleet to a mixed-fleet operation, the airline quantified the risk impacts of 11 parameters, containing both traditional and innovative items, as well as some that are only appropriate to the specific situation. The list can be divided into three categories of items. The first six concern revenue and operating cost, to which are added two specific management costs, and three macro effects:

- Maintenance cost
- Fuel burn and cost
- Operational resilience (lack of scheduling flexibility given a mixed fleet)
- Possible decision to reduce growth rate
- Technical dispatch guarantee
- Fare for the last available seat in the (larger) aircraft
- Management time
- Implementation and complexity costs

- Potential financial community reaction to fleet decision
- Dollar exchange rates
- European product benefits

Revenue and cost items

In addition to analysing classic cost items such as fuel cost, maintenance cost, this approach quantifies the value of a technical dispatch guarantee in cash flow terms. The list also includes quantification of revenue items such as the value of the last available seat in the aircraft. The author's experience with clients shows that planners often concentrate primarily on cost comparisons between aircraft to establish valuation differences. Marginal revenue from the last sold seat on the aircraft is often either ignored because an assumed maximum load factor or spill calculation precludes a full aircraft, or assumed to be very low, since traditional airlines often sell "excess" capacity at a low cost to "bucket shop" agencies which sell the seats on at bargain rates. On the other hand, most of today's airlines, and certainly the point-to-point low-fare carriers, are strong revenue managers in the sense that their reservation systems tend to increase the fare as the date of travel approaches, leading to the opposite outcome: the last seats sold can be the most profitable. The sensitivity NPV for the last seat in the aircraft generates two NPVs, one assuming that the seat is sold at a relatively high fare under revenue management principles, and a second assuming that this seat is sold at a lower average fare.

Each risk factor is quantified with probabilities, yielding an expected NPV benefit or penalty to the manufacturer's aircraft. This is used to obtain price concessions, based on the fact that NPV is perfectly comparable to aircraft price. This kind of sensitivity analysis is practiced by many airlines: the unique feature of the risk quantification paradigm is that the valuation implications are openly discussed with the manufacturers, another major difference from the neo-classical paradigm with its strong information asymmetries between airlines and manufacturers. The final assessment (amount of NPV benefit or penalty) is a matter of judgement of the airline management, and discussed with the manufacturer to justify the bargaining position.

Management costs

To keep costs low and the service level consistent, many point-to-point carriers operate a single aircraft type when possible. A manufacturer who wishes to penetrate one of these carriers is often subject to a 'penalty' in the valuation, in the form of an explicit switching cost. In addition, the example cited here quantified a fleet complexity cost, as well as management time required for the shift.

Macro effects

These effects – exchange rates, potential financial analyst reaction to the decision, and potential benefits from using a European product – are the most difficult to capture quantitatively, because they are very far from the "operational detail" sought by the airline throughout the analysis. They serve for discussion points, but can only be captured in figures by making huge assumptions.

Thus, the discussion with the manufacturers has two pillars: the base case NPV difference and the individual and collective sensitivity NPV differences including operating, switching, and macro effects all form the basis for discussion and negotiation.

Estimation of valuation parameters

While there is a high level of information sharing with suppliers for the purposes of validating aircraft performance and cost assumptions, the primary sources for aircraft operational cost data are not the manufacturers themselves, in spite of the fact that the airlines frequently have no operational experience of the various aircraft under consideration. Rather, offers are sought directly from suppliers of inputs such as line and heavy maintenance, based on on-going negotiations with these suppliers. Internal operating costs and revenue, and the associated risk probabilities and impacts, are derived from management experience and brainstorming. Finally, aircraft residual value estimates are sought from appraisers and/or official aircraft trading organisations. Parameter estimation is thus similar to the neo-classical approach, but without the benefit of extensive operating experience to validate the figures. Room for error is presumably larger, and the risk quantification all the more relevant for these airlines.

Managers using the risk-quantitative paradigm declined to comment on the cost of capital and investment horizon used for the study: even in this transparent approach, certain parameters are not discussed outside the company.

Decision-making & treatment of risk

After reaching a consensus with the vendors regarding risk parameters, an internal analysis is performed and presented to the board. Based on the high, low and most likely parameter values, a Monte Carlo analysis is performed putting all the variables and associated probability distribution estimates together. Application of Monte Carlo to investment analysis was first proposed in Hertz (1964 and 1968), and roundly criticized in Lewellen and Long (1972) and Bower and Lessard (1973), in which the authors found that the failure of businesses to adopt this approach was primarily due to the analysts' "inability to translate results into simple measures executives could reconcile with their intuition and experience and use." This research found a counter-example to this statement: adoption of the technique today may be a result of the increasing availability of MC analytical tools, often available as add-ins to popular spreadsheet programmes.

In the risk quantification paradigm, the key output of the MC analysis is a reverse cumulative probability chart, with project value (NPV) charted against cumulative probability. An example of this type of output is given in Figure 6.13.

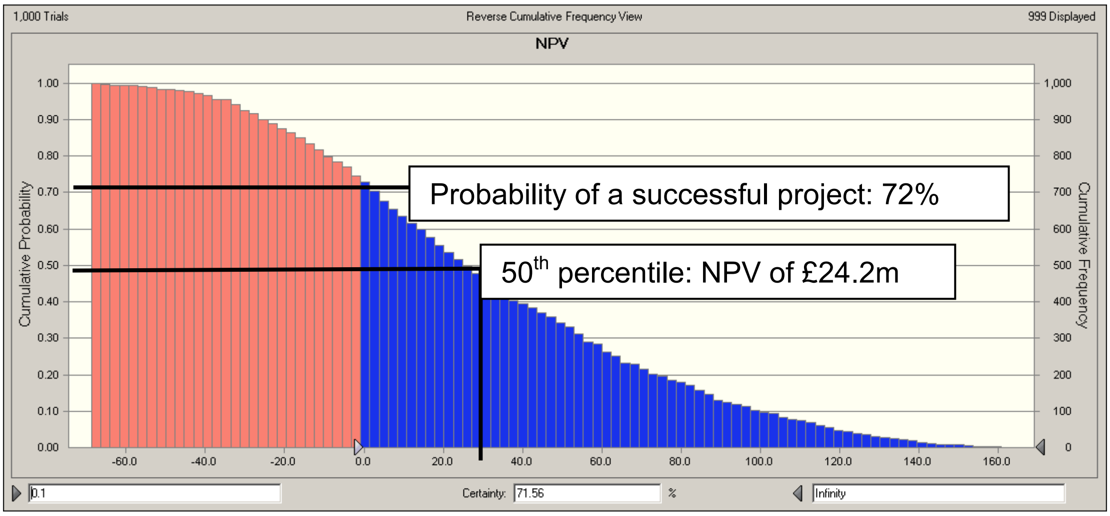



Figure 6.13: Example of reverse cumulative distribution of Net Present Value under Monte Carlo analysis

This analysis has two purposes. Internally, the project with its uncertainties is presented to airline's board, which is thereby queried regarding its appetite for risk. Using the example shown in Figure 6.13, two questions emerge: is a 72% probability of success acceptable? Is £24.2m sufficient shareholder value creation with an even chance of success? The criterion for acceptance or rejection of the project is fundamentally different here from the neo-classical model, in which the project's risk characteristics are "captured" in the discount rate, an estimate of the companies WACC inflated with a risk premium estimated more or less scientifically. In the risk-quantitative paradigm, the analytical output is a probability of success given the risk assessment. It is no surprise that this method is typically used in start-up operations where there is a paucity of hard data underlying the analysis, particularly in the crucial areas of growth potential and revenue (yields).

Depending on the board's decision based on its appetite for risk, the airline's managers may return to the bargaining table, demanding compensation (in the form of price reduction or guarantees to limit downside risk), until a satisfactory balance is achieved.

As in the neo-classical model, the value of options provided by manufacturers are not specifically quantified, according to the managers interviewed; however, comparing the options proposed under different offers is a significant qualitative input to the selection process. Among the options compared are:

- Aircraft price protection (for any new orders) through a specified date
- Ability to switch aircraft type (family conversion)
- Ability to increase order size (purchase options)
- Ability to defer deliveries
- Ability to accelerate deliveries
- Price escalation cap

This intuitive and qualitative comparison of options offered was mentioned by many executives during the interviews, but its use in the risk-quantification was the most extensive encountered in the field research.

The risk-quantification paradigm makes extensive use of statistical techniques, and fully integrates both the technique and the managerial logic of Monte Carlo analysis. Its use in start-up carriers with limited operating experience suggests a paradox in which the managers least equipped to measure historic distributions around revenue and cost assumptions use a technique which requires such inputs.

The power of this approach is two-fold. The creation of the "sensitivity NPVs" is a very powerful tool used to negotiate purchase terms and conditions, but requires a degree of openness in sharing information with manufacturers that is rare in aviation: neo-classical airline practitioners interviewed frequently mentioned firewalls used to keep valuation information from flowing to the manufacturers.

The second powerful innovation concerns the way the valuation is presented to the airline's Board. Rather than inflate the discount rate to cover downside risk and present a "stress-tested" NPV, risk-quantifiers use the uncertainty of the project itself as the key decision points for the Board, querying Board members on their taste for risk, and the expected return required to compensate for this risk. The author's consulting experience with airlines, lessors and manufacturers suggest that few airline Board's are willing to take an analysis in this form, preferring a unitary valuation (NPV) that has been stress-tested by management.

### 6.3.2. Aircraft financier views of investment valuation & risk assessment

Aircraft financiers analyse the business plans and fleet development strategies of airline customers seeking financing, using information provided by the airlines themselves as well as data provided by trade associations, ratings agencies, and regulatory bodies. These financiers are today invited to provide funding for both new entrants and established carriers who often operate in riskier, emerging markets. Executive interviews with providers of finance revealed recognition of the merits of the three aircraft valuation paradigms identified within airlines, but also a pronounced scepticism about the rigour of analysis within airlines.

The managers interviewed made a clear distinction between replacement aircraft and expansion fleet analysis. Replacements tend to be carefully analysed in terms of operating costs per seat, as opposed to a more global analysis including new prospects for revenue generation. Expansion fleet tends to be viewed and valued more comprehensively (i.e., including cabin product, fare class marketing, and related revenue opportunities). The strategic goals examined by financiers centre around market position, potential first-mover benefits and QSI-type analysis, as in the neo-classical model.

A second distinction is made based on the size of the aircraft. The financiers interviewed recognise that the market for narrow body aircraft has become commoditized, with unit costs and aircraft price being the primary analytical focus. Wide-body aircraft analysis tends to be more sophisticated, taking seat-class and fare-class (revenue management) and cargo potential into account. The analytical focus of aircraft financiers can be summarised along two axes, with comments in parentheses.

| | Replacement<br><br>(lower-risk) | Expansion<br><br>(higher-risk) |
|---|---|---|
| Narrow-body (lower-risk) | Operating cost (commoditisation of the airline product) | Cost (deemed essential due to low-fare entrants) |
| Wide-body (higher-risk) | Cost (revenue continuity assumed) | Revenue and cost (in a comprehensive strategic framework |

Table 6.2: Types of fleet investment, perceived risk, and focus of analysis among aircraft financiers

Several interviewees suggested that operating cost, with revenue continuity either assumed or ignored, when airlines analyse replacement wide-body aircraft. The managers noted that cost data is more reliable than revenue projections, raising the risk level for airlines forecasting high levels of growth and/or "exotic" revenue generation models.

The financiers stated that there is extensive interaction between airline business plans and fleet plans, as was discovered with the risk-quantitative and aircraft as commodity paradigms. New business models and start-up airlines, a major source of aircraft orders today, are often dealing with highly risky assumptions in their business plans. The financiers often have to push potential customers to provide more than a very short-term view of the financial impacts of fleet investments. They stated as well that the depth of research they observe in aviation is far less than for other types of project finance. The managers also stated that cash-flow analysis in general is "narrow" in scope, and emphasized that "the answer is not in the spreadsheet." The primary use of cash flow analyses they have observed is evaluating the different aircraft prior to ordering, rather than justifying the investment to shareholders or financiers.

The up-front financial evaluation performed by the financiers is thus placed in a strategic and political context: a qualitative view of the strategic vision of the airline managers is paramount in the credit risk analysis. For the financiers, the approach to strategic questions of market coverage (network structure) and QSI (notably the frequency parameter) is paramount. The managers noted that barriers to entry have been dramatically lowered in recent years by the availability of operating leased aircraft and state that a lack of long-term capital in the market "forces a more intuitive approach to planning" and consequent short-term bias among airlines. Finally, "extraneous" influences such as domestic and international political considerations often form part of this qualitative and strategic view of the airline's prospects. The analytics frequently are secondary in this approach, leading to a situation where the most extensive financial analysis often takes place in the case of an airline default, when the financiers seek to establish the potential for a potential restructuring of loan terms to achieve a successful conclusion to the transaction.

In terms of the risk evaluation, the financiers use, and recommend, statistical risk estimation measures proper to the financial community, such as Value at Risk (VaR), a near-universal risk metric in banking which is based on Monte Carlo analysis, which uses using historical asset volatilities to estimate future risks. One financier suggested that airlines should raise equity to cover the value at risk for an aircraft investment at a 99% confidence level. This view is in stark contrast to the approach of the neo-classical and aircraft as commodity paradigms, which do not use such statistical measures in the valuation. Managers in these airlines expressed four reservations about this type of metric. First is the assumption that historical trends remain constant in a volatile industry. The second critique, that VaR analysis does not take catastrophic events into account, is not strictly true: input distributions of economic parameters can encompass these types of events, even if they rarely are in fact included in VaR analyses. Third, the airline managers view a statistical approach as “abdicating responsibility” for managing the risks of the business. Finally, there is a pronounced reluctance to present and explain these methods to boards of directors: risk is to be captured in the discount rate and sensitivity analysis for the neo-classicists, and individual risks must be carefully divided up and actively managed by the entities most able to do so, in the aircraft as commodity paradigm.

Regarding Real Options Analysis, the financiers expressed the view that such sophisticated analysis is taking place, if at all, at lower management levels of the airlines, and are used to “guide” the risk assessment, a view strikingly similar to that expressed by practitioners of the neo-classical approach. The financiers suggested that the operating lessors are the most appropriate users of such techniques to manage residual value risk.

The debate on the use of statistical risk estimation techniques Monte Carlo was striking. It seems impossible to remain indifferent to this technique, which while reviled by many airline managers, is at the heart of the risk quantification paradigm. This paradigm tends to be practiced in companies who are either new entrants, have double-digit growth forecasts, or both: their emerging presence in a dynamic airline world is “filled with imponderables,” obliging responsible managers and boards to explicitly recognise that success is only probable, not certain. The managers using this paradigm have a sharp focus on the usefulness of the analysis, that is, as a way to enhance the quality of dialogue with aircraft manufacturers, and to bargain for concessions in price and aircraft performance guarantees.

Equally sharp is the focus of the third paradigm, which breaks down and assigns risk in a way very much like recent financial derivative instruments, separating credit risk from ownership risk to reduce the unit cost of operating the aircraft. A careful analysis of the risk-management competences in the value chain is exploited as the best way to decrease the costs, and risks, of airline operations. Arbitrage opportunities deriving from the perceived under-pricing of risk are fully exploited. This risk pricing takes place in a clear segmentation of aircraft types by liquidity class, and is driven forward in light of expected near and medium term evolutions in the market for new capacity.

The financiers revealed substantial scepticism about the valuation processes within airlines and manufacturers. They suggested that operating cost is in many cases the metric most frequently used to evaluate aircraft, and that valuation is mostly used to compare aircraft types, rather than as a project justification method. Senior management intuition and experience, market-leadership strategy objectives and extraneous influences are seen as more important than valuation techniques and quantitative rigour. While the financiers both use and recommend statistical risk metrics, they confirmed the view that, most of the airlines they work with are not in fact using these techniques at the highest management levels.

## 6.4. Investment-financing interactions and risk management

In neo-classical aircraft investment valuation, companies evaluate strategic investments using a theoretical cost of financing, and separately optimise the financing. This is consistent with classical finance theory, in which investments are analysed using forecasted operating and investing cash flows, and the overall cost of financing is captured in the WACC. This has led to an orthodox view in which investment and financing decisions should be kept separate. The classic Modigliani and Miller Propositions I & II discussed in Chapter Three of this research have been the object of many re-examinations over the years, notably by Joseph Stiglitz (1970), who strongly defended the Modigliani and Miller propositions, while finding that investor expectations, differentials in corporate vs. individual borrowing costs, and the threat bankruptcy may temper their universal application.

The risk quantification approach begins with the classical notion that the investment project should be analyzed without taking financing into account, but goes beyond classical finance's assumption that all risks should be captured in the project discount rate, applying Monte Carlo analysis to quantify the projects' prospects and, not incidentally, to build a case for manufacturer concessions in the aircraft purchase negotiations.

The last section in this chapter examines the interactions of investment and financing decisions and associated valuation issues for airlines, in light of their extensive use of operating leasing. It identifies a third valuation paradigm which rejects classical financing tenants by viewing aircraft capacity as a cost which may be commoditized, while simultaneously arbitraging aircraft residual values in light of prospective changes to aircraft product developments.

In the 1970s and 1980s, a large body of literature debating potential interactions between investment and financing decisions arose, centring on the valuation of investments given the possibility to acquire an asset under an operating lease and return it to the lessor after a pre-determined period of usage, as opposed to an outright purchase. Managers are faced with three options in acquiring assets. Firstly, they may purchase the aircraft out of existing resources, that is, without recourse to financing. Due to cash constraints in the low-margin airline business, the overwhelming majority of aircraft are acquired either under a finance lease (or loan), or operating lease. Certain typical characteristics of the two financing vehicles in the aircraft market are presented in Table 6.3.

| | Finance lease | Operating lease |
|---|---|---|
| Typical term of the lease | 12 - 18 years | 3 – 7 years |
| Advance payments by the airline prior to delivery | Manufacturer pre-delivery payments (PDP): 20-30% of aircraft price | 3-6 months rentals as a deposit |
| Repayment structure | Pincipal+Interest | Rental |
| Tax treatment of lease payments | Interest deductible in most jurisdictions, capital is a balance sheet item, not deductible | Total rental deductible in most jurisdictions |
| Frequency of payments | Every six months, in arrears | Every month, in advance |
| Asset value exposure | Aircraft transfers to lessee after last payment made | Aircraft returned to lessor at lease expiry |
| Balance sheet treatment | On balance sheet under International Financial Reporting Standards (IFRS) | Off balance sheet |
| Lead time to delivery | Based on manufacturer lead times | Can be shorter than manufacturer lead times |

Table 6.3: typical characteristics of finance and operating leases for aircraft

In this section the different methods of valuing operating leases in comparison with purchasing (with or without a finance lease attached) are examined, airline practice is established, and a recommended approach to lease vs. purchase analysis is recommended.

### 6.4.1. Valuation of operating leases

A carefully considered approach to lease valuation using DCF is important, for two reasons. First, both investing costs (the asset's loss of value over the lease period, captured in accounts by a non-cash depreciation charge), and financing costs (the lessors implicitly provide financing to the lessee, thereby 'displacing' debt) are embedded in operating lease payments from airlines. The inability to disaggregate these two items in the cash flow, and the non-cash nature of the implicit depreciation charge, make DCF-based comparison between leasing and purchasing problematic using a single discount rate such as WACC. Second, the tax treatment of operating leases is distinct from borrowing or finance leases in most jurisdictions: operating lease payments are fully deductible from corporate profits, where only the interest portion of borrowing repayments is deductible.

The question managers face in lease vs. purchase analysis concern which cash flows to discount, at which rate (cost of debt, cost of equity, other), and the treatment of tax. The initial debate about valuation of leases in light of these complexities was comprehensively framed in Bower (1973), who summarized the approaches recommended by 13 different authors on the subject. Bower analysed the debate, and narrows methodological divergences to seven different approaches, which vary on both choice of discount rates and treatment of tax in the analysis. A variety of discount rates was found to be recommended for the cash flows in Table 6.4.

| Cash flow category | Potential discount rates identified in the literature | Bower recommended discount rate |
|---|---|---|
| Lease rental | i, i(1-t), r, r(1-t), k | r |
| Tax shelters from<br>▪ Rental<br>▪ Depreciation<br>▪ Interest expense | i, i(1-t), r(1-t), k | k |
| Additional ownership cash flows (not incurred in leasing) | i, i(1-t), r(1-t), k | k |
| Residual value of owned equipment | i, i(1-t), r(1-t), k | k |

Table 6.4: Cash flows categories and discount rates in lease vs. purchase analysis in Bower (1973)

Where:

- r = cost of debt
- r(1-t) = after-tax cost of debt
- i = implicit interest rate on lease (an output of the calculation, or IRR)
- i(1-t) = after-tax implicit interest rate

- k = Corporation after-tax cost of capital

Looking at the table, a practitioner could be excused for gathering that depending on the academic asked, any possible discount rate could be used for any given parameter. Bower himself promoted a Net Advantage of Leasing (NAL) concept common to several authors, which in his formulation calls for discounting the lease rental at the cost of borrowing, and all other cash flows at the "company cost of capital" (presumably, the WACC). In the conclusion, Bower states that the different approaches "disagree substantively on very few points." This paper helped frame the issues for the ongoing debate which, like many theoretical innovations in finance, has taken a long time to filter into the work of practitioners.

In succeeding years, the debate and its underlying definitions were more sharply defined, not least by clearly distinguishing operating and financing leases, and re-qualifying 'lease vs. purchase' as the more accurate 'lease vs. borrow'. Merton Miller and Charles Upton (1976) reached the twin conclusions that lease valuation is fundamentally different from purchase due to tax treatment of leases, and that many operators of equipment may be unable to take advantage of tax benefits due to low underlying profitability. This state of affairs leads to the creation of leasing companies who are specialized in finding and exploiting such tax benefits, a defining feature of the aircraft leasing industry today.

Schall (1973) emphasized that each distinct cash flow stream arising from the lease or borrow decision should be discounted at a different rate. Stuart Myers developed his concept of Adjusted Present Value (APV) in a theoretical framework in Myers (1974), applied it specifically to leasing in Myers, Dill, Bautista (1976), and laid out the practitioners' approach in the widely-used finance textbook Principles of Corporate Finance, currently in its sixth edition. Under Myers' version of APV, the NPV of a project is first calculated by discounting the after-tax operating cash flows using the firm's cost of equity. To this is added the 'side-effects' of the project, notably, the tax shelter on depreciation and interest. The primary insight is that these 'side-effect' cash flows may be discounted at the firm's cost of debt, because they are low risk.

When applied to leasing, the "value" or advantage of leasing is calculated by comparing the present value of the lease payment tax shields with the (lost) tax shields on interest and depreciation. When applied to *aircraft* leasing, Miller and Upton's point that tax shields depend on airline profits comes to the fore. Aircraft operating lessors are either structurally set up under parent companies who can absorb tax losses – as is the case with GECAS parent company General Electric, and *was* the case with ILFC parent AIG), or are adept at finding third-party investors with tax capacity, as is the case with Babcock and Brown's extensive network of medium-sized Japanese companies.

### 6.4.2. Extending APV to aircraft operating lease vs. purchase analysis

The airline CFO survey shows that there are clear interactions between the investment analysis and the financing preferences in responding airlines. This is confirmed by the extensive preference for using cash flow analysis to evaluate the critical lease vs. purchase (or lease vs. borrow) decision in aircraft financing. Airline CFOs overwhelmingly use discounted cash flow analysis to help decide between operating lease and purchase options for acquiring aircraft.

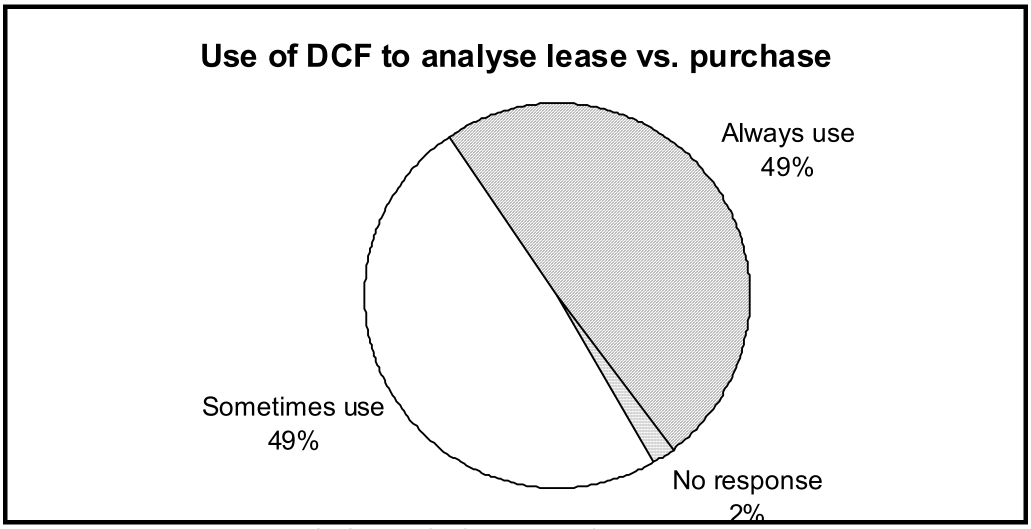



Figure 6.14: Airline CFO use of DCF analysis for lease vs. purchase decisions

At the same time, only 24% of the airline respondents use APV to analyse such decisions in a strategic context. One executive interviewed as part of this research emphasized that the lease/purchase decision was purely tactical and under the purview of the Finance function, not part of the fleet planning process itself. Similarly, the risk-quantification approach does not include analysis of aircraft acquisition and financing, focusing instead on the project itself. The discount rate used under such tactical analysis is invariably the airline's cost of debt: as financing structures have grown more complex over the years and tax implications have become paramount, such discounting of financier 'term sheets' (commercial offers) is done on an after-tax basis. As discussed above and in Gibson and Morrell (2004), improper (higher, WACC) discount rates used to evaluate leases could encourage companies to take on more aircraft than they need under lease, and such relative advantages are certainly a "selling point" for operating lessors working with less sophisticated airlines.

Operating leasing has undeniable benefits for operators of aircraft, offering a level of fleet flexibility and residual value risk reduction unobtainable when purchasing. Growing far beyond their origins as a "cheap" – or more accurately, low cash-out - solution to aircraft finance, operating leases are the financing vehicle of choice for around one quarter of all new large civil aircraft delivered today, and are extensively used by the world's largest and wealthiest airlines. Companies can use operating leases for flexibility when adopting a new aircraft type, or as part of an aircraft type exit strategy, as shown in the figure below, taken from Gibson (2003).

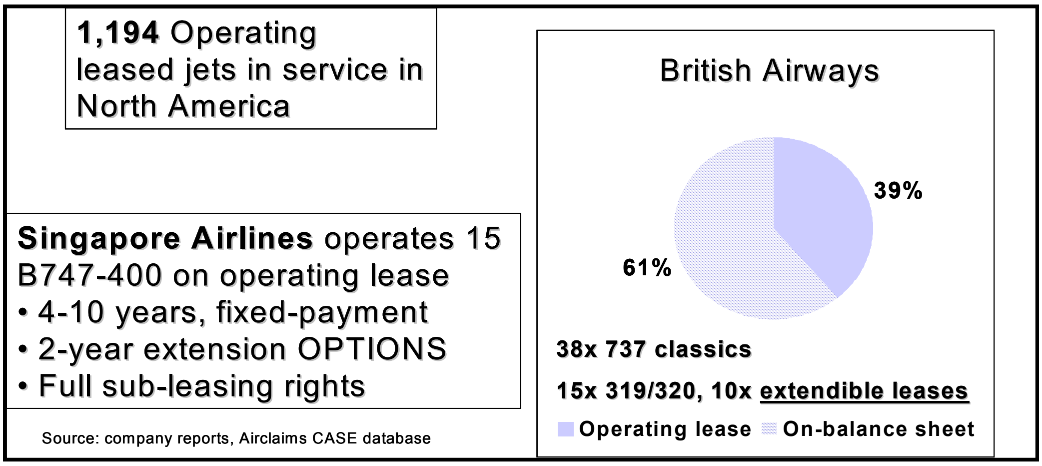



Figure 6.15: examples of operating lease use in U.S., Europe, Asia, from Gibson (2003)

The large number of aircraft under lease in North America reflect both the overall size of the world's largest aviation market, and the fact that many airlines in the region have been through Chapter 11 bankruptcy (Continental, United, Delta, Northwest, U.S. Airways, to name only survivors).

Operating leasing is no longer a solution of expediency for cash-strapped airlines, but has become a strategic means to facilitate either abandonment, or adoption of aircraft types. SIA's sale and leaseback of 15 747-400s reflects a strategy to move out of the type in preparation for the A380. BA's lease of two thirds of its initial A319/A320 fleet reflected both the post-9/11 financing environment and a low cash-out approach to its partial re-fleeting with the Airbus types, of which 10 were acquired under flexible, extendible operating leases.

In order to analyse the impacts of investment and financing interactions on fleet investment decisions, this research uses a valuation model developed by the author. The model is in active use for both instructional purposes and in consulting practice with airline fleet planners and financial managers. The model accepts a complete set of inputs regarding the financial and economic environment, aircraft acquisition, financing and disposal, and operation of the aircraft over a horizon that may be varied by the user. The model outputs a set of project financial statements – Profit and Loss and Balance Sheet – as well as its analytical focus on project cash flow. This model allows the evaluation of acquisition and financing alternatives as well as a classical NPV analysis, and is suited to the lease vs. purchase analysis discussed below. The model's use is extended in Chapter Seven to include Real Options Analysis.

A correct NPV analysis of leasing vs. purchasing should estimate and include the cost of the flexibility benefits, when compared to debt financing. Consulting and teaching experience shows that among airlines, project NPVs are often calculated including comparing operating lease cash flows against purchase cash flows. Viewed graphically, the differences are apparent.

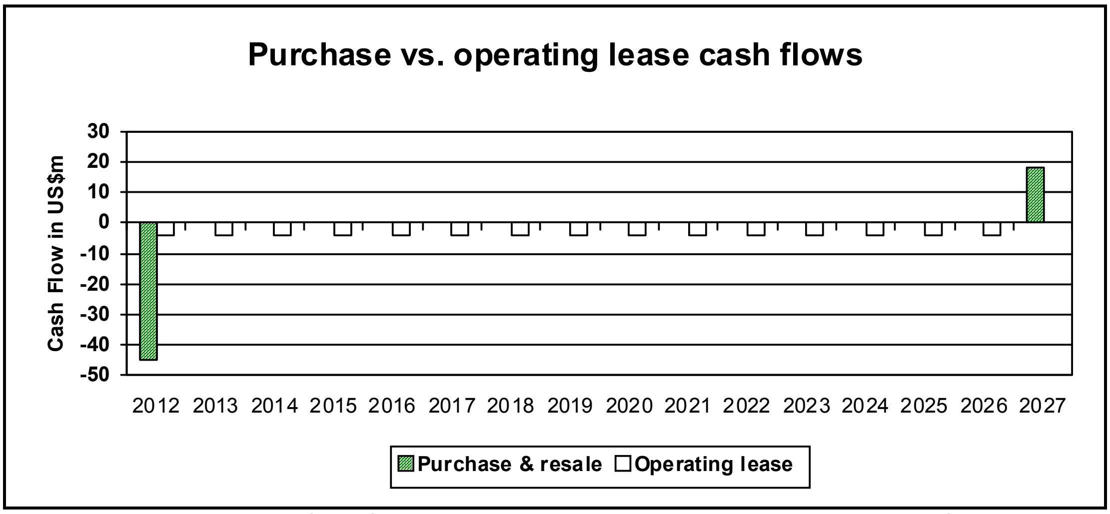



Figure 6.16: cash flows for purchase and resale, compared to operating lease flows

When each set of cash flows are discounted at the firm's WACC, the result is inevitably favourable to leasing, with its lower and progressive payments compared with the initial purchase cash outlay. In addition, this approach places undue emphasis on residual values, particularly when a short project horizon is used.

This is conceptually incorrect under classical finance theory and practice, for two reasons:

- Lease payments include both investing and financing cash flows, as well as a risk premium for the lessor

- The cost of purchasing or leasing an aircraft should be compared to the benefits of operating the aircraft, not to one another

Leasing is fundamentally a financing vehicle, and should be compared with the costs of borrowing or taking on a finance lease (also known as a capital lease).

To correctly estimate the cost of leasing, this research recommends using a variant of Myers' Adjusted Present Value concept. Under APV, cash flows of different risk classes are discounted at the discount rates that reflect the risk class of the cash flows. Implementing the method is straightforward, as summarised in Table 6.5.

| Discount rate | Purchase scenario | Operating lease scenario |
|---|---|---|
| Cost of debt | Financing cash flows: Loan or finance lease advances<br>Repayments of interest and principle<br>Tax shield on interest and depreciation | Lease payments |
| Cost of equity | Operating cash flows<br>Purchase and re-sale of the aircraft | Operating cash flows |

Table 6.5: Cash flow categories and discount rates for lease vs. purchase analysis

All cash flows are discounted after any appropriate taxes have been deducted. WACC is not used for the discounting calculations, in order to isolate and properly compare the financing costs under leasing and purchasing.

This approach has two major advantages:

- clarifying that the risks of owning & operating aircraft are borne by the equity investors
- directly comparing the financing alternatives, and showing the cost of the flexibility inherent in leasing

When it comes time to finance deliveries, airline financial managers discount the term sheets offered by different financiers to determine the best offer, using the airline's cost of debt to discount the different flows. The recommended approach to investment analysis using APV simply extends this tactical approach to investment valuation. In this sense it is a recommendation to change the process, in recognition of the risk pricing inherent in leasing arrangements.

The results of NPV and APV are compared in a static valuation (i.e., under a common set of inputs regarding the economic and operating environment) in Figure 6.17 below. The only difference between the two scenarios is whether the aircraft are acquired under operating lease, or purchased outright and sold at the end of the 15-year project horizon. As the static case depicted in Figure 6.17 shows, the differences in valuation are clearly significant.

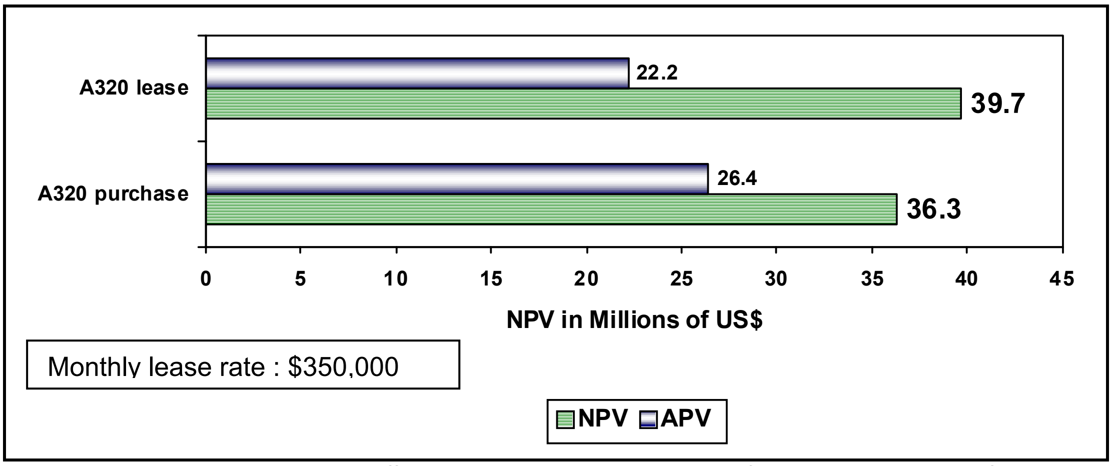



Figure 6.17: Valuation differences between NPV and APV for a single-aisle aircraft

APV results in a lower overall project valuation, because the operating cash flows are discounted using the higher equity rate: these operating cash flows are identical between the lease and purchase scenarios, and discounting at the higher equity cost reduces the overall project valuation, which is not particularly popular among managers in a low-margin business. Second, the lease scenario APV is $4.2m lower than the purchase, reflecting the financial cost of replacing the cash investment by lease payments, transferring the residual value risk transfer to the lessor, as well as the lessor's profit margin. In this technique, the financial cost of flexibility is made explicit.

In the example above, lease rates are $350,000 per month, a typical rental for a new singe-aisle type such as the A320 in an up market. Lease rates are highly cyclical, reflecting the demand for relatively short-capacity in aviation markets worldwide. Operating leases are generally less than ten years in length, and are often three, five, or seven years, with or without options to extend. To properly compare leasing and purchasing over a longer term, it is necessary to assume that a lease is renewed over the investment horizon. Methods used to re-price the lease after the primary period range from simply assuming that the lease rate will remain fixed, to modelling the variation in lease rates as a function of aircraft values.

Sensitivity analysis can reveal the sensitivity of valuations to lease rates under NPV, and can help managers establish a maximum acceptable lease rate. In the singe-aisle example, a lease rate of $290,000

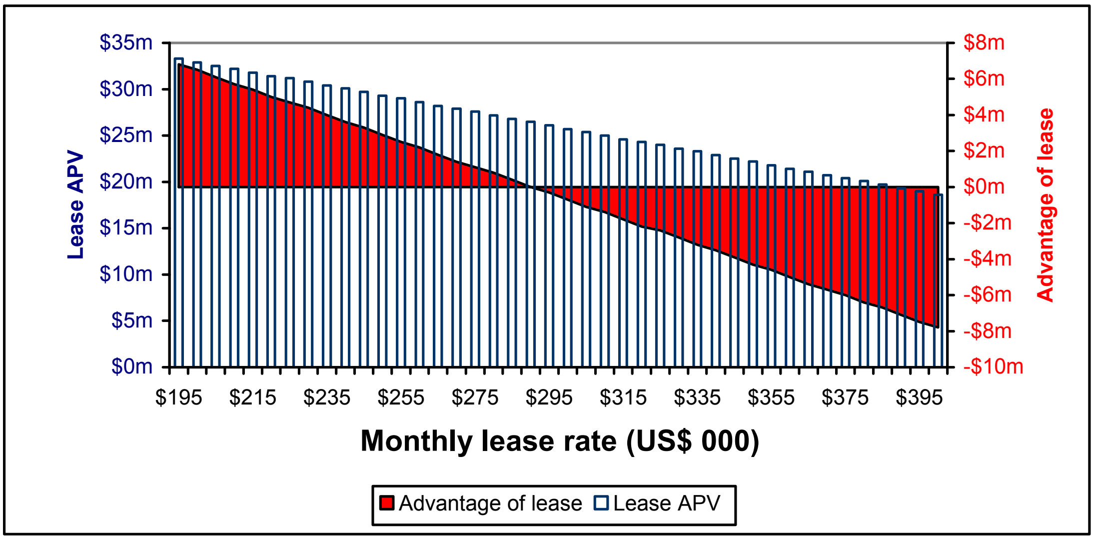



Figure 6.18: APV sensitivity to aircraft lease rate and lease value advantage over purchase

In a classical NPV analysis using WACC to compare leasing and purchasing, it is similarly possible to use sensitivity analysis to determine an aircraft residual value that yields an NPV equal to the leasing scenario, as in Figure 6.19.

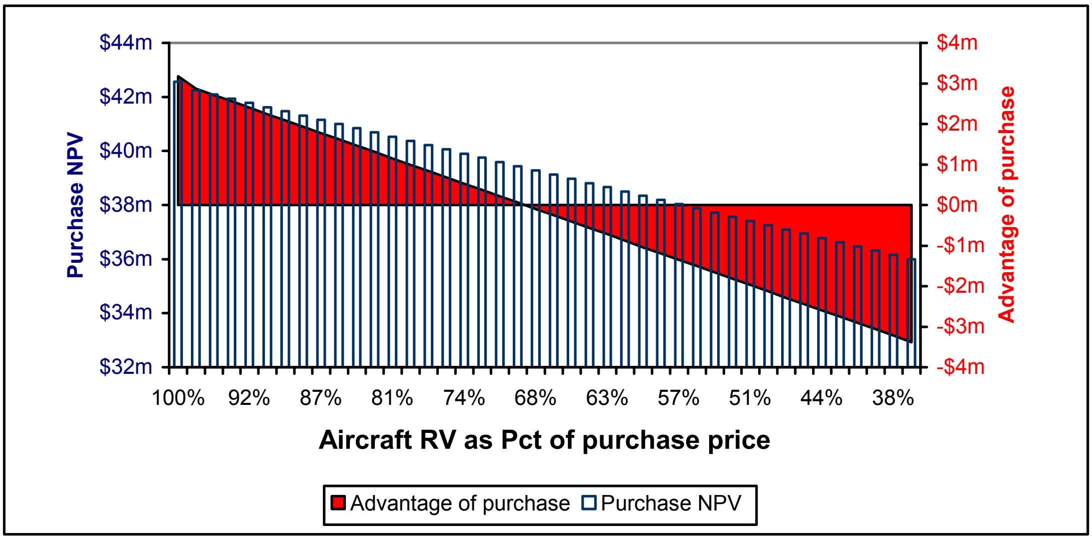



Figure 6.19: NPV sensitivity to aircraft residual value and purchase value advantage over lease

A prospective aircraft purchaser would have to take an extremely bullish view of aircraft market values using NPV/WACC to compare the options. The crossover residual value is 68% of purchase price, implying that aircraft must only have lost 32% of value 15 years from the date of acquisition, slightly over 2% loss of value per year, in order to justify a purchase under classical NPV.

One of the key advantages of leasing is precisely laying off the risks of residual values (RV) to lessors willing to manage such risks. The lessors manage the RV risk by virtue of a core competence in aircraft remarketing. The leasing business has concentrated in recent years, with the dominant players (GECAS and ILFC) actively managing and trading fleets which number many hundreds aircraft at a given time. The use of our extended definition of APV can give airline fleet planners a means of establishing the cost of such risk transfer. The technique is consistent with established lease valuation theory and with lease evaluation practice: the innovation is to move the locus of such analysis from the tactical to the strategic realm.

Summarising this section, we can see that airline managers tend to see significant interactions between analysing investments and they way they are financed. The clearest indication is the use of investment analysis techniques to evaluate the lease vs. purchase financing decision. Unfortunately, the survey's responses and the author's experience in the field (primarily with emerging-market airlines) show that they often do not do so in a way that allows crisp comparison of the options.

Three fundamental reasons have been found to cause this problem in practice:

- Ownership and governance issues: airline managers may not be aware of shareholder return expectations, particularly among state-owned airlines. State-owned airlines were found in Chapter Four to have majority shares in airline capacity in Africa, Asia-Pacific, and the middle east
- Organizational issues: questions of aircraft financing are often placed in the tactical and financial realm, rather than viewing financing options at a strategic level, as part of the fleet planning process
- Theory-practice gap: airline fleet planners tend to be quite familiar with and use DCF, but do not thoroughly understand the nature or the components of the discount rates they are using
- Palatability of NPV vs. APV: APV valuations are consistently lower than NPV because of the higher Equity costs used to value the operating cash flows: because the NPV is the arbiter of the decision and the conclusion of the 'Board paper' used to justify the project, there is substantial resistance to using such lower valuations at the project level
- Discount rate estimation issues, as discussed in Chapter Four

In the remaining paradigm investigated as part of this research, these problems are to a great extent obviated by a strictly non-classical view of aircraft acquisition.

### 6.4.3. Aircraft as commodity: integration of investment and financing

The aircraft as commodity paradigm is an extreme example of the use of operating leases to reduce aircraft residual value risk and increase flexibility. This third paradigm identified in the interviews is a revolutionary and integrated approach, in which aircraft are not viewed as investments in the traditional "buy-fly-sell" approach, nor indeed as equipment to be leased over a specified period. In this paradigm, the aircraft investment cycle is broken down into its components: managers then seek to locate each function – aircraft selection, buying, financing, operating, and selling – in the type of entity which can perform the function most efficiently. Rather than evaluating cash flow and NPV for the fleet alternatives, the objective is to operate the aircraft flexibly - with a minimum of ownership commitments - and to minimise the overall unit operating cost by integrating and comparing all ownership and financing costs of the various alternatives.

The valuation is based on optimising the capital cost per unit of capacity, comparing lease rentals (for operating leases), principal and interest (for finance leases) + depreciation (for on balance-sheet aircraft) for various acquisition and financing combinations. This approach cuts across classical distinctions among the different cost categories, treating cash and non-cash items equally. It is fundamentally different from either the neo-classical or risk-quantification paradigms, which are based on a cash-flow analysis and NPV. Among the advantages stated by executives is that the traditional distinction between cash flow and Profit and Loss items which bedevils users of NPV is erased: the earnings forecasts are the primary output of the analysis.

One precedent for this paradigm is the extensive use of operating leases to increase fleet flexibility, a practice which is an integral part of fleet management among all the managers interviewed (particularly but not only the financial managers). In traditional operating leasing, this flexibility objective is in contradiction to the objective of minimising capital costs, because operating leases have traditionally been an expensive way to acquire capacity, compared to purchasing and obtaining long-term financing. By breaking the ownership-operating-financing value chain into its component parts, the aircraft as commodity paradigm seeks to reconcile these contradictory goals.

The managers interviewed suggested that straight operating leases are expensive because lessors justifiably seek financial compensation for both airline credit risk and aircraft residual value risk, building risk premiums for both into the operating lease rate. This paradigm seeks to separate these two risks and place each with the most appropriate (or willing) counter-party, an approach analogous to recent financial innovations such as securitisation and credit default swaps, where financial risks are compartmentalised and sold down to counterparties. In the airline case, credit risk is sold to financial market investors, while residual value risk is sold to "insurers."

The first step in this paradigm is to assign each activity and risk – evaluating, ordering, operating, financing, selling - to the most efficient player for that particular activity. Each is discussed in turn.

Evaluating and ordering: airlines are quite logically the best equipped to evaluate the fit of aircraft types into their network, from operational, revenue and cost standpoints. The firm best equipped to order aircraft will be the one with the best bargaining power with the manufacturers, both in terms of pricing and obtaining performance guarantees, often not transferable from one aircraft owner to another.

In the post 9/11 aircraft market, many operating lessors reduced their former leadership role in placing large, speculative orders for aircraft, preferring to offer financing capacity for aircraft originally ordered by airlines to reduce their risk of not placing the aircraft profitable. Lead by large orders placed by low cost carriers during the recent downturn, airlines have shown an increased willingness to place large aircraft orders in recent years, garnering both volume discounts and pricing based on competition among manufacturers, which are eager to maintain order books and market share in a difficult market.

Because of the expertise in evaluating the equipment and these new ordering trends, airlines are the most efficient entities to evaluate, order, and of course operate the aircraft in this paradigm. The fleet planning process itself very much follows the classic lines discussed in Chapter Five. On the other hand, managers emphasised that airlines are not the best entity to sell the equipment at the end of the investment horizon, being relatively small players with limited visibility on the complex world of used aircraft trading. To this difficulty are added conflicts within the airline, where entrenched interests - pilot unions and aircraft maintenance units, for example - can conspire to prevent efficient and timely disposal of aircraft types.

Financing and selling: operating lessors are better equipped than airlines to place used aircraft into second operators; this is after all their business.

However, the residual value risk leads them to charge high lease rates. Further, many smaller operating lessors do not have the lowest-cost access to financing for the aircraft, and the larger lessors offer very handsome equity returns to their own shareholders: in both cases, they pass on the additional funding costs to the lessee. Resolving this dilemma is at the heart of the aircraft as commodity paradigm.

The ownership and financing structures used in this paradigm are akin to financial derivatives, as they seek to separate the credit risk from the residual value risk, assigning the former to investors with relatively low funding costs, and the latter to providers of residual value insurance. The airlines thus optimise the cost of borrowing by isolating the credit risk, and by seeking tax-efficient structures with their financing partners and "tax investors", typically Japanese companies facing a high marginal tax rate, and which are willing to share benefits from income tax reductions (based on depreciation and financing tax deductions) with the operators. In the tax area, banks, lessors and private investors have varying capabilities to achieve benefits, and offers from multiple sources can be compared to achieve the lowest overall cost.

The residual value risk is laid off on insurers, who may be third parties to the transaction explicitly providing the coverage, or manufacturers offering return options at the end of the lease term. Concretely, the residual value arrangements tend to be structured in two parts: as purchase options at fair market value for the airline, thus allowing operating lease treatment for accounting purposes; as return options, or outright residual value insurance, offered to the nominal owners of the aircraft, i.e., the financing entities. This type of structure has become known as a "synthetic operating lease," as it is a hybrid between financing and operating leases: in plain terms, it is a finance lease with return options. Tax treatment of such leases varies from one country to the next, with some allowing the return options to qualify the structure as an operating lease, allowing full deduction of lease payments for tax purposes.

The value chain is thus broken down, and risk distributed to those most capable of mitigating them, as shown in Table 6.2.

| Activity | Entity | Associated risk | Risk mitigation |
|---|---|---|---|
| Evaluating | Airline | Performance<br>Reliability | Guarantees from manufacturers |
| Ordering | Airline or lessor | Availability of aircraft | Order during downturn<br>Large, multi-year orders |
| Operating | Airline | Cycle in demand for transport<br><br>Catastrophic events<br><br>Competition/new entrants | Return options<br><br>Wet leases, subcontracting<br><br>As in neo-classical paradigm |
| Owning & Financing | Financial institutions<br>Tax investors | Credit risk | Evaluation and monitoring of airline financial health |
| Selling/placing with second operator | Residual Value Insurer or lessor | Asset value risk | Aircraft return conditions<br>Internal capacity to place aircraft |

Table 6.5: Distribution of roles and risks in the aircraft as commodity paradigm

Managing the first four activities, and mitigating the associated risks, lies well within the competences of the entities involved. On the other hand, various managers interviewed pointed out that the most problematic risk in the table is aircraft residual value. In the synthetic operating lease structure, this risk is explicitly stripped away from ownership and financing, to lower the cost of financing to the airline. Is this residual value risk correctly priced in today's market? There are several factors which lead one to doubt this:

- Liquidity of the market for residual value risk: the market for this risk is highly illiquid, as no viable market for the risk has as yet evolved;
- Data points for analysis: there are a limited numbers of buyers and sellers of used aircraft at any one time, creating inefficiencies in pricing. In addition, the aircraft covered by residual value insurance tend to be larger, lower-volume products with even fewer transactions;
- Information availability: sales prices for used aircraft are confidential between buyer and seller, so that pricing information is not widely available for analysis;

- Lease valuation: often used aircraft are placed with second operators upon return, making comparison of outright sales and re-leases difficult;
- Organisational inefficiencies: given the current high level of competition among the manufacturers of civil aircraft, the organisational expediency of “kicking the ball (the risk) forward” in time, to be dealt with by another area of the insuring company, in the more or less distant future.
- Valuation methods: techniques such as real options have yet to be adopted in many companies. Although substantial research and valuation techniques are available (see Gibson and Morrell (2004), Otero (2006), the lack of reliable data points regarding actual transactions make them difficult to apply in practice.

For all these reasons, residual value risk can easily be either overpriced (by operating lessors seeking excess returns, as discussed above), or underpriced (as a sweetener placed in an aircraft deal by manufacturers), in the aircraft market. The managers interviewed suggest that the latter condition reflects the current competitive situation in the market for large civil aircraft.

As a final strategic input to evaluating fleet alternatives and residual values, the managers interviewed take an explicit and long-term view of aircraft value potential in light of expected new product introductions in the civil aircraft market. Residual value insurance could be deemed appropriate in two specific cases: first for large, illiquid aircraft, and second, for aircraft which are expected to be superseded by new products during the investment horizon. In the case of small current-generation (and hence liquid) aircraft, the managers suggest that explicit residual value insurance may not be necessary, as financing entities appear to accept the residual value risk without building price premiums into the aircraft lease rates.

This is strategic arbitrage, building on the intuition that the residual value risk for current aircraft types may be underpriced by financiers in the market, given expected evolutions in aircraft product offerings. A good example of this is the current speculation about the dates for replacement types for current narrow-body aircraft (A320 and B737 families). An airline looking 15 years into the future may see that a replacement aircraft knocking down current-generation aircraft residual values. One executive stated the view that operating lessors may currently be under-pricing this risk in lease rates, offering an arbitrage opportunity to current acquirers of aircraft. On the other hand, taking such a view on aircraft market conditions in the future exposes these companies to a potential shortage of inexpensive capacity as leases on existing aircraft expire.

A second weakness of this paradigm is its dependence on efficient markets in all phases of the aircraft investment cycle. Specifically, three problems have arisen. The market for asset securitization has largely disappeared in the wake of the crisis. Second, investors willing to take cross-boarder credit risk, even when offered tax savings, are hard to come by in the post-crisis environment. Third, the market for aircraft residual value insurance offered by third-party insurers never really developed over the last boom, remaining thin and problematic: in the current environment, mega-insurers willing to take exotic risks are few and far between. The viability and extensibility of this paradigm in the post-crisis environment is thus highly questionable.

A second potential weakness is one of aircraft availability during an upturn. With the majority of aircraft on synthetic operating leases requiring refinancing at regular intervals and expiring at fixed moments in time, with no certainty that the aircraft will remain available on favourable terms. The aircraft-as-commodity paradigm offers many insights and potential flexibility benefits to planners, but its dependence on liquidity renders the purest version of the paradigm fragile: downside risks are well covered, but substantial counterparty and availability risks also characterize this approach.

Finally, the current financial crisis has undermined confidence in the efficient-markets logic underlying the financial aspects of the paradigm. The notion of compartmentalizing credit and residual value risk has become suspect at a time when the role and power of comprehensive risk management techniques (e.g. “fat tail” analysis, increasing counterparty risk analysis in derivative trading, and consolidating asset/credit risk management departments) is being augmented in the financial community. That said, the ingenious approach of assigning distinct and clear roles to different counterparties in an investment plan holds many useful lessons for airline planners who have in the past used the more traditional, buy-fly-sell approach to investment planning.

## 6.5. Conclusions

The interviews of European practitioners of fleet planning and investment valuation revealed a vibrant debate about the proper way to value investments and capture risk in airlines. In the most traditional neo-classical paradigm, the energy and effort of quantification is placed in analysing the airline’s competitive position and optimising the operation to capture the most desirable passengers. The financial valuation in this paradigm is an investment, buy-fly-sell view extremely close to that recommended by academic writers since the sixties.

Risk quantification takes the place of classic sensitivity analysis, where results are subjected to stress tests to demonstrate project viability. The only major deviation from classical valuation theory is the “padding” of the discount rate by adding a more or less intuitively estimated risk premium, a practice which has been revealed as a common approach in aircraft valuation.

This research finds extensive use of classical financial valuation techniques to analyzing the lease vs. borrow decision, revealing significant interactions between investment and financing decisions in airlines. The field research and the author’s experience with aviation professionals points up the real danger that managers may not be careful enough in deciding which discount rates to use for such analysis. With operating lessors firmly established as providers of aircraft today, a clear distinction between equity and debt costs allows airlines to place the lease vs. borrow decision within the strategic valuation process, to explicitly price the risk transfer to the lessor, and to establish acceptable lease rates, just as they establish acceptable aircraft prices in purchase projects using NPV.

The aircraft as commodity paradigm takes investment-financing interactions to a logical conclusion, calling into question the very notion of investment in aircraft. It is complementary to other two and shares many of their characteristics, particularly in the area of evaluating the aircraft and its operation using discounted cash flow. As in the risk-quantification paradigm, the analysis of the aircraft costs is fully embedded in the airline business plan. Risks beyond the business plan horizon are “insured away” with third parties. The competitive analysis underlying the business plan presumably borrows substantially from the neo-classical model. However, this approach is in stark contrast to classical valuation techniques common to the other two paradigms. Aircraft capacity is viewed very nearly as a commodity to be acquired and used with the greatest possible contractual flexibility, and the lowest unit cost, rather than as an asset with an intrinsic value to be exploited by the airline. This research argues that this strategy, while extraordinarily powerful, has its weaknesses as does any strategy. The strategy relies extensively on the continuity of financial markets willing to refinance used aircraft, the availability of aircraft capacity as leases expire during an upturn, and the existence of markets willing to dissociate credit risk and aircraft value risk, and price each efficiently from the airline’s standpoint.

# 7. Advanced financial theory, investment & uncertainty

Since the firm establishment of classical valuation in practice, many theories and methods have been advanced to guide managers in the area of strategic fleet investment. This chapter completes the examination of financial theory and its application in the airline sector by investigating the relevance of these innovations to explain and potentially guide investment analysis practice. This research has revealed very large uncertainties in key fleet planning assumptions, linked to strategy and geopolitics, demand and yields, fuel cost and emissions charges. The last chapter established that as of today, the majority of managers – whether in airlines or the general business community - use subjective assessments and intuitive adjustments to project discount rates, rather than quantitative methods, for capturing project uncertainty in investment valuations.

The first two sections in this chapter analyse the potential for implementation of the primary advanced techniques available to practitioners in recent years, game theory and real options analysis (ROA), in aircraft investment analysis processes. A brief third section discusses recent advances in environmental cost modelling, addressing a major emerging uncertainty facing planners, identified in the fleet planning expert panel. The fourth section returns to the key question of investment-financing interactions, comparing the results of the airline CFO survey on financing preferences with research in the area of information asymmetries. This leads to the final and related section investigating the role of signalling to investors, as practiced in today's listed airlines.

## 7.1. Game theory application to fleet strategy

Game theory and ROA are analytical techniques that have the highest academic credentials, as economic theories underlying both have won multiple Nobel Memorial Prizes in Economics. These techniques are periodically reviewed and advanced in the theoretical literature, and promoted in management journals – most notably, the Harvard Business Review. Game theory is one of the tremendous advances in economics that has difficulty finding a central place in practitioners' playbooks: managers often consider it abstruse and difficult to relate to real-world problems. In this respect, game theory has had a quite similar track record to attempts to use real options to value the benefits of delaying choice under uncertainty, discussed in the next section. These two theoretical frameworks seem to remain stuck in the domain of academics and consultants, who never tire of pointing out their potential benefits for managers and planners. A brief review of recent research by Mark Hanson and Wenbei Wei at the University of California Berkeley suggests that in today's world of increased input volatility and market uncertainty, game theory may yield useful insights for investment planners. At the same time, their research reveals the substantial limiting assumptions necessary to apply game theory to complex market situations.

Wei and Hansen (2007) is the recent culmination of prior game-theoretic studies of both authors, notably Hansen (1990), in which an n-player game is devised between two types of operators, hub-and-spoke and point-to-point, and Wei's 2001 doctoral dissertation. The games defined by in the 2007 article were crisply defined and limited to two-player games (such as the duopolists in Wei and Hansen (2005)), facilitating both the finding of equilibrium solutions and the applicability of the framework and its implications: the mathematics of two-player games are far less arcane than those of n-player games. They sought to provide insight into the central question of determining the relative merits of aircraft size and service frequency by applying game theory.

The profit function used to evaluate strategic options was based on the empirical airline studies in the authors' 2003 and 2005 articles discussed in this research, lending a greater degree of real-world credibility than many academic expositions of game theory. The authors emphasised the proper positioning of a game-theoretic approach at a strategic and more abstract level than aircraft evaluation or fleet assignment. The authors restricted the game-theoretic choice to aircraft size and frequency, eliminating fare as a decision variable: this helped to frame the size vs. frequency trade-offs in a clear way.

The authors find game-theoretic equilibria for three games in this article:

1. a one-shot game where each competitor chooses both size and frequency simultaneously
2. a leader-follower game where the first airline analyses the competitors' responses to her possible size-frequency choices, and selects the best option based on this analysis by backward induction
3. a two-level hierarchical game where the airlines first choose aircraft size simultaneously, then make frequency decisions based on their own choice and their knowledge of the competitors' aircraft size.

The third game is the closest to airline management practice, since fleet decisions are inherently long-term, while frequency can be adjusted at a tactical level as the "game" evolves.

For the demand functions, the authors used the Albuquerque-Phoenix (ABQ-PHX) city-pair market dimensions, one of those used in the 2005 article. Fares are identical between the airlines, who choose size and frequencies for each of two routes, one of 400 statute miles and another of 2,400, under profit-maximizing objectives.

The authors found the same game-theoretic equilibria for each of the three games, with each airline operating 13 daily frequencies of 100-seaters in the 400mi market, and 7 frequencies using 200-seaters in the 2,400 mile market. Because the fares are fixed and distance-related in the model, the absolute profit levels achieved are less interesting than the combination of size-frequency choices made. One implication of these identical solutions is that the leader in the leader-follower game should not have a first-mover advantage (or disadvantage) from analyzing the competitor's responses in deciding size or frequency and moving first. Frequency gains in a game-theoretical framework are relative to market preferences, not to innovation in service provision. This tends to support the common view toward the increasing commoditisation of air transport, where frequency is one of the rare differentiating factors in many short-haul markets.

The advantage presented by the third game is that aircraft size and frequency are analysed separately, allowing the choices of each "sub-game" model to be used independently. The authors illustrated this with a stylized example showing that a competitor to a single aircraft-type operator such as Southwest can estimate an optimal frequency based on various sizes of aircraft: 13 for a 100-seater, 7 for a 200-seater, 4 for a 300-seater. The second and third solutions yield lower profits than the 100-seater solution for the hypothetical competitor, but since the size of aircraft selected will be based as well on other considerations than competing in this particular market, the additional information on larger planes can be useful.

The authors then performed a sensitivity analysis to growth in demand, demonstrating that under game-theory assumptions, profit-maximising airlines should meet increases in demand by increasing frequency, whether in the one-shot or leader-follower scenario. This result confirmed their earlier findings that airlines will offer frequency rather than upsize the fleet, assuming airport slots and airspace permit.

One fundamental problem in applying game theory is that models such as this cannot readily be scaled (to include, for example, more city-pairs or more competitors). In this simple two-market model, with four aircraft sizes and 10 daily frequency options, the airlines have 1,600 possible combination strategies: application to a network would clearly be impractical. A second and more fundamental problem is that airline owners may have differing strategic objectives, such as market share or growth, whereas game theory requires a single objective function for all players: due to the various ownership patterns identified in this research, the profit objective in the Wei and Hansen formulation may not be sought by all players in the international airline arena.

The methods developed in Wei and Hansen (2005 and 2007) can yield substantial insights into the size vs. frequency problem facing airlines in competitive markets. In particular, the third game analyzed by the authors can be useful to planners examining specific city-pairs in the fleet assignment process, particularly in hubs dominated by one or two airlines.

Some of the methods used by the authors, particularly the QSI approach to estimating market share in Wei and Hansen (2005), are used in fleet sizing and investment appraisal exercises in network airlines. By focusing these methods on specific competitive markets where the dominant players seek to maximize profits, airline managers can gain insight into the competitive dynamics in both the strategic (fleet) and tactical (assignment/scheduling) areas. Viewed together, the recent Wei and Hansen articles contributed both calibrated models and a consistent set of findings to the tools available to fleet planners. Game theory occupies an area of strategic thinking intimately linked to fleet investment decisions, but carries a level of abstraction and requires simplifying assumptions that make it impractical to decision-makers seeking concrete valuations of the uncertainties of fleet planning

## 7.2. Real Options Analysis

Real options analysis has made a more direct impact on aircraft investment analysis than game theory. The method is derived from financial options valuation, which has earned a central place in securities' valuation and trading since introduced in the early 1970s.

Certain elements of ROA are present in each of the three fleet investment paradigms identified in this research: the neo-classicists use decision trees with associated probabilities to evaluate larger or smaller alternatives within aircraft families: this is the basis of binomial options pricing, the preferred method for valuing real options. The risk quantification practitioners use Monte Carlo analysis – a fundamental building block for real options pricing - to estimate the risks and the probability of project success for the airline Board. The aircraft as commodity group goes furthest in the application of options to aircraft residual value, arbitraging the pricing of residual value guarantees in aircraft selection and financing structures. And yet, the survey of the broader airline CFO community has found that the technique is not commonly used. This section reviews the evolution of the methodology, its pitfalls and its specific applications to aircraft investment analysis.

### 7.2.1. Foundation and early applications of options pricing

The foundations of options pricing were established in Black and Scholes (1973), which posited the value of financials options as a function of the underlying asset prices, the option exercise or strike price, the time to exercise date, the risk-free borrowing rate, and the underlying asset volatility over time. The mathematics underpinning options pricing has been shown to be entirely consistent with classical valuation theory, and the model was shown to be robust in practice throughout the 1970s, as outlined in Copeland and Weston (1983 and succeeding editions). In this framework, asset prices follow the familiar random walk of efficient markets theory, which can be represented by a normal distribution.

The Black-Scholes model is a continuous-time solution in which options are continuously traded, which reflects the liquidity of securities markets. Cox, Ross and Rubinstein (1979) developed a binomial pricing model for options, using risk-adjusted decision trees. This model, which converges to a continuous-time solution as the number of decision points is increased - has proven more useful than Black-Scholes for pricing real options, which are certainly not continuously traded, and indeed may not be traded at all.

The purpose in this section is not to review the vast literature on options pricing, but rather, to identify and analyse the potential applications of the theory to the valuation of aircraft investments [21]. Asset volatilities for exchange-traded securities are readily estimated from historical data, a fundamental difference from assets such as aircraft, which are traded "over the counter," that is, between individual counterparties. The model developed for share options uses both binomial and continuous-time stochastic modelling techniques to derive the option's value. This method is easily applicable to securities' pricing, with public, liquid markets for trading both the options and the underlying securities: this liquidity is completely absent in aircraft trading markets, a pitfall also typical in valuation of other types of capital investment. This absence of data points and organized markets is the greatest pitfall to using ROA.

[21] A comprehensive list of sources on the topic of options valuation and applications to aviation finance and risk management may be found in Otero (2006). Section 7.2.2 of this research discusses Dr. Otero's application to aircraft residual value insurance.

This pitfall has not prevented extensive research and development of ROA valuation methods. An early application to cancellable operating leases on computer equipment is found in Copeland and Weston (1982), which proposes using the "standard deviation of asset returns" as a proxy for variation in the asset's value, to value the put option embedded in such contracts. The authors suggest that the appropriate exercise price (return fee) for such a contract should decline in time "at the same rate of the expected decline in the market value of the leased asset." In the absence of organized exchanges, variability of project returns are used a proxy for market value volatility required, an approach further developed in Copeland and Antikarov (2003) and labelled the "Marketed Asset Disclaimer" or MAD, perhaps an unfortunate acronym for the leap of faith needed to apply securities valuation theory to physical assets.

The literature on real options has grown tremendously over the years, led by academics and consultants such as Copeland, Stewart Myers, Lenos Trigeorgis, Han Smit, Robert McDonald and a host of others. At the same time, a "practitioners' literature" of techniques and methods has developed, among which the clearest is the work of Johnathan Mun, whose 2002 book and accompanying software suite clarified the issues with a practical bent. All the methods begin with DCF, use Monte Carlo analysis to establish volatility, and transform the volatility into binomial lattices in order to value projects under various states of nature in the future. Implicitly, these methods embrace Tom Copeland's Marketed Asset Disclaimer, using management's valuation of the project (NPV) as the best unbiased estimate of a project's underlying value.

Current practice of ROA entails using MC analysis to establish the volatility of investment projects, given uncertainty in their underlying assumptions, as will be demonstrated in the example in section 7.2.3. MC was proposed as an aid to project valuation in Hertz (1964), a very complete description still frequently cited as a definitive guide to applying MC to a classical investment valuation. The interviews performed for this research show that there is a large range of opinion regarding the usefulness of MC analysis for aircraft investment valuation. The proponents its use (notably the start-up airline risk quantifiers) point up the value of explicitly considering the range of possible values given to key economic assumptions, as well as the learning and the insight managers gain from the iterative process of assessing the uncertainties, valuing the project, and negotiating with manufacturers to reduce the uncertainties. Those against application of MC in this research cited an "abdication" of management judgement during the investment analysis process.

### 7.2.2. Recent aviation applications of real options

The basic taxonomy of options available to airlines includes the right, but not the obligation, to:

- increase fleet capacity: purchase options and purchase rights: (call option)
- alter fleet mix: aircraft family conversion options (switching option)
- delay fleet increases by deferring delivery (deferral option)
- decrease fleet capacity: return options (put option)

In all cases, airlines are given additional flexibility in managing fleet changes, by being allowed to defer decisions (the first two options) or reduce contracted capacity (the latter two). These options have been embedded in certain aircraft deals for many years. Intuition as well as options pricing theory suggests that these options will increase in value with many of the uncertainties assessed by the expert panel surveyed in Chapter Five of this research:

- volatility in the economic cycle
- change in the competitive environment
- uncertainty in input prices: fuel, labour, financing, currencies…
- time to delivery of the aircraft
- the interest cost of borrowing

On the other hand, the value of such flexibility to the airline will decrease as the price paid to the counterparty for the option increases, and as well as the cost of its implementation. One executive practitioner of the aircraft-as-commodity paradigm stated flatly that his counterparties were substantially under-pricing the real options in aircraft deals, opening the door to risk arbitrage based on the low cost of options on offer.

Two recent practitioners have applied ROA to aircraft investment, bringing various insights and extensions of options pricing theory to fit the specifics of aviation.

John Stonier (1999) followed a step-by-step approach from DCF analysis, through decision trees, to binomial real options valuation. Under the decision tree methodology, the option can be roughly valued using the expected of the decision tree NPVs. The upside NPV is weighted by the probability of a successful project, while the downside has a weighting of 0.0%, because the airline will not exercise the option to invest in adverse conditions. This use of decision trees is consistent with neo-classical practice identified in this research.

Stonier's additional contribution was integrating the aircraft option decision with both manufacturing lead-times and the cyclicality of the airline business.

Based on the insight that airlines can always defer the decision to purchase (a "natural option"), the author drew a distinction between the airline holding a contracted option and the other which does not. Upon exercise, the option-holder has to wait to receive the aircraft only during the manufacturer's lead time, while the "natural option" holder faces both lead time and a queue length based on the manufacturer's delivery slot availability at the time of the order, as well as uncertainty regarding the aircraft price at the time of the future order. Stonier showed that because of this price uncertainty for the natural-option holder, the option purchased from the manufacturer will always have greater value for the holder than the "natural" option to defer firm orders. In Stonier's work, the primary driver for the option value was traffic demand over the economic cycle. He found values for A320 delivery options ranging up to $4m per aircraft, conditioned by the volatility of demand. Using an annual project volatility (standard deviation, $\sigma$) of 21% estimated based on an unidentified U.S. transcontinental sector, the A320 purchase option value would centre around $3m.

The purchase option increases in value still further as the manufacturer's lead-time is reduced: Stonier suggested that nearly $1m/aircraft in option value is created by reducing single-aisle aircraft manufacturing times from three years to 18 months. Finally, Stonier proposed an approach to valuing the option to convert orders between different types of aircraft prior to delivery. Because he uses a model whose NPVs are driven primarily by traffic demand, smaller aircraft generated higher annual $\sigma$ than larger ones: the authors finds $\sigma$ of PVs for Airbus single-aisle family of:

- A319: 27.7%
- A320: 23.3%
- A321: 18.6%

Today's aviation environment has evolved substantially since Stonier's research. This research develops and applies a model to value aircraft conversion options, updated from Stonier (1999) to take into account two features of today's aviation environment: the recent dramatic increase in fuel price and related volatility, and the increasing amplitude of the cycle in airline profit performance, which has gained pace over the most recent decade (see Figure 5.17). This model is discussed in section 7.2.3.

The most advanced research in options pricing in aviation was completed by Dr. Jorge Otero in 2006. This 485-page doctoral thesis covers the full range of airline financial risk management, applying both classical and options financial models to the airline business model. Relevant for this research is Otero's discussion of aircraft Residual Value Guarantees (RVG) at the end of a specified period of operation by an airline. The focus thus lies at the opposite end of the aircraft investment cycle to Stonier's analysis, which is focussed on acquisition phase. In options jargon, Otero discusses the nature and valuation of put options purchased by the operator or lessor from the provider of the guarantee.

Dr. Otero's research benefitted from his experience working under the direction of Ignacio de Torres Zabalá, Finance Director of Iberia. Thanks to this unique collaboration, Otero's descriptions of RVGs and related financial instruments are precise in terms of business practice and implications for investment valuation. Under de Torres' leadership, Iberia revolutionized the field of aircraft financing over the last ten years, initiating the first aircraft securitizations in Europe, and stretching the possibilities of synthetic operating leases to reduce the airline's cost of capital and its exposure to a myriad of financial and asset-value risks. The valuation methods examined below are thus informed by direct experience in the field.

RVGs are purchased from manufacturers, leasing companies, or insurance companies. If the RVG forms part of a purchase agreement with a manufacturer, its pricing is embedded in the overall terms and conditions negotiated with a manufacturer. Because of the bundled pricing model practiced in the aircraft market, quantification of individual elements can be fuzzy, particularly if discounts are offered in the heat of the negotiation: attributing such discounts to individual elements of the pricing package is largely arbitrary[22]. Dr. Otero's research used real options to quantify the appropriate premium for such guarantees.

RVGs take two forms, both of which resemble European put options, in that the exercise dates are fixed at signature. Full RVGs offer the purchaser the right to return the aircraft to the guarantor for a price for the aircraft which is fixed at contract signature, on a specific date or dates ("return windows"). The costs to the purchaser include the option premium (price), the payment of a negotiated remarketing fee in case of return, and potentially, a profit-sharing agreement with the guarantor in case the aircraft is sold for a price above the guaranteed level.

Full RVGs are rare in the market, as guarantors usually negotiate a lower limit to the guarantee (Partial RVG): if the aircraft's value is below this limit, the guarantor will only pay the difference between the guaranteed value and the lower limit. This value "slice" approach limits the downside risk for the

[22] A third-party observation of the pricing and gamesmanship of a recent long-range aircraft transaction was published in the 10 March 2003 Wall Street Journal, available on the WSJ Factiva web site

guarantor, and gives the operator of the aircraft an incentive to maintain the residual value of the aircraft to the best of its ability.

Otero also reviewed two other forms of residual value guarantees, as well as combinations and extensions thereof. An early form of guarantee in the market was the First Loss Deficiency Guarantee, which is an American put option – i.e., it can be exercised during the contracted period - with an exercise price that decreases over time (reflecting the aircraft's market value depreciation). Lastly, Otero discussed the combination European put and call options typical in Japanese or Spanish operating lease structures (JOL or SOL), akin to abandonment and extension options in real options terms.

The evolving value of the underlying asset is obviously critical to determining the value of an option on the asset. Otero modelled the future residual value states of nature using historical data, specifically 185 observations of nine different aircraft types over the 1992-2002 period, as published in the AvMark Aviation Economist. A certain paucity of observations (21 data points on average per aircraft type) due to the illiquidity and confidentiality of the aircraft market is a perfect example of the difficulty of applying options pricing to real assets. Otero's analysis revealed nominal annual base value depreciation rates between 3.08% for single-aisle aircraft and 4.42% for wide-bodies, intuitively consistent with the long-lived nature of such assets. Price volatility was calculated as the standard deviation of such values (difficult with such a small sample), and ranged from 4.10% to 4.15% (the higher figure is for single-aisle).

In addition to using base (average) asset value and volatility figures, Otero's analysis estimated the cyclical impact on lease rates and aircraft values and the tendency of market values to revert to base values, an approach similar to that in Stonier (1999). The development of the methodology used is sketchy in Otero (2006), which leaves the reader with some doubt as to how the author actually derived the mean-reverting velocities, which ranged from 4.22% to 6.54%.

A more clear methodology for estimating the cyclical effects on aircraft values has been developed by aircraft financier PK AirFinance under its president, Nils Hallerström. The first published article on this topic were Hallerström and Melgard (1997), followed by a series of discussion papers published by PK AirFinance. Much of this work has been embodied in PK's much-imitated Statistical Aircraft Financing Evaluation (SAFE) model, which is used to evaluate secured loans and leases. The most recent publication is Hallerström 2010, a compendium of insights into drivers of aircraft and loan values. Hallerström and Melgard's methodology for estimating cyclical values is intuitive and highly transparent, as it is driven by fundamental and widely available market data. The approach is in contrast to the more theoretical methods of Stonier and Otero. Aircraft value swings are modelled by accumulating the gap between traffic growth and capacity growth to generate "pent-up relative capacity shortage," or PURCS. Positive PURCS will drive cyclical upswings in aircraft values, and negative values the reverse. To forecast the cycle, the relatively reliable forecasts for near-term aircraft deliveries are used as a proxy for capacity growth, and the cycle for air transport demand is modelled separating amplitude and duration (wavelength), which can then be calibrated using the wealth of data PK has collected since the mid-nineties. Hallerström (2010) tests the methodology against actual PURCS since 1995. The results show that the model tends to forecast downturns before they actually occur, while the timing of cyclical upswings forecasted show no clear relationship to actual data. On the other hand, the methodology is strikingly accurate at predicting the *amplitude* of the PURCS cycle, which has oscillated around ±8% since the mid-nineties. Given the large forecasting error in the PURCS forecasting (50% standard error against initial estimate in this test), Hallerström proposes a MC simulation approach using historical forecasting errors to replicate the volatility input to the model. In Hallerström (2010), the cyclical effect is combined with aircraft-specific drivers such as maintenance status and aircraft model obsolescence, resulting in aircraft-specific forecasts taking the cycle into account. This precision is obviously needed in order to use the model to evaluate specific financing transactions.

Common to Otero and Hallerström's approaches is underlying asset value is thus a function of aging and the economic cycle, with volatility around the base value measured by standard deviation, an elegant and transparent analysis that contrasts sharply with the abstruse formulations often found in real options literature

Using age (drift rate), volatility around base value and mean reversion velocity variables as inputs, Otero's valuation of the RVG for a $100m wide-body aircraft was based on a Monte Carlo simulation and binomial options pricing model. The value of options for a full RVG found by the author vary are under 3% of the residual value covered, compared with the 4%-7% market prices cited by Otero. With market prices over twice the calculated amounts, Otero speculates that the difference can derive from one or more causes. The oligopolistic nature of offering entities, which are few and far between, may lead to excess returns for guarantors. Second, volatility estimates used by the guarantors may be higher: indeed, the PURCS amplitudes identified in Hallerström (2010) are substantially higher than Otero's 4% (although direct comparison is hazardous). Otero's aircraft value volatilities represent only a single standard deviation from the mean, whereas financier value at risk (VaR) methodologies tend to cover much higher levels of certainty, often up to 99%. The third reason for "overpricing" cited by Otero is his observation that many methodologies use Black-Scholes options pricing model with no obsolescence or drift rate to value aircraft. Use of Black-Scholes to model future values is clearly inappropriate, as the value of an option on future value reflects only current pricing and volatility information. Finally, Otero allows that guarantor assessments of counterparty credit risk may be integrated into prices. These arguments are all sound, and reflect the financial world where the efficient markets hypothesis rules financier thinking, including VaR and its implicit reliance on MC modelling.

The next section of this research presents a valuation model for aircraft conversion options based on the valuation of the investment project itself as the "underlying asset", an approach that is fundamental to real options valuation.

### 7.2.3. Aircraft family conversion option value in today's environment

The two arguments underlying this section are managerial rather than methodological in nature, and stand in direct relation to the practices identified in this research. The methodology proposed uses a model constructed by the author, to which conventional binomial options pricing is applied using the Mun (2002) methodology, which is clear and well documented. The first problem which should be tackled is current practice in discount rate estimation, which has been revealed in this research to be often subjective and rough. Experience in the field and the results of both airline surveys and executive interviews has revealed that aircraft valuation models are most commonly deterministic in nature, and that airline financial managers use subjective assessments and discount rate adjustments to adjust valuations for risk. This fact, and the positioning of the investment appraisal as an arbiter of the project, places the financial function in the position of adding a sort of insurance premium to the discount rate, without the benefit of sound actuarial data to back it up. Several fleet planning executives spoke of the "black box" of the discount rate, and very few managers interviewed were aware of the specific components of this rate, which among other problems makes lease vs. purchase analysis using APV impossible for fleet planners[23]. The addition of a subjectively-estimated "insurance premium" to the discount rate used to

[23] This managerial problem of information-sharing in the context of investment analysis has been resolved most notably by Lufthansa, which communicates the components of its cost of capital broadly to investors and managers.

value investments captures risk in an obscure and unscientific way. With all its assumptions and methodological pitfalls, ROA can add valuable information for the decision-making process, by capturing risk in the cash flows and valuing them over the project's decision horizon.

The second argument advanced is that the highest value of the options approach to investment analysis is that planners are obliged to think of the future as uncertain, and to make explicit estimates of the uncertainty of specific parameters, enhancing their ability to prioritize these risks in managing the company's investments. Rather than "insuring the problem away" with a high discount rate, the project's uncertainties are estimated at the outset. This argument amounts to a defence of the risk-quantification investment valuation paradigm identified in this research.

The two most common reasons given for non-adoption of options pricing tend to be problems of explaining the methods to non-financial managers and Boards, and problems of data availability. The first can be overcome by taking a pedagogical and graphical approach to explaining the method and its results. In this respect, the proponents of options pricing are the guilty party. In their search for theoretical-mathematical correctness, most authors propounding real options often seem intent on describing their methods as beyond the understanding of mere mortals, a classic ivory-tower mentality which helps restrain adoption in the business community.

The unavailability of market data for valuing future aircraft options is more concrete and serious, and is without doubt valid in the highly non-transparent world of aircraft trading. However, refusing the method as applied to project valuation for this reason reveals a deep misunderstanding of real options. These options are valued as a function of the present value of the investment project itself, which the majority of airline respondents calculate and use as a matter of course. This project NPV, and managements' assessments of the uncertainty of the model's inputs, are the only requirements of real options. Far from the "abdication of management judgement" view of such modelling techniques expressed by some managers, real options forces planners to refine their thinking of project uncertainties, and is in fact complementary to standard approaches such as sensitivity and scenario analysis.

The recommendation of this research are that the steps toward a real options valuation are more important the results themselves. The airline CFO survey performed in this research reveals that only 22% of the respondents use ROA in evaluating investments. Further, the interviews with airline executives confirm that ROA is often viewed as a technique wholly distinct from DCF, and is perceived as an analytical black box, with obscure inner workings, where in fact the path to ROA leads from “plain vanilla” NPV (or APV), through Monte Carlo analysis, to a decision-tree-like structure, the obscure-sounding binomial lattice.

Management distaste for ROA has been found true in the general financial literature as well. Authors such as van Putten and MacMillan (2004) writing in the Harvard Business Review take pains to show that ROA is an extension of discounted cash flow analysis. Favato (2008) confirms that “real options are still unpopular among business practitioners,” and proposes using a video game metaphor to make the technique more user-friendly and comprehensible. Without oversimplifying the problem using video games, this research recommends a number of methods which can provide more insight into project uncertainties.

Step One: establish a transparent cash flow model

First, simplify the model initially, and generate base case NPVs under a clear set of assumptions. If managers don’t understand the model’s structure and workings clearly, the insights of ROA will be sabotaged by a “black box” suspicion. This model can and should be very like the cash flow projection method outlined in the neo-classical model. It is important to remember what decisions & questions the model is intended to inform.

The cash-flow model used in the research was developed by the author. The model is in current use with aviation professionals performing fleet development studies for airlines. The model is capable of simulating a complex fleet build-up with multiple aircraft types. In the ROA example, below, an acquisition of a single aircraft – either an A319 or an A320 – is used. By looking at the dynamics of a single aircraft, the relevant decision parameters are clearly identified, without ‘clouding the picture’ by building up an entire fleet in the model.

The model is based on Excel and Visual Basic. The statistical routines used are from Oracle’s Crystal Ball Monte Carlo analysis add-in to Excel, one of many such packages available as add-ins to spreadsheet programmes. The specific ROA valuation routines were written by the author, using standard spreadsheet functions. The workings of the model are thus – with the exception of Crystal Ball – fully documented in the Excel model itself.

In the example modelled here, the decision point is valuing the family conversion option between a high-density 156-seat A319 and a 180-seat A320. The modelling choices were intended to reflect realistic assumptions, while not biasing the results by overstating the uncertainty of a single parameter such as residual value. Single-aisle aircraft were chosen in order to minimize any potential impact of residual value estimation uncertainty: these aircraft are more frequently traded than wide bodies and therefore residual value is more reliably predicted. Authors such as Hallerström and Melgaard (1997 and 2000) and Otero (2006) have discussed the greater uncertainty of wide-body RV forecasts relative to single-aisle. Clearly, the use of a wide-body operation would yield different results, with greater variability in valuation due to the greater dispersion of RV forecasts.

High-density layouts were chosen in order to reflect the rapid growth of this type of operation in Europe, where revenue and cost data is reliable and relatively easy to come by. Finally, the operation was selected because such MC analysis reflects the risk quantification approach discussed in this research, which can be extended to a ROA framework. While the attempt is made to be "realistic" by using typical European operation cost and revenue figures, the model and its results are necessarily stylized, and are used primarily to illustrate the nature of the output, rather than modelling a specific transaction or situations. Detail of all modelling assumptions and output is provided in Appendix E

The decision point is 2010, and the aircraft are to be delivered in 2015. The deterministic base case reveals NPVs of $12.7m for the acquisition of a single A319, and $13.6 million for the A320. The A320 is valued $0.9m higher than the A319, reflecting its potential to more fully accommodate traffic growth of 4% annually. The deterministic model fuel price is $2 per US Gallon.

Step Two: estimate the potential distributions in key assumptions

The next step is to identify the assumptions subject to uncertainty, very much along the lines of the management interview methods used in the risk-quantification paradigm. The degree of uncertainty in each parameter is used as an input to the Monte Carlo simulation, the second step in ROA valuation.

The uncertain parameters illustrated in this example were clearly identified by the fleet planning expert panel as critical: fuel price and growth of passenger and cargo demand for the airline in question, in the presence of both underlying demand fluctuations and competition from other carriers. In addition, the impact of the business cycle is modelled (again, consistent with the results of the expert panel).

To model fuel price, historical data is used the international fuel prices 2009-2009, as reported by the U.S. Energy Information Administration[24]. The fuel prices are represented in Figure 7.1 as a histogram, with price per gallon on the X axis, probability and frequency on the dual Y axes.

[24] Complete historic data sets for major jet fuel markets are available on the EIA.gov web site

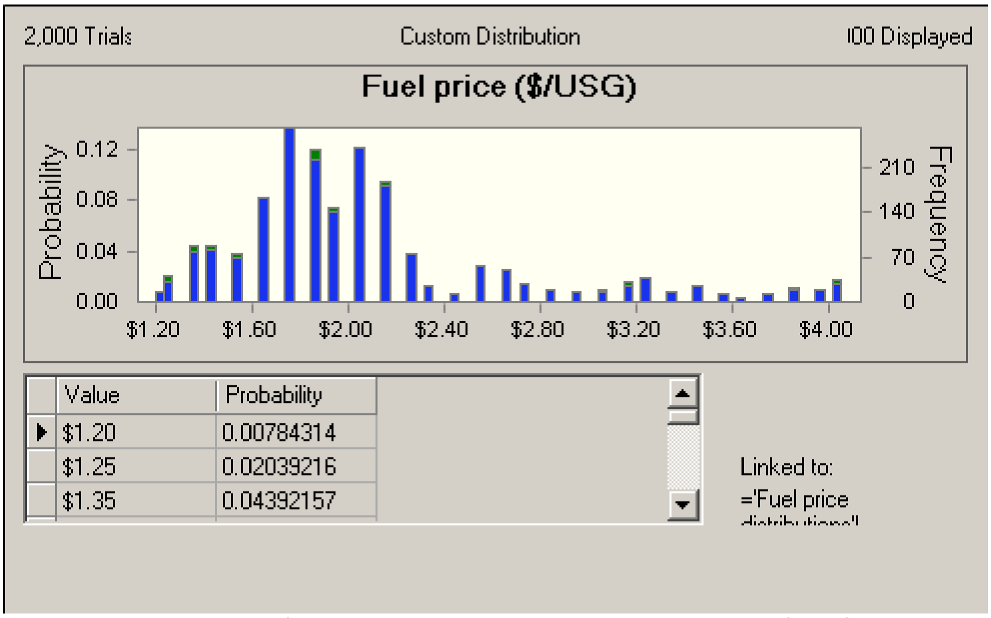



Figure 7.1: Distribution of international Jet Fuel prices, 2005-2009 used for MC simulation

This method is of course fully guilty of the past vs. future pitfall present as well in estimating the beta and cost of equity. The best defence for this approach is that the most recent period is being used, rather than a long-term average. Clearly in the last ten years, fuel demand has growth sharply in emerging markets, creating a rising trend in world fuel prices.

Demand growth is modelled as changing over the cycle, as opposed to the deterministic 4% average growth used in the base case, depicted by the black line in Figure 7.2.

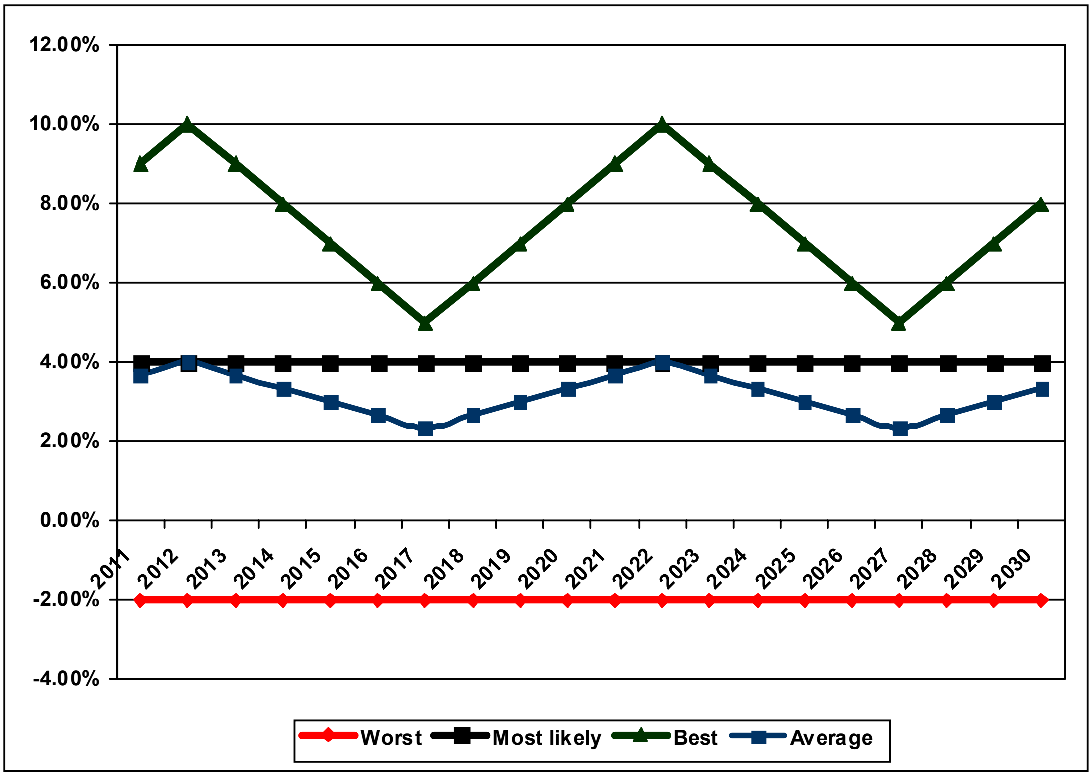



Figure 7.2: Demand growth modelled over the cycle

For the Monte Carlo analysis, the base case value of 4% is replaced by a cyclical growth pattern applied in each year of the study. Again, simplicity is the rule in selecting the distributions used to model demand uncertainty. A simple best-most likely-worst case triangular distribution is assigned to each year of the investment horizon. The green line in Figure 7.2 shows the upside for each year, and reflects the growth prospects for a European low-cost carrier such as Ryanair or easyJet, with top growth rate of 10% at the top of the cycle, achieved in 2012 and again in 2022. The red line shows the worst case for all years, with demand shrinking by 2% each year of the study. The blue line depicts the simple average of the high and low values: while not used in the simulation, this line does show the overall conservatism of the estimates. This modelling approach is in contrast to the use of mean reversion functions used by Otero and Stonier, which “force” the overall patterns of values to revert to an underlying trend line. The pattern of demand over the cycle is entirely determined by high-medium-low (HML) estimates for each period. This specific pattern used seeks merely to simulate the undeniable demand cycle, without pretending to any sort of exactitude.

Step Three: run the MC simulation

With these two uncertain inputs, a Monte Carlo simulation was run 2,000 times, requiring about an hour to run each time. During each iteration, the MC routine assigns a value to each uncertain variable, recalculates the NPV, and constructs a data set for statistical analysis of the output. In the method used, fuel price is considered as a random variable, and its value for the entire study reflects recent fuel price history. On the other hand, the demand growth parameter is selected by the software independently for each year, based on the H-M-L distribution for each year. This approach again reflects the risk-quantification approach of interviewing managers to establish expected distribution: assessing project uncertainty is placed in the hands of those most capable to do so, the firm's managers.

The first-level output of the simulation is depicted in Figure 7.3a and b., with the outputs of the simulation under 255 individual iterations (the maximum displayable with Microsoft Graph) on the Y axis. The red line on each graph shows the average operating cash flow over the 2,000 iterations, while the blue line shows the standard deviation.

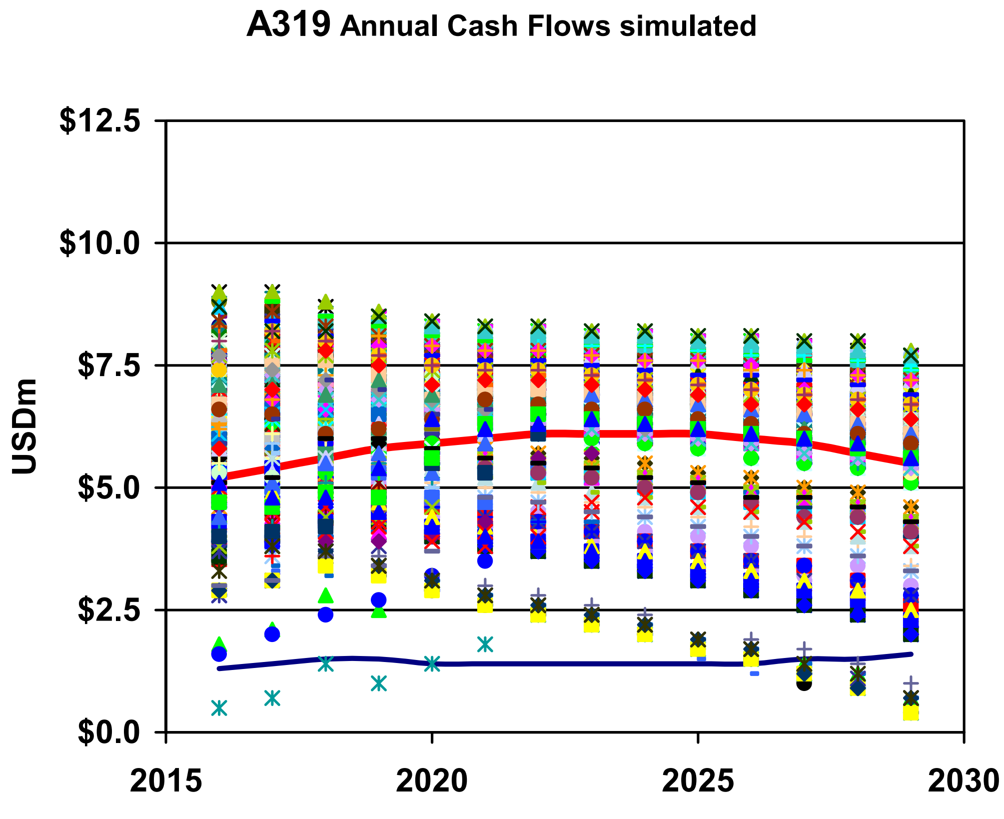



Figure 7.3a: annual operating cash flows from A319 investment

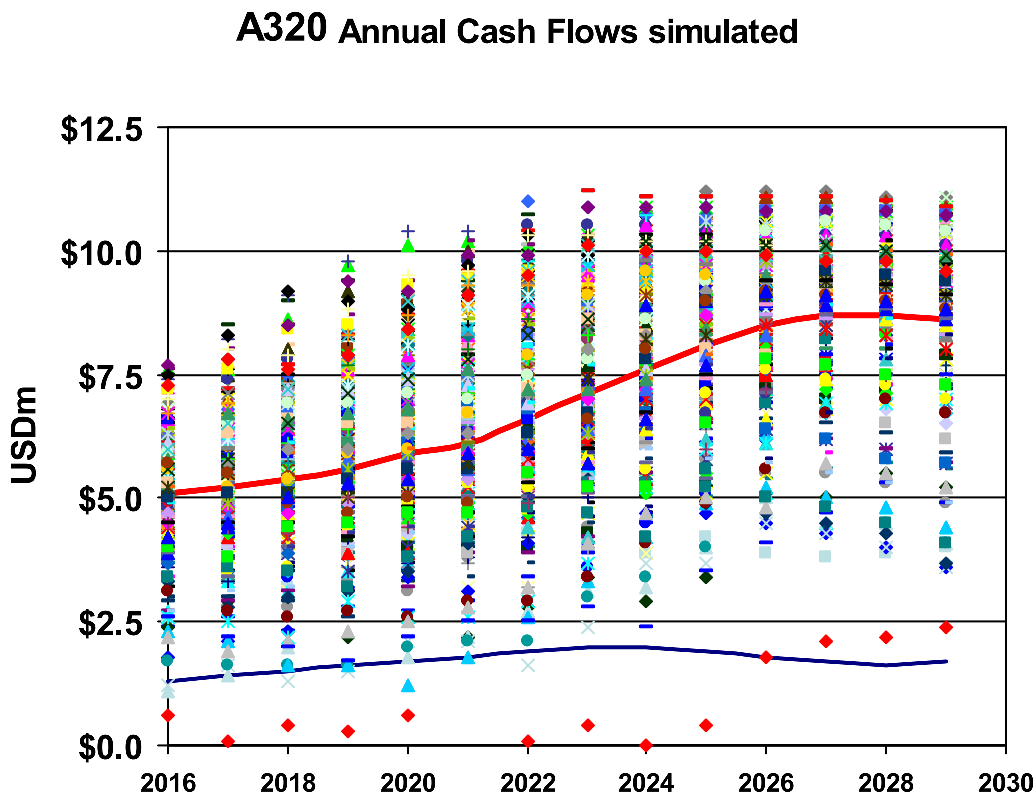



Figure 7.3b: annual operating cash flows from A320 investment

The spread of simulated operating cash flow estimates reflect uncertainty in both fuel and demand estimates. All operating cash flows were found to be positive, even given the variation in fuel price and demand, in itself an interesting piece of information for management: the basic *operating* economics of this investment are robust under the given assumptions of uncertainty. The different potential for operating cash flow upside is apparent in the A320 graph, which shows continued passenger growth potential due to its larger size, whereas the A319 tops out just after the 2022 cycle peak, and declines thereafter, due to the 'drag' of potentially higher fuel price, as well as the aircraft aging factor on both fuel and maintenance cost that begins as the aircraft enters mid-life. These factors are routinely used in assessing aircraft performance over time. In this model, both fuel burn and maintenance costs are marked up 2% after year 12 of operation (2027 in this study).

The A320 upside is accompanied by a higher spread of potential outcomes as reflected by the blue standard deviation line, as the uncertainties in market growth over the cycle have a greater impact on the higher-capacity and higher cost aircraft. This higher volatility will be captured in the ROA valuation.

Based on these insights, the NPV simulation is performed very much along the lines of the risk-quantification paradigm. In Figure 7.4a and b, the discounted cash flows are accumulated over the investment horizon, and include the impact of the aircraft price. The thin lines show the potential NPV paths, while the dark red line shows the expected or mean NPV over the entire set of 2,000 iterations. The small number of widely-dispersed downside lines reflects the fuel price distribution, with its fat tail of fuel prices reaching $4.00 per USG at the extreme.

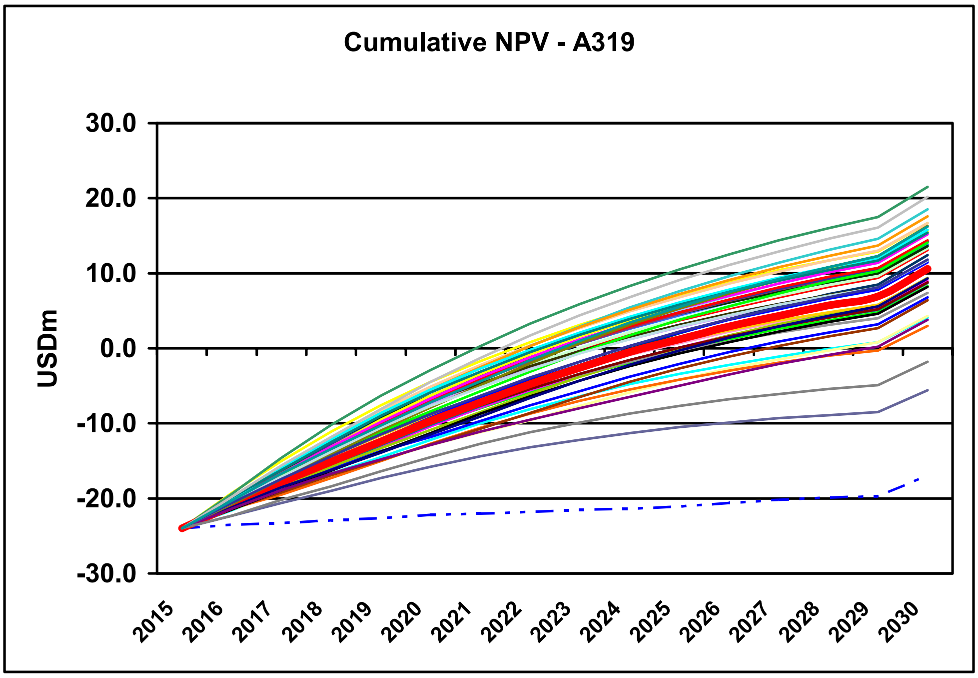



Figure 7.4a: A319 cumulative and expected NPV over MC iterations

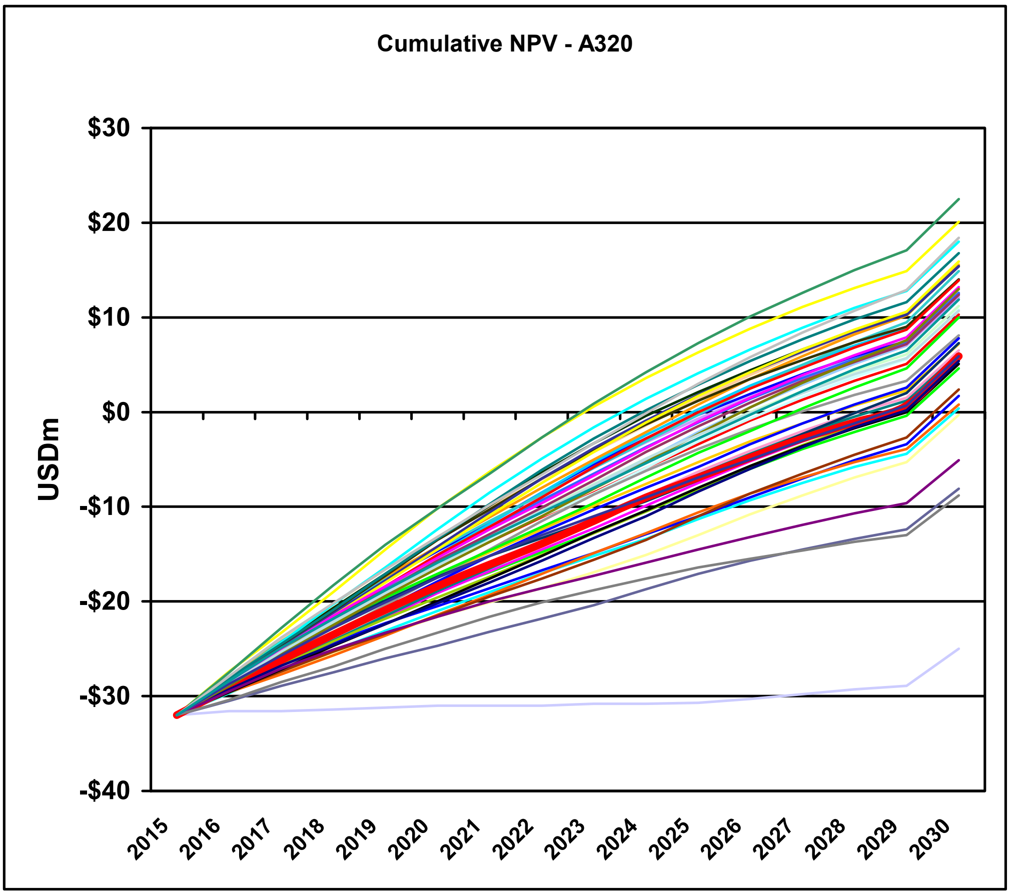



Figure 7.4b: A320 cumulative and expected NPV over MC iterations

The picture revealed here is strikingly different from the base-case, deterministic NPVs, which showed slightly higher value from acquiring the larger aircraft. The A320 scenario under uncertainty only reaches a positive expected NPV in the final year of the study, and then only due to the shift upward in 2030 reflecting the aircraft residual value[25]. Simple statistics comparing these deterministic results with the MC simulation are presented in Table 7.1.

[25] To provide contrast to Otero's study, the RV assumption for both aircraft is deterministic, estimated based on 4% decline in market value per year.

| | A319 forecasts | A320 forecasts |
|---|---|---|
| **NPV with deterministic model** | **$12.7m** | **$13.6m** |
| Monte Carlo simulation statistics | | |
| Trials | 2,000 | 2,000 |
| **Expected NPV under uncertainty** | **$8.77m** | **$5.75m** |
| Standard Deviation | $7.1m | $8.2 |
| Coefficient of Variability (σ/mean) | 0.81 | 1.42 |
| Kurtosis | 4.45 | 3.38 |
| Minimum | -$19.2m | -$26.3m |
| Maximum | $21.5m | $23.8m |
| Range Width | $40.7m | $50.0m |

Table 7.1: NPV under certainty and MC simulation results

The expected NPV (E(NPV)) is lower in both cases, due to effects of uncertainty, and the A320 project carries a substantially lower value than the A319, contrary to the deterministic case. As observed in the operating cash flow simulation, the higher operating cost of the A320 produces more widely-dispersed cash flows under uncertain market growth, and a lower E(NPV) than the A319. The risk-reward equation is represented by the Coefficient of Variability (σ/average, known as the K-Factor in demand spill modelling) is nearly twice as high for the A320. Still, the greater statistical dispersion of results is not by itself the driver of the lower valuation.

The absolute range of simulation outcomes given in Table 7.1 begins to explain the difference: with only limited maximum upside advantage $2.3m over the A319, the A320 has a minimum value $6.1m below that of the A319.

The full picture becomes clearer when looking at the NPV distributions in order to establish the causes of the lower valuation, as in Figure 7.5.

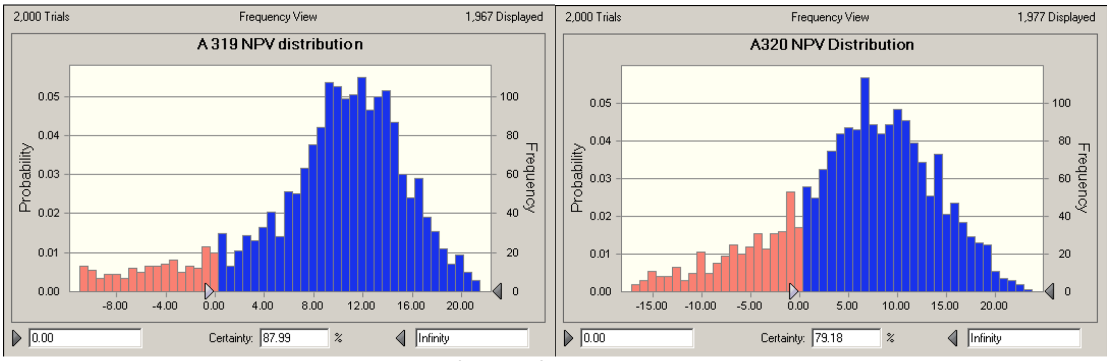



Figure 7.5: distribution of NPVs for the A310 and A320 investments.

It is easy enough to see that A319 NPV distribution is peakier, confirming the kurtosis measures of each distribution. There is less spread in the outcomes and less skew to the left, showing clearly the downside present in the A320 scenario. The overall shapes of the outcomes suggest that the “fat tail” of recent fuel prices overcomes the potential upside of the A320 investment, a fact which will be confirmed in the sensitivity analysis below.

To view the analysis in terms of project acceptability, the histograms are structured in the form used by the risk-quantifiers. The pink columns of the histogram in Figure 7.5 show the frequency of NPVs less than $0.0 (i.e., unacceptable projects), and the blue, those greater. At the centre of each chart, the percentage of positive NPV outcomes under the simulation: 88% for the A319, and 79% for the larger aircraft.

Crystal Ball combines the probability distribution and the model sensitivity (uncertainty and impact) of assumptions in "Sensitivity charts," displayed below.

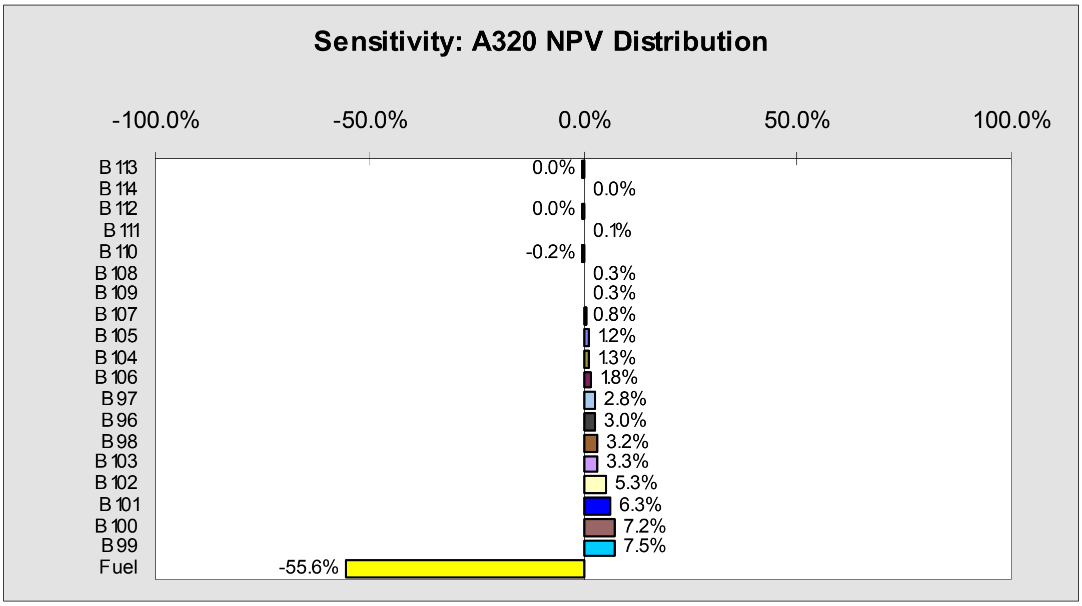



Figure 7.6: Crystal Ball "Sensitivity chart" for the A320 simulation

The traffic effects over the cycle are pictured in the upper part of the chart (labelled B96-B113). The small downside of lower growth during the down cycle is clearly offset by the potential upside offered by traffic growth, particularly in the lower-numbered early years of the project. However, this upside is completely overwhelmed by the downside risk of recent fuel prices, held to explain 56% of the simulation's variability.

Under reasonable fuel price and demand cycle uncertainty assumptions, the A319 project is clearly preferable to the larger aircraft, yielding a higher E(NPV) with less downside. Still, has the fleet planner learned anything from this analysis? Any fleet planning professional realises that a larger, higher-cost aircraft bears more financial risk than a smaller one. However, the MC analysis reveals that in spite of its greater revenue-earning potential, the A320

E(NPV) under uncertainty is dominated by the wide spread of recent fuel prices. As stated above, the greatest benefits of using these proven and in-use methods are managerial rather than methodological:

- The cash-flow analysis is tied to the fleet planning risk assessment, rather than being an after-the-fact, arbitrary assignment of a discount rate premium to account for risk. The cash flow 'arbiter' of project approval is explicitly adjusted for risk
- Key uncertain assumptions are identified, and explicit uncertainty estimates are made by management, helping them to discuss and assess the impacts of market uncertainties.
- Operating cash flows may observed under a precise combination of uncertain assumptions, combining the effects of different scenarios in readily identifiable patterns
- The NPV model uncertainties are documented and quantified (in the case of fuel from most recent available data), making later follow-up on the project more transparent.

The probability-of-success output of this approach often makes managers nervous. Boards of Directors of established companies are not readily amenable to requests for funding that require them to explicitly place bets on investments (even if this is precisely what project approval entails). This type of probability output is the one most often cited by the risk quantifiers, who share this type of results with manufacturers, inviting them to make improved offers to raise the probabilities to acceptable levels.

Practice of MC analysis clearly identified among risk-quantifying practitioners ends with this step. MC has been seen to be rarely used among the general airline community, while having been declared by the risk-quantifiers to be very effective in project assessment and manufacturer negotiations. Given the complexity of the fleet planning models used by the neo-classical practitioners, one can easily imagine the difficulty of adding an MC dimension on top: it is easy enough to develop a 1 megabyte spreadsheet model and apply MC, quite another to modify highly sophisticated network demand and fleet assignment models. These planners stated in interviews that they use the output of the fleet planning models to generate cash flow inputs: the answer in this case would be to add a middle layer of quantitative analysis within the cash-flow (doubtless done with spreadsheets), allowing the financial evaluation to capture the effect of certain key uncertainties, while using the main outputs of the fleet planning models.

In any case, the conversion option problem at the base of this question is not yet solved. Aircraft manufacturers offer aircraft family conversion options that may be exercised up to 12 months prior to aircraft delivery, allowing managers to observe events leading up to the exercise date before confirming or dropping the conversion from the base aircraft type ordered. A final question is the value of this option.

Step 4: Family conversion option valuation

It is important to note at the outset that ROA valuation is distinct from the MC analysis, in that it begins with the base case (deterministic NPVs), $13.6m for the A320 and $12.7m for the A319 in our case. This is why authors take pain to point out that it is complementary to traditional NPV analysis.

The simplicity of the model developed thus far is in this particular case sharpens the analysis of this specific issue. Because a single operation and aircraft is modelled, the value of the option can be estimated on a unitary basis. The methodology used is binomial options pricing, using the Mun (2002) methodology[26].

The valuation of a real option relies in the insight that in the absence of obligation to exercise, the value of an option at any point in its life will be the maximum of 0 and the underlying asset value less the cost of implementation. In real options terms, the "asset value" is the NPV of the project itself. For a switching option, the value is the greater of the A319 project value, and the A320 value minus the cost of implementing the A320 (such as additional training and spares provisioning). Because the airline can exercise at any point up to a date 12 months before delivery, these are American-style options, and will be valued as such. The goal of the valuation is to determine an appropriate price for the option. As discussed in Chapter Six, the *price* of such embedded options within aircraft contracts can be elusive: our goal here is to establish its *value* to the airline.

To estimate potential values for the project during the years preceding delivery of the aircraft, a "binomial lattice" (or decision tree) of potential project values is established. Establishing these project values over time requires an estimate of potential upside and downside at each node in the tree, and for this a secondary output of the MC is used. In Mun (2002) and Copeland (2003), the logarithm of year one returns ($PV_{Year\ 1}/\ PV_{Year\ 0}$) is used to convert dollar returns into the percentage volatilities needed for the lattice construction.

This approach leads to a methodological problem, as the logarithm of a negative number is undefined (and clearly, aircraft projects can yield negative returns). In the present implementation, undefined log returns are set to zero,

[26] Extensive expositions of real options theory and methodology are in Schwartz and Trigeorgis (2001), Mun (2002), and Copeland and Antikarov (2003

resulting in the distribution with 350 to 500 of the iterations yielding undefined returns, as depicted in Figure 7.7.

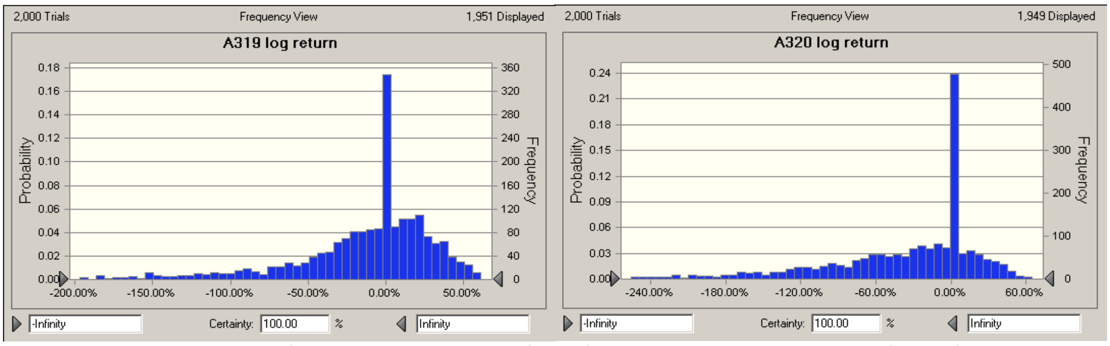



Figure 7.7: distribution of LN($PV_{Year\ 1}$/ $PV_{Year\ 0}$) for MC simulation, large number of undefined returns

This methodological problem is not discussed in the various exegeses of ROA. The method is clearly far from perfect, if certainly no more so than CAPM. The volatilities thus established are 65.35% for the smaller plane, and 75.81% for the higher-risk A320, substantially higher than the 23%-28% volatilities calculated by Stonier. Applying these volatilities to the MC simulation results (following an assumption-strewn path), the potential project returns are calculated moving forward in time from each node, beginning with the initial project valuations for each aircraft. On the upside, the A319 expected NPV of $12.7m could nearly double to $24.0m, or nearly halve to $6.8m, and so on until the 2014 last exercise date.

| | 2009 actual | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| **Potential passengers on each flight** | 110 | 114 | 119 | 124 | 129 | 134 |
| **Project values under uncertainty** | **Today's expectation: deterministic NPV estimate** | **Varying market conditions may produce different project values: the upside and downside are quantified using the volatility of the project's returns under MC simulation** | | | | |
| **A319 NPV** | $12.7m | $24.0m | $45.2m | $85.1m | $160.3m | $302.1m |
| | | $6.8m | $12.7m | $24.0m | $45.2m | $85.1m |
| | | | $3.6m | $6.8m | $12.7m | $24.0m |
| | | | | $1.9m | $3.6m | $6.8m |
| | | | | | $1.0m | $1.9m |
| | | | | | | $0.5m |
| **A320 NPV** | $13.6m | $28.9m | $61.7m | $131.7m | $281.1m | $600.0m |
| | | $6.3m | $13.6m | $28.9m | $61.7m | $131.7m |
| | | | $3.0m | $6.3m | $13.6m | $28.9m |
| | | | | $1.4m | $3.0m | $6.3m |
| | | | | | $0.7m | $1.4m |
| | | | | | | $0.3m |

Table 7.2 project values under volatility estimates from MC simulation

In Table 7.2, the rows represent the upward and downward movements in NPV, driven by project volatility. These are purely theoretical valuations, needed only the actuarial calculation of the option's value, presented below. Options reasoning begins with potential states of nature at options exercise date, and reasons backward, using backward induction.

At the exercise deadline, the potential value of the A320 project is compared with the A319, and the final exercise-or-drop decision made. As Table 7.3 shows, in the top three cases the conversion option will be exercised at the deadline, because trading conditions are favourable to the larger plane (even with the $500,000 cost of adopting the A320), whereas in the bottom three, the option will be dropped.

| | 2009 conditions | 2010 | 2011 | 2012 | 2013 | Exercise deadline |
|---|---|---|---|---|---|---|
| **Value of the option to convert to A320** | $13.7m | $29.0m | $61.5m | $131.3m | ***$280.6m*** | $599.5m |
| | | $6.6m | $13.7m | $28.8m | $61.2m | $131.2m |
| | | | $3.3m | $6.7m | $13.6m | $28.4m |
| | | | | $1.7m | ***$3.4m*** | $6.8m |
| | | | | | $1.0m | $1.9m |
| | | | | | | $0.5m |
| | **2009 conditions** | **2010** | **2011** | **2012** | **2013** | **2014** |
| **Decisions based on different trading conditions** | **A320** | **A320** | **A320** | **A320** | **A320** | **A320** |
| | | **A319** | **A320** | **A320** | **A320** | **A320** |
| If favourable conditions warrant the larger plane, the A320 option will be exercised. If not, the A319 is retained | | | **A319** | **A319** | **A320** | **A320** |
| | | | | **A319** | **A319** | **A319** |
| | | | | | **A319** | **A319** |
| | | | | | | **A319** |

Table 7.3 binomial lattice of A320 family conversion option gross values under varying states of nature

At each “step” or decision node before this date, the option’s value is the maximum of the current state of nature between the projects (from Table 7.2) and the actuarial value of the following nodes, discounted one period at the risk-free rate. In the output in Table 7.3, the highest upside value in 2013 ($280.6m) is favourable to the A320, and so the option has the A320 project value (minus the switching cost). Two nodes below, under adverse trading conditions, the discounted expected value of waiting another period is higher than the A320 project value, and this value is carried.

This backward-induction process is continued at each node until the contract signature date, where a present-time value for the option is available: $13.723m in the present A319/A320 model. The excess of this value over the A320 project value under the deterministic scenario is the calculated value of flexibility. In Table 7.4 below, the conversion option value is calculated as $673,000 per aircraft. This is the amount the airline should be willing to pay for the option.

| Valuing the flexibility of the family conversion option: final step | |
|---|---|
| **1. NPV of the A320 project, after switching costs** | |
| A320 forecast NPV (deterministic) | $13.550m |
| less the implementation cost of switching to the A320 | $0.500m |
| = Net value of the A320 project | $13.050m |
| **2. calculation of the value of the flexibility to switch** | |
| A320 project value under uncertainty | $13.723m |
| Less the net A320 project value | $13.050m |
| **= Option valuation at date of contract signature** | **$673k** |

Table 7.4: calculation of the net option value (premium) at contract signature

This example has gone through the process of model development, NPV calculation, MC analysis, and finally the ROA valuation. The first two steps are commonly used by more advanced practitioners, but what is the use of this last step? The calculations are arduous, difficult to explain and justify, and the results are non-intuitive, demanding many theoretical and methodological leaps of faith, particularly concerning the volatility estimation methods and the extraordinary project values calculated in the binomial lattice.

This step could easily be dismissed if it were not for the undeniable fact that this type of option is routinely sought by airlines in single-aisle aircraft markets, and has become a fundamental feature of B737 and A320 family aircraft contracts. Clearly the flexibility has a value for airlines: in such a volatile market as today's, this value cannot be trivial. One would assume that manufacturers carefully value the options granted to customers, and that any such premiums paid are fully non-refundable against aircraft purchases later confirmed or converted: if not, the airline is paying for flexibility only in the case the option is not exercised, an additional financial benefit to the buyer. ROA analysis responds in a complex way to the dictum, "if you can't measure it, you can't manage it."

In this section the two most common types of options in the aircraft market have been reviewed. Values for return options or residual value guarantees were established in Otero (2006) at between 4 and 7% of insured value (higher than the 3% he calculated using ROA). A model demonstrating the process of moving from NPV practiced by a great majority of airline CFO respondents was implemented, the process steps demonstrated, and a ROA valuation for a family conversion option calculated using established methodologies. The modelling clearly requires effort acceptance of methodological imperfections, in just the same way as establishing and applying WACC to project valuation does. The differences are that the path to results is rather longer than under CAPM, the convenient workarounds for methods more numerous, and finally, the undeniable fact that the underlying math appears abstruse to non-statistically oriented managers.

## 7.3. Environmental cost modelling

One of the key sources of uncertainty identified in the fleet planning expert panel was that of environmental costs, particularly at the international level. Morrell and Lu (2007) analysed this problem in the context of network strategy and fleet selection, illustrating the broad range of environmental cost uncertainties facing fleet planners, who must clearly capture and model what are for the moment more often than not externalities, such as noise during landing and take-off (LTO) and emissions. Their 2007 article follows a body of aviation-specific research into environmental costs, including Alamdari and Brewer (1994), IPPC (1999), Pearce and Pearce (2000), Sentance and Kershaw (2005), as well as a series of articles by the authors themselves (Morrell and Lu 2000, 2001, and 2006). Morrell and Lu (2007) summarized their earlier research and the methods that can be used to estimate environmental costs, used as a basis for this article's focus on estimating environmental costs arising from an airline's choice to feed a hub or to offer hub-bypass direct service.

The authors identified four distinct cost categories. Noise cost was estimated based on hedonic estimation, that is, as a function of certified aircraft noise contour (emissions), and housing costs in the airport area. Emissions costs were divided into three categories (LTO, 30-minute cruise in the vicinity of the airport, and cruise), and estimated separately based on certified aircraft emissions and environmental cost estimates from a variety of expert sources.

The resulting estimated environmental costs from Morrell and Lu (2001) are presented below, in Euros per landing. Using the representative seat counts for the aircraft common between the article and this research, the last column shows the cost per seat.

| | Airport -level costs | | | | | | |
|---|---|---|---|---|---|---|---|
| Aircraft type | Noise | LTO emissions | 30-minute cruise emissions | Cruise cost | Total cost | Seats | **Cost/seat** |
| B737-300 | 308 | 168 | 366 | 1020 | 1862 | 107 | **€17** |
| A310-203 | 503 | 393 | 897 | 4096 | 5889 | 240 | **€25** |
| DC10-30 | 1384 | 700 | 2453 | 20485 | 25022 | 250 | **€100** |
| B747-100 /200/300/SP | 1852 | 936 | 3375 | 33343 | 39506 | 374 | **€106** |
| B747-400 | 1206 | 950 | 4562 | 48934 | 55652 | 429 | **€130** |
| MD11 | 727 | 795 | 1919 | 12585 | 16026 | 285 | **€56** |

Table 7.5: social costs by category and total cost per seat from Morrell and Lu (2007)

Assuming that airlines passed the cost on to passengers in an operation averaging 70% load factor, the per-ticket surcharge would range from €25 for a 737 classic flight, to €185 for a 747-400: they would be very significant additions to airline unit costs. Each of the authors' recent articles applied these methodologies to specific cases, including a specific application to Amsterdam Schipol (Morrell and Lu 2000) and a broader study including Heathrow, Gatwick and Stansted as well as Schipol and Maastricht. Using the costs calculated in Morrell and Lu (2001), airport-level cost and resultant charges would range from €7 to €18 per seat.

In Morrell and Lu (2007), this methodology is applied to the consolidation-fragmentation question. In the scenarios analysed by the authors, airlines can either add direct service, or add upsize the aircraft used in the hub-and-spoke operation, substituting larger and more-polluting aircraft for smaller ones, which are assumed to be pre-existing in the airline's operation. In this way, the costs estimated are truly analysed as accommodating growth in pre-existing services. The costs are closely related to concrete aircraft types, improving calculation precision while bringing the analysis closer to the real-world tools and methods of fleet planners.

The authors found that the environmental diseconomies of hubbing with current-generation aircraft range from 25% to 71% per passenger, relative to bypass operations: environmental costs strongly support the fragmentation view of long-haul network growth.

| | **Costs per passenger** | | |
|---|---|---|---|
| | **Bypass** | **Hub** | **Increase of cost of hubbing** |
| Glasgow-Chicago | €59 | €101 | 71% |
| Glasgow-Dallas | €69 | €113 | 64% |
| Heathrow-San Diego | €84 | €105 | 25% |
| Hamburg-Tokyo Narita | €82 | €124 | 51% |
| Hamburg-Dallas | €75 | €112 | 49% |

Table 7.6 Environmental cost per seat for Bypass / Hub-and Spoke service, from Morrell and Lu (2007)

The authors then perform a sensitivity analysis to look at announced performance characteristics of the 787-8 and A380-800, finding that the Airbus aircraft does substantially reduce hubbing costs compared with the 747-400 or the 747-8, *if* the aircraft is not delayed idling on the runway due to airport congestion.

Environmental cost research is relatively new, and as such there are many questions to be resolved. Noise impacts are the best-known, several European airports charge based on aircraft type already, and the hedonic cost estimation method is well-established and can readily be calibrated from public-domain data. Estimates from research into the environmental costs of emissions show enormous variation, as the authors found in 2001. In 2006, they add that "the impacts from these emissions are still subject to wide ranges of possible damage, both because of the lack of knowledge of the physical processes and the different discount rates used to determine present value marginal cost." Finally, as a purely O-D study of long-haul markets, this analysis does leave out the potential negative impact of not accommodating local traffic growth in the short-haul network with either greater size or increased frequency.

This sort of forward-looking study is important for this research first for the contribution to the consolidation-fragmentation debate facing fleet planners, and second for the crisp categorization of environmental cost categories and drivers, all of which add to the uncertainties of any investment appraisal in the 21st century.

## 7.4. Agency, information, and signalling in aviation markets

### 7.4.1. Asymmetries of information and financing choices

A large body of research has evolved attempting to address the effect of potential divergences of interest between a firm's shareholders and its managers on investment and financing choices. This theory has evolved from the seminal writings of Myers (1977 and 1984), the latter complemented in a more formal way in Myers and Majluf (1984). In this first strain of thinking the firm's managers are assumed to act in the interest of shareholders, but to have superior information about the prospects for investment profitability, when compared to shareholders, a phenomenon dubbed asymmetric information.

In order to explain financing decisions, Myers develops two possible explanations. First is the notion of the costs of financial distress which lead to an optimal amount of debt in a firm's capital structure, as discussed in

Chapter Two of this research. This approach is quite close to the traditional value-investing view of investors' tolerance for a "reasonable amount of debt," though updated taking the Modigliani and Miller propositions into account, allowing a stylized pseudo-quantification of this optimum, as presented in Figure 2.1. Myers' second strain of reasoning follows the field research including Donaldson (1961), who found that "management strongly favoured internal generation as a source of new funds even to the exclusion of external funds."

To capture this phenomenon Myers coined the term the Pecking Order Theory, and formalized with Majluf a model to explain the observed preference for internal funds, then "safe" debt securities, and only finally for equity in the context of information asymmetries. The intuition behind this is that in the absence of full management information regarding projects which management approves after 'proving' internally that they will generate returns at least earning the cost of capital during the investment appraisal process, external lenders and shareholders without such detailed proof will require excessive returns to justify the risks of investments.

Starting with the basic assumption that management acts in the interests of its shareholders, Myers' and Majluf proposed a model that suggested a two-level pecking order. Quoting from Myers and Majluf (1984):

"(1) It is generally better to issue safe securities than risky ones. Firms should go to bond markets for external capital, but raise equity by retention if possible. That is, external financing using debt is better than financing by equity.

(2) Firms whose investment opportunities outstrip [current] operating cash flows, and which have used up their ability to issue low-risk debt, *may forego good investments rather than issue risky securities to finance them*. This is done in the existing stockholders' interest. However, stockholders are better off ex ante - i.e., on average - when the firm carries sufficient financial slack to undertake good investment opportunities as they arise."

The airline CFOs surveyed for this research ranked their preferences for sources of financing. To reflect the importance of operating leasing, the survey added a fourth financing possibility, the use of operating leases. The respondents tended to indicate the following ranking:

1. Use internally-generated funds
2. Minimise cash out (for example, through operating leases)
3. Debt financing
4. Equity financing

These preferences were not unanimous among the respondents. The average ranks for each for each financing options are presented in Figure 7.8.

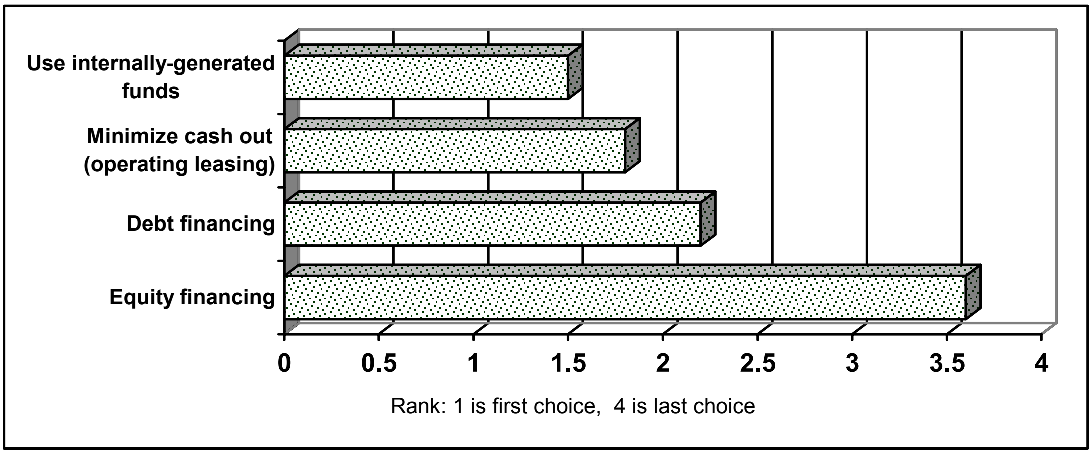



Figure 7.8: Airline CFO ranking of preferences for project financing

These preferences confirm the moderate support for the Pecking Order theory of financing choices also found by Graham and Harvey (2001), particularly in the aversion to equity financing, ranked fourth by 73% of those stating a rank for equity financing. The close proximity of the first two ranked preferences also suggests the attractiveness of operating leasing as a source of aircraft capacity.

To address the overall capital structure question, airlines CFOs were asked about their *overall* preferences for debt vs. equity financing for the airline as a whole, a question more related to corporate financial policy than to investment analysis. 59% of the respondents were found to have flexible target capital structure, consistent with the view advanced by Myers that there is an optimal capital structure – however difficult to quantify - for companies. The remainder of the responses were split equally between a strict target capital structure and no target at all.

Finally, the airline CFOs were proposed a number of criteria which may be used to determine the appropriate amount of debt to issue in financing the airline's activity, using the never (1) sometimes (2) always (3) preference scale.

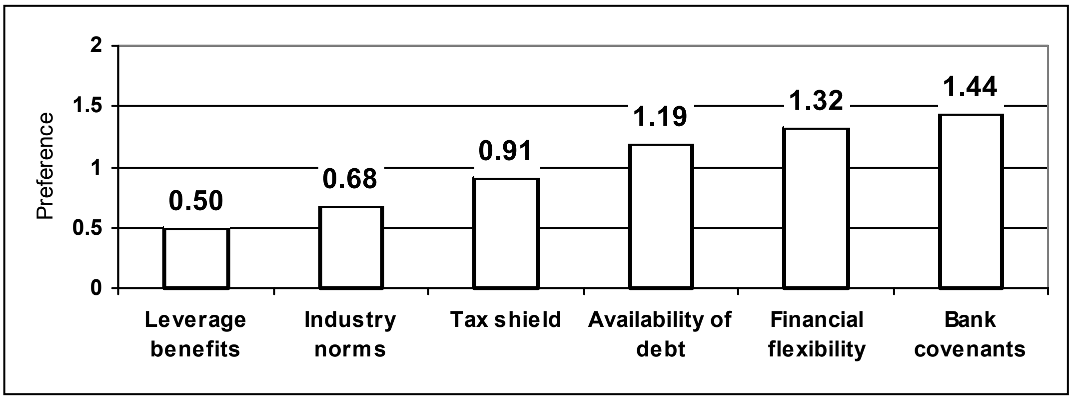



Figure 7.9: Airline CFO preferences in selecting appropriate debt levels

Leverage benefits propounded by traditional financial theory ranked lowest of all, followed closely by levels set along industry norms. Assuming the industry uses a "reasonable amount of debt" (even if many would argue that the industry uses too much debt), the respondents showed little taste for traditional logic in capital structure. The tax shield benefit formalized by Modigliani and Miller also showed a preference less than "sometimes" among the respondents.

The airline CFOs revealed themselves to be more pragmatic than theoretically correct, with the basic availability of debt, desire to retain financial flexibility in a cyclical business, and above all, existing bank covenants setting the limits to debt issuance. The airline industry's low and erratic profitability means that most financing will be secured by assets, and aircraft financing agreements routinely stipulate both maximum subsequent debt levels and "cross-default" conditions, whereby a default on one debt agreement can be held in court to be a default on another such agreement. Financing choices among the airline respondents take classical financial precepts into account, but are more rooted in problems of information asymmetries and debt capacity than seeking optimal debt and equity levels through tax arbitrage, as developed in classical theory.

### 7.4.2. Lufthansa & British Airways investor information and signalling

In finance theory, the traditional signals cited as having powerful impacts on investor perceptions include dividend policy and announcements, changes to capital structure, stock splits, share repurchases and new equity issues. As the focus of this research is investment valuation rather than financial policy, these types of signalling are not addressed. However, financial market signalling is very much present in the current era of information availability. To alleviate potential undervaluation due to information asymmetries, listed airlines in Europe have adopted active investor communication practices.

Lufthansa (LH) introduced value-based management concepts in the company in 1999. Its application to investment valuation was discussed in Chapter Four. In this section the focus is on the nature of the signals sent by the company regarding such valuation techniques. Reading the company's annual reports over time, it is quite apparent that LH seeks not just to practice Value Based Management (VBM), but to communicate the results under this rigorous methodology to investors, as a signal of its commitment to shareholder value. British Airways' communication has been more muted but at the same time more informative, particularly regarding issues related to cost of capital. This section reviews the two approaches.

The company's annual report of that year announced the introduction: "In the current year every business segment of the Lufthansa Group will once again be put under the spotlight. Their strategic position, expected profit contributions to the Group and potential to create value for our shareholders on a sustained basis, will be subjected to critical scrutiny. In this connection the financial ratios Cash Flow Return on Investment (CFROI) and Cash Value Added (CVA), on the basis of capital costs calculated individually for each business segment, will be employed as a new gauge for measuring entrepreneurial performance, starting with the next planning period. It is our expectation that using these ratios will enable us to optimise our investment decisions."

In its 2000 Annual Report, LH only made one explicit reference to the cost of capital, stating on page 4 of the 148-page report that "Our aim is to increase the value of the company and exceed our cost of capital of 9.6 per cent. We can do it." On the other hand, the goal of shareholder value through value-based management was mentioned 27 times in report. The company was clearly proud of the implementation of VBM across the segments, and was satisfied to report an increase in the company's market value from €4bn in 1996, to €10.5bn in 2000. In something of a revolution for the airline industry (and unusual in *any* business), LH went further in 2001, publishing the details underlying its cost of capital calculation, entirely consistent with classical financial theory.

| **Value-oriented management of the business segments**<br>Basis for calculating the cost of capital | **2001** |
|---|---|
| Risk-free interest rate | 5.1 % |
| Market risk premium | 5.7 % |
| Beta factor | 1.05 |
| ➔ Cost of equity after taxes | 11.1 % |
| Cost of debt | 6.3 % |
| Equity share (market value, target capital structure) | 55.0 % |
| Debt share (target capital structure) | 45.0 % |
| ➔ WACC after taxes | 8.9 % |

Figure 7.10: Lufthansa estimate of WACC, from 2001 annual report

In the years leading up to its most recent report of 2009, the airline increased the volume of financial communication regarding VBM, and now publishes estimates of cost of capital for each of its business segments, without however revealing how the individual Divisions' WACCs are estimated.

**Cost of capital (WACC) for the Group and the business segments**

| in % | **2009** | 2008 | 2007 | 2006 | 2005 |
|---|---|---|---|---|---|
| Group | 7.9 | 7.9 | 7.9 | 7.9 | 8.6 |
| Passenger Airline Group | 7.9 | 7.9 | 7.9 | 7.9 | 8.6 |
| Logistics | 8.2 | 8.2 | 8.2 | 8.2 | 8.9 |
| MRO | 7.6 | 7.6 | 7.6 | 7.6 | 8.3 |
| IT Services | 7.6 | 7.9 | 7.6 | 7.6 | 8.3 |
| Catering | 7.9 | 7.6 | 7.9 | 7.9 | 8.6 |

Figure 7.11: Lufthansa estimate of WACC for each business unit. Source: 2009 LH Annual Report

Lufthansa continues to use a 5.7% risk premium for equity, consistent with the "forward-looking" estimates from Dimson et al. (2002). Its estimated WACC at 7.9% is consistent with the 7.73% WACC estimate from Bloomberg cited in Table 4.2. Bloomberg estimated 9% as LH's cost of equity and 3.65% for cost of debt, but used much lower 24% debt ratio based on the market capitalization at the time, whereas LH uses (correctly from a theoretical standpoint) a target debt ratio of 50%.

British Airways was the other airline whose WACC estimates were analyzed in Chapter Four of this research, where it was argued that the revealed approach showed up inevitable pitfalls in classical valuation precepts. In terms of signalling to investors the airline has been quite a bit more muted than LH, while however communicating their estimate of the company's WACC at different debt levels during "investors' days."

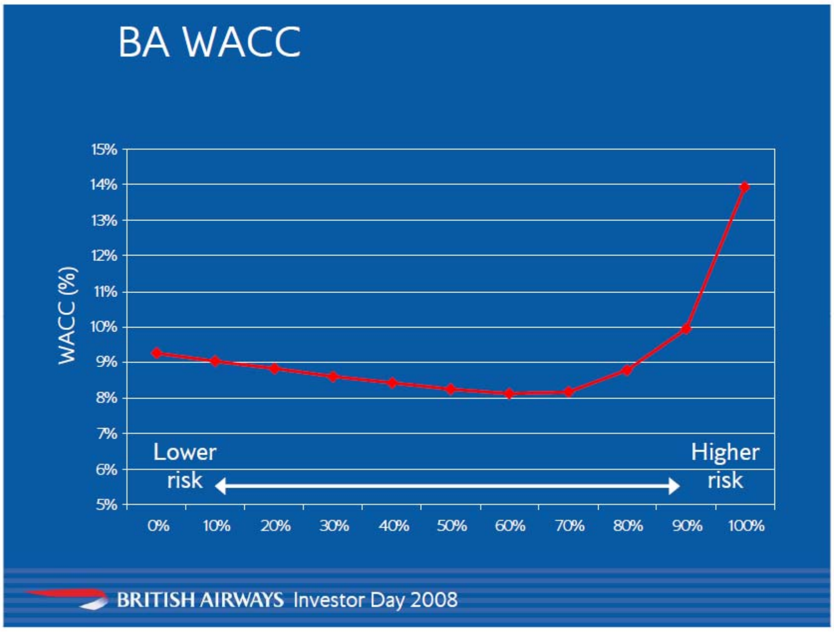



Figure 7.12: BA WACC estimates at various levels of debt Source: 2008 Investors Day presentation

The pattern follows the static "cost of distress" view discussed in Myers (1984),[27] where cost of capital will increase if the company goes beyond 70% level of debt (figure derived from BA's graph). These two companies are the most transparent in discussing their consistent application of classical valuation concepts and VBM, and form part of the group of airlines whose performance will be tested against European peers and overall airline performance in the concluding chapter of this research.

## 7.5. Conclusions

This chapter has examined alternatives and extensions to classical financial valuation theory proposed by academics and consultants today. Game theory has recently been applied to strategic decision of aircraft size vs. frequency. The theory can clearly provide insight into competitive dynamics in duopoly markets. However, the theory is unwieldy in dealing with more complex market situations, and is best-suited to two-player games. Game theory has not been shown to be practically scalable to an entire airline's network, or to markets with multiple competitors and/or potential new entrants with attendant

[27] To be fair, Myers was not the first proponent of this approach, but his exposition is the clearest and most widely cited

innovative strategies such as the low-fare airlines have demonstrated over recent years.

Monte Carlo and ROA, on the other hand, can readily be applied to fleet investment valuation. These techniques are extensions of classical valuation theory and can be used to apply well-established statistical methods to the valuation question. The results of the stylized example carried out in this chapter are strikingly different from the deterministic models found in this research to be the most commonly used in investment valuation. Expected NPVs under fuel price and market growth uncertainty are substantially lower for both aircraft, and the expected NPVs found to be lower for the larger aircraft. The common wisdom is that larger aircraft carry more risk due to market demand and a higher cost structure, but that the potential returns are greater as well. The MC analysis reveals that the risks are indeed greater for the larger aircraft. In addition, however, the addition of cyclical impacts and a wide random distribution of fuel prices over the investment horizon substantially reduce the expectation that the larger aircraft will prove the more profitable investment for shareholders.

The fundamental “pecking-order” theory of financing vehicle selection under information asymmetry between managers and shareholders was found to hold true among our airline respondents. Financing choices were further found to be conditioned rather by questions of debt availability, flexibility, and restrictions under existing covenants than of tax considerations or the choice of an “optimal” capital structure among the airline CFOs.

Information signalling to investors regarding airline implementation of classical valuation techniques and the derivative VBM has been found to be actively practiced in two of the largest airlines in the world, BA and Lufthansa. This active communication of managers’ assessments of company cost of capital and use of classical valuation techniques to the investor community shows a remarkable transparency, and a willingness to signal shareholder value as the primary driver of investment selection and company management. However (of course), such examples are few and far between in the world’s airlines, and are clearly the exception rather than the rule. The conclusions of this research will examine possible relations between practicing classical financial rigour and airline profitability over the most recent 5-year period.

# 8. Conclusions and further research

## 8.1. Research findings and conclusions

### 8.1.1. Review of research motivations

The initial motivation for this research arose from many experiences working with aviation finance and fleet planning professionals as a lecturer and advisor on the topic of investment valuation. Perhaps the clearest statement of the problem came from Mr. Nils Hallerström, President of PK AirFinance, who remarked during a seminar his surprise that in an industry where all technical features of the equipment are subjected to the most rigorous scientific analysis and field testing before certification and acquisition, the process of financial evaluation by airline customers often appeared to be cursory and superficial, singularly lacking in the rigour applied to questions of economic performance of investments.

Indeed, observations of several practices among aviation managers suggest this lack of rigour. The first is the common practice of indiscriminately discounting *all* project cash flows at WACC, whereas discounting financing cash flows calculated using the firm's borrowing rate at (a higher) WACC produces a positive NPV from financing, which is patently absurd in a service industry such as aviation.

A second common observation has been use of "magic" numbers as discount rates, the most common for some reason being 12%, with no particular interest or understanding as to why a given number was being used. While it is true that when *comparing* aircraft types it is sufficient to use a consistent discount rate, a more rigorous approach is certainly appropriate when evaluating investments. This distinction often seems lost on clients, who are bent on finding the right aircraft type, seemingly ignoring the essential question of whether the investment makes financial sense in the first place.

A third common observation with clients based in emerging market countries has been the statement that because banks often drive the requirements for business cases and financial evaluations, it is acceptable and sufficient to discount all project cash flows at the borrowing rate to calculate the project Net Present Value. This practice is often observed among airlines without majority ownership and active governance by private shareholders, which as this research has revealed is the case in many of the world's regions and airlines.

In order to establish the state of airline practice, the aim from the beginning has been to seek insight from industry practitioners, as opposed to observing or measuring results from an outside perspective. That is, the aim has been to elucidate financial analysis practice in light of theory, rather than test financial theory empirically. In this section, the findings regarding the three research aims announced in Chapter 1 are discussed in turn.

### 8.1.2. Is modern financial theory coherent, usable, and used?

This research has reviewed in some detail two distinct schools in investment valuation, labelled traditional and classical. Traditional theory (aka "value investing") is firmly rooted in the analysis of firms' reported financial statements by arms-length analysts and shareholders. As such, it has proved to be very useful for corporate valuation, while saying little about how managers should evaluate specific investments in order to maximize profits and shareholder returns. This firm-wide approach is consistent with traditional investment analysis metrics like ARR, which are similarly based on accounting rules (notably depreciation rules), and ignore the time value of money.

Classical valuation theory has its foundations in the monumental work of Modigliani and Miller and of Markowitz. While its origins lie in mathematical modelling of rational investor behaviour and share price movements in a Gaussian distribution framework, these theories have proven over time to be more normative canon than scientific fact. They are not fully borne out by empirical tests, and fully apply only to countries with broad and deep securities markets that offer investors substantial opportunities to diversify and to invest in risk-free securities (or to borrow at the risk-free rate). Aside from recommendations regarding management behaviour, these theories allowed valuation to move from financial-statement based corporate valuation, to cash-flow based project valuation.

This research has reviewed the serious methodological pitfalls in cost of capital estimation. Aside from the inevitable difficulty of using historical data to forecast future expected returns, nearly the only cost of capital parameters than can be estimated reliably relate to the cost of borrowing, whether it be the risk-free rate or the firm's own cost of debt. The appropriate share market risk premium for CAPM is a matter of substantial debate, and the beta coefficient needed for cost of equity varies widely depending on the horizon and calculation method used for its estimation.

Notwithstanding these difficulties, classical evaluation techniques are clearly in use for project valuation among the airline CFO survey respondents, of which the largest group is European airlines. NPV is the preferred technique followed by IRR, though these are not used to the exclusion of the more traditional ARR and basic PBK: indeed, these last are more commonly used in airlines than in the U.S. business community. These findings are borne out by experience in the field, where the use of accounting-based return on assets metrics is common in, for example, the People's Republic of China.

The research has shown that airlines – like other firms – routinely make subjective and/or sensitivity analysis-based upward adjustments to the discount rates in order to capture and value project risk. This is equivalent to adding an actuarial "insurance premium" to the discount rate, which would be perfectly rational, were it not for the non-actuarial, subjective basis for such adjustments. The executive interviews and review of practice in listed airlines revealed that the rate is also in some cases raised to compensate for the difficulty of estimating cost of capital with some degree of assurance.

Classical financial theory is mathematically rigorous and coherent, but fraught with substantial "heroic assumptions," making scientific validation and application difficult using real-world data. These difficulties do not prevent airline managers from using it to value projects today, with "seat-of-the-pants" adjustments for risk.

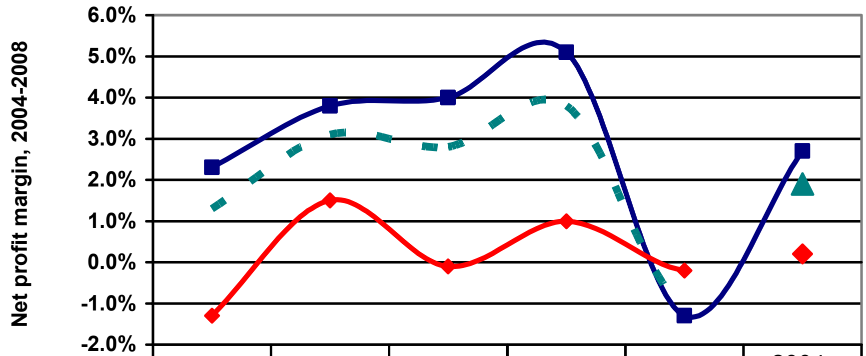
### 8.1.3. Financial performance of classical valuation practitioners

European listed carriers have led the industry in application of classical financial evaluation techniques over the past ten years, and practice a transparency regarding fleet development and investment valuation unknown in most of the world's regions. Many of these listed carriers participated in the CFO survey, the executive interviews and the expert panel performed for this research. Classical valuation theory was developed for practice among listed companies, and calculations of the valuation inputs tend to use listed share performance as a proxy for investor expectations of future returns.

This tendency to use classical valuation techniques has followed the successive airline privatizations in Europe, beginning with BA and culminating (for the moment) in the 2001 full listing of Iberia (minus 1 "golden share" initially held by the government). Newly-listed companies are forced to perform corporate valuations when privatized[28], setting the stage for the use of such valuation techniques in the post-privatization period. Have these practices enhance the firms' profitability over the recent cycle?

[28] It is interesting to note that corporate valuations are often done using earnings-based traditional methods, increasingly complemented by cash-flow based measures.

Figure 8.1 shows the net profit margins of European carriers with the largest shareholding listed on organized exchanges as reported in Table 4.9, and the profit margins of all other European carriers analyzed in Chapter 4. Net profit (as opposed to operating profit) is used because it captures financing costs, and is the earnings figure that most interests shareholders.




| | 2004 | 2005 | 2006 | 2007 | 2008 | 2004-2008 |
|---|---|---|---|---|---|---|
| European listed | 2.30% | 3.80% | 4.00% | 5.10% | -1.30% | 2.70% |
| Other European | -1.30% | 1.50% | -0.10% | 1.00% | -0.20% | 0.20% |
| Total | 1.30% | 3.10% | 2.80% | 3.80% | -1.00% | 1.90% |

Figure 8.1: net profit margins of listed and other European airlines, 2004-2008

Listed carriers reported increasing net profit margins from 2004 to 2007, reaching a maximum of 5.1% of revenue in 2007, amid the mid-decade recovery hampered by steadily increasing fuel prices, before plunging into a net loss position as fuel prices first peaked and then the North Atlantic market collapsed during the onset of the current financial crisis. Over the period as a whole, the listed carriers produced 2.7% profit margin, while Europe's non-listed airlines seesawed between very slight profitability and net losses over the period, producing only 0.2% profits over the five years.

Figure 8.2 shows the listed airlines' share of the European region's profits produced in US$ terms. While these companies produced 93% of the region's *losses* in the whipsaw year of 2008, they produced 96% of the region's profits from 2004-2008.

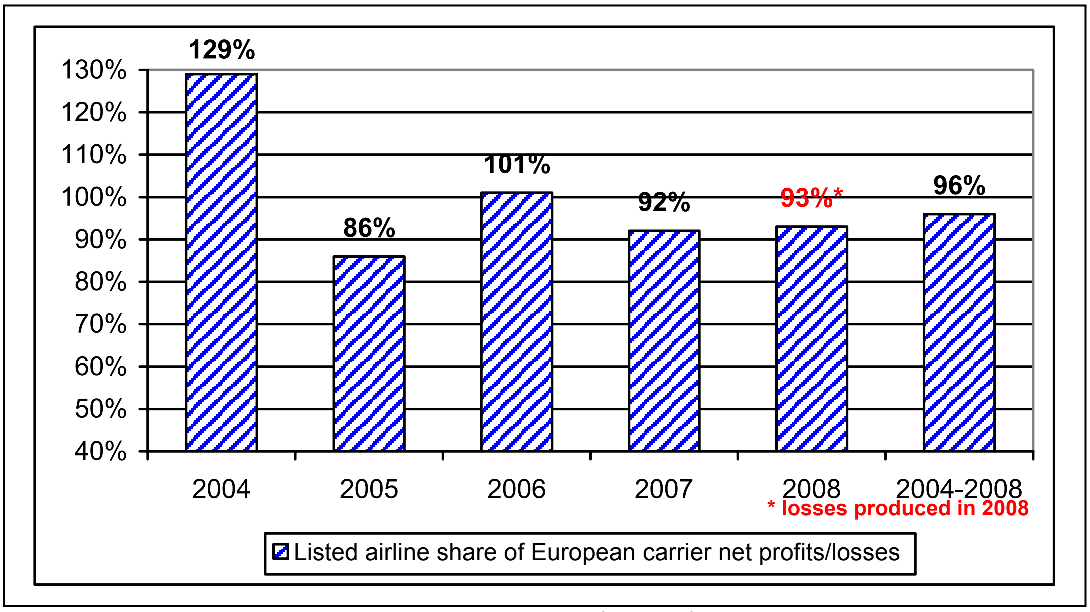


Figure 8.2: Listed European airlines share of net profits in the region, 2004-2008

The listing model has proven more successful than other ownership structures over the last cycle in Europe, but there are far too many factors in this success to attribute profitability to listing and its attendant use of classical financial evaluation methods. Aside from industry-leading strategies and relative peace in terms of labour relations, the Western European airlines operated with European-currency revenues providing a natural hedge against the weakness of the U.S. dollar over the period. This macro-economic variable contributed substantially to Western European airlines' recent profitability.

The most active airline in signalling and promoting use of classically-derived valuation techniques is Lufthansa. The airline's Lufthansa Consulting subsidiary performed a survey of the use of VBM in 2004 (Homburg et al. (2004)). Working with a sample size of 18 airlines, LH consulting found that the level of airline VBM implementation was lower than in other industries, and that even airlines practicing VBM do not transparently communicate performance to shareholders. The authors somewhat bravely asset that "continuing global deregulation [and] competition for both capital and passengers will most likely enhance the distribution and depth of VBM concepts" in the airline industry.

Lufthansa itself has increased its VBM signals to investors by reporting Cash Value Added (CVA) – its preferred metric[29] - for each of the segments and for

[29] The choice of CVA over P&L-based Economic Value Added (EVA) shows the classical bent of Lufthansa.

the company as a whole, over the 10 years since implementing VBM and reporting WACC in 2000.

**Value creation (CVA) of the Lufthansa Group and the individual business segments**

| in €m | 2009 | 2008 | 2007 | 2006 | 2005 |
|---|---|---|---|---|---|
| Group | −858 | 654 | 1 546 | 552 | 386 |
| Passenger Airline Group | −691 | 346 | 768 | 317 | −53 |
| Logistics | −264 | 71 | 59 | 37 | 39 |
| MRO | 164 | 188 | 205 | 85 | 121 |
| IT Services | 3 | 29 | −16 | 32 | 36 |
| Catering | −68 | −17 | 21 | −50 | −71 |

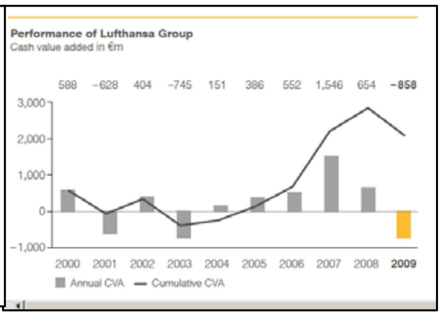



Figure 8.3: Cash Value Added for Lufthansa Group companies, 2000-2009 (Group) and 2005-2009 business units Source: 2009 LH Annual Report

This information reveals the dominance of the passenger airline and the deep trough of the cargo ("Logistics") business in 2009, but also points up the far smoother performance of Lufthansa's industry-leading global MRO business, which produced positive CVA in both 2008 and 2009.

Lufthansa's VBM communication has built in intensity from its beginnings in 2000 to today, and is clearly intended to send a clear message to the company's shareholders about the firm's rigour in managing in the interest of the shareholders. The company's reported share market value history (left scale) is compared with CVA (right scale).

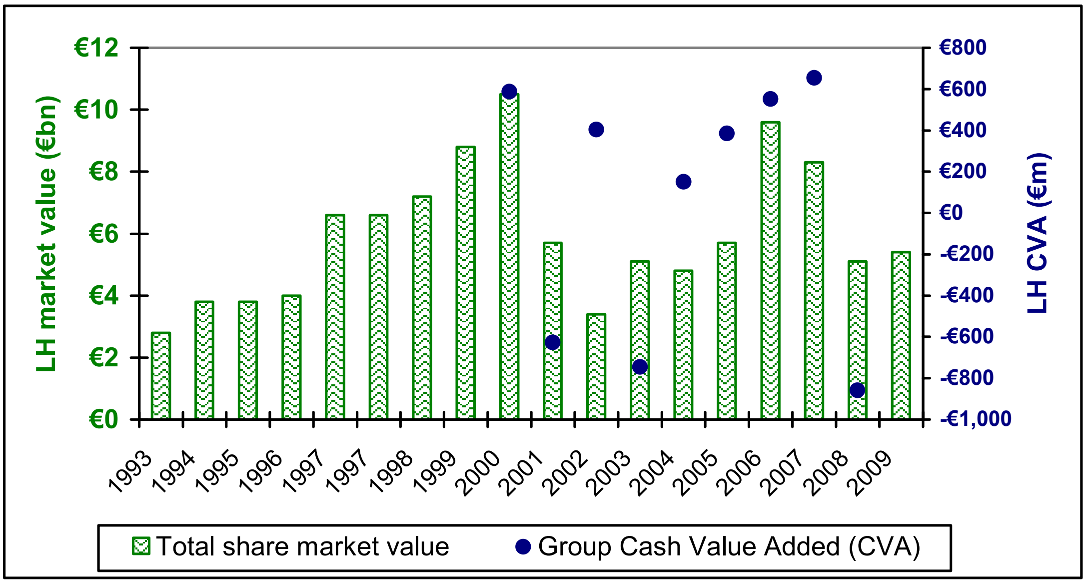



Figure 8.4: Lufthansa share market value and CVA

In the post-9/11 period to 2003, the company's CVA gyrated wildly, while the share held somewhat steadier. The 2004-2006 period saw growing share value and CVA growing in tandem, while the share market anticipated the current miasma as early as 2007, beginning to discount the share's value at the peak of the cycle. One can see a certain relationship in this anecdotal data, but this does not show that CVA is a superior metric than the traditional EPS. Value movements of the company's share over the nine years since introduction of classically-inspired VBM seem to have more to do with cyclical swings than with its VBM performance.

The LH example does demonstrate the company's management focus on cash flow and cost of capital. All of the European airline and financial executives that participated in the field research for this thesis were completely convinced of the usefulness of classical valuation techniques, and clearly privatization and listing has been beneficial to airline financial performance. The contribution of the financial valuation techniques is only one piece in the gigantic puzzle of airline management and performance.

### 8.1.4. Do global equity ownership patterns foster rigorous financial analysis?

This research has revealed strikingly different dominant governance patterns among the world's regions. Table 8.1 compared production with profits over the five-year period, 2004-2008, and reveals a very mixed picture.

| Largest shareholder RPK distribution, 2004-2008 | Africa | Asia-Pacific | Europe | Middle East | North America | South America | Totals |
|---|---|---|---|---|---|---|---|
| **Listed** | 20% | 30% | **65%** | 0% | **87%** | 18% | **57%** |
| **Government** | **80%** | **48%** | 15% | **94%** | 0% | 0% | 24% |
| **Other airline** | 0% | 2% | 1% | 0% | 4% | 0% | 2% |
| **Closely held** | 0% | 20% | 17% | 0% | 9% | **82%** | 15% |
| **Institutionals** | 0% | 0% | 1% | 6% | 1% | 0% | 1% |
| **Management** | 0% | 0% | 1% | 0% | 0% | 0% | 0% |
| Totals | 100% | 100% | 100% | 100% | 100% | 100% | 100% |

| Largest shareholder Net Profit distribution, 2004-2008 | Africa | Asia-Pacific | Europe | Middle East | North America** | South America | Totals |
|---|---|---|---|---|---|---|---|
| **Listed** | 32% | **69%** | **96%** | 0% | **101%** | **-7%** | n.a. |
| **Government** | **68%** | **-9%** | -10% | **99%** | 0% | 0% | n.a. |
| **Other airline** | 0% | 1% | **0%** | 0% | 2% | 0% | n.a. |
| **Closely held** | 0% | **38%** | **12%** | 0% | -3% | **107%** | n.a. |
| **Institutionals** | 0% | 0% | 2% | **1%** | 0% | 0% | n.a. |
| **Management** | 0% | 0% | 0% | 0% | 0% | 0% | n.a. |
| Totals | 100% | 100% | 100% | 100% | 100% | 100% | n.a. |

**** Listed carriers in N.A lost 101% of the total US$56.5b losses over the 5 year period, greater than ROW profits**

Table 8.1: Shares of RPK and net profits by region and ownership, 2004-2008

While European listed carriers show profits far outstripping their share of production, North American listed carriers produced a spectacular 101% of the losses over the period, led by United Airlines' three years under bankruptcy protection and emergence in early 2006. Even allowing that some of the losses were one-off items, this region, the most commonly surveyed and the most steadfastly classical in valuation, has clearly not benefitted from using the techniques in recent history. Asian production is nearly half produced by government-controlled carriers, while the profits were over 2/3 generated by listed carriers. The region's closely-held airlines are also profitable out of proportion to production, while the state-owned carriers dragged the entire region's performance down. Privatization and listing seem to be healthy antidotes to poor profit performance, just as has been found to be the case in Europe since the 1980s. The Middle East and very small African sample show production and profits strongly dominated by government-owned carriers over the five years. The government-owned airlines responding to the CFO survey were far and away the most likely to adjust discount rates subjectively: of the 12 CFOs responding that they adjust the rate subjectively, 10 were government-owned. Notwithstanding, the growth and profit performance of Emirates in particular shows that government ownership does not preclude profitability. Finally, Closely-held equity has proven to be the preferred ownership structure in Latin America, producing 82% of RPKs and all of the region's profits. Not a single Latin American carrier CFO responded to the survey in this research, reflecting the secretive financial culture of the region, often associated with family ownership. There is clearly not a single governance pattern that leads all of the world's regions in profitability, which gives rise to questions regarding the universality of classical valuation methods.

#### 8.1.5. Does advanced theory offer solutions to valuing project uncertainties?

A quote from Trahan and Gitman (1995) sums up practitioner issues with advanced theory in the business community (recalling their finding that *understanding* of the techniques was not a barrier to their use): "the most important barrier [to adoption] is that the underlying assumptions are unrealistic; second most important is the difficulty of explaining the technique to top management; and third most important is a tie between difficulty of application and that the required inputs cannot be obtained."

Game Theory and environmental-cost fleet modelling have been revealed as useful in strategic and policy-making settings, while practical implementation at the company level is doubtful given the complexity of fleet and networks.

An application of the Adjusted Present Value extension to classical theory to the omnipresent question of lease vs. purchase has been developed and explained. Neo-classical and risk-quantification practitioners clearly continue to separate the investment and financing decisions at the planning level, while the aircraft as commodity paradigm fully integrated financing cost as an input to be managed on a unit per ASK basis, flouting classical prescriptions and methods. In this sense, this third paradigm goes 'beyond' classical financial theory, implicitly (and sometimes explicitly) integrating options valuation logic into the entire fleet acquisition and disposal process.

The intuitive adoption of real options valuation logic in aircraft acquisition and negotiation has been found to be rare but far from absent in the field. Models for real options valuation have been proposed by aviation practitioners over recent years, while the concrete adoption of these quantitative methods has been found to be elusive among fleet planners and financiers. The speculation in McDonald (1998) and Alesii (2003) that heuristic measures such as PBK may in fact approximate the conclusions of valuations using more sophisticated techniques such as ROA is consistent with the non-quantitative use of options logic found in the aviation field during this research.

## 8.2. Contributions to the field

This research has attempted to help airline managers place financial analysis in the strategic realm of the fleet planning process, by clarifying the body of theory available, and suggesting methods to move finance from the tactical search for funds, to a strategic view of fleet investment and financing. This thesis' emphasis on identifying the state of practice in valuation was in some ways intended to provide a valuation "manual" for the use of classical techniques, carefully reviewing the relevant financial theory, exploring its pitfalls, and establishing the state of practice among the world's large airlines.

The research has shown that cash-based measures such as Internal Rate of Return (IRR) and Net Present Value (NPV) are preferred techniques among respondents, and particularly among European airline CFOs. Each technique has been examined for methodological flaws, a comprehensive search for best practice in the literature performed, and recommended valuation methods applied to the specifics of the airline industry with a model build by the author. Each of these techniques has advantages and disadvantages for practitioners, as summarized in Table 8.2.

| Method | Calculation | Pros | Cons |
|---|---|---|---|
| NPV | Discount operating and investing cash flows at company cost of capital | ▪ Result is a monetary amount, so can be used to compare different sizes of projects<br>▪ Well-documented and recommended by financial scholars | ▪ Must estimate the company's cost of capital, the discount rate |
| APV | Similar to NPV, but discount low-risk financing flows at lower rate, higher risk flows at equity rate | ▪ Allows useful comparison of the valuation impacts of leasing vs. purchasing and borrowing | ▪ Detailed cost of equity and debt estimation necessary<br>▪ Usually gives lower valuations in absolute terms, because investing and operating cash flows discounted at relatively high cost of equity |
| IRR | Discount rate where NPV=0 | ▪ Result is a percentage return, simple to explain and compare to any investment return<br>▪ No need to estimate cost of capital ex ante | ▪ Can give two results if cash-flows change direction twice<br>▪ Doesn't account for project size |
| PBK | Date on which cash inflows first equal cash outflows | ▪ The simplest method of all, very intuitive<br>▪ Complementary to the other methods: shows breakeven as a function of time, seen as a measure of risk | ▪ Does not show investor returns for the project: cost of capital assumed to be zero |

Table 8.2: Summary of classical techniques used to value investments, pros, and cons

In addition to the inherent pros and cons of the techniques, each has a more ready applicability in practice, depending on the airline's capital structure and sources of equity finance. NPV is most easily adapted to companies with listed shares, even if the cost of equity estimation methods discussed in this research are fraught with methodological pitfalls. In a closely held company with diverse shareholder blocks, a form present in all regions and dominant in Latin America, a consensus view of cost of equity may be difficult to achieve, with individual shareholders unwilling to disclose their particular expected returns. Even greater difficulties are present when government shareholders are mixed with non-governmental shareholders holding large blocks, and/or with listed shares (the hallmark of the Chinese "big three" majors). Governments may not have requirements for investment returns, unlike private investors. One could imagine a sort of "weighted average cost of equity" for these firms, but again, private shareholders may not be willing to share such information with airline management, creating a major asymmetry of information which precludes the use of NPV.

This research recommends the use of Adjusted Present Value (APV) in order to compare leasing and purchasing, a change which would allow managers to move financing questions to the strategic level. Historically, the leasing decision was largely a question of necessity and tactics. This is no longer the case at a time when major – and relatively wealthy - carriers have significant percentages of capacity on operating lease as a strategic risk mitigation tool. When looking at specific financing transactions, managers routinely discount leasing term sheets at the cost of debt, in order to determine the best deal in a manner very similar to APV: this research has demonstrated how classical valuation accommodates the shift to a strategic view of leasing, with very few additional assumptions. This use is of course limited to companies who separately estimate cost of equity and cost of debt, which are used separately as discount rates for more and less risky cash flows. One additional "inconvenience" is that the overall valuation is substantially lower than that under NPV. This, added to the "complexity" of the calculation and customized discounting of different cash flows, is presumably off-putting for top-level management discussion: hopefully this research has made it less so.

Internal Rate of Return (IRR) avoids cost of capital estimation difficulties, and has the additional advantage of producing a percentage return which is comparable to any other type of investment, including simple interest-bearing bank account. This is a major advantage that should not be underestimated, particularly given the variety of airlines ownership patterns identified in this research. On the other hand, IRR as a applied to fleet planning projects has a major – even insurmountable – methodological problem: when solving for IRR by iteration, the calculation gives two distinct and inconsistent results when the cash flows change direction twice (-/+/- or +/-/+). Given delivery streams of aircraft over many years, the total cash flow can often change directions twice or frequently more, as intermittent deliveries of aircraft occur. In this case, management has no option but to use NPV: a solution to this is discount rate sensitivity analysis discussed in Chapter 6, where NPVs are calculated with varying discount rates to determine the impact of discount rate estimates on project profitability. In any case, management must form a view of its cost of capital – however approximate and subjective - in order to apply either of the techniques usefully.

Finally, the oldest and most familiar cash-based measure is Payback (PBK), found in this research to be preferred nearly on a par with NPV and IRR. The output of the payback is different from the other measures, being a time required to recover one's investment. In this sense it is highly complementary to the others, and provides useful perspective on the risk of a project, given the increasing uncertainties of economic situation as the time horizon lengthens. This research recommends both simple and discounted payback (time required for NPV to reach zero) as providing complementary information, particularly since the field research has shown that managers clearly prefer to use a range of metrics to evaluation investments.

An ownership typology of world airlines has been detailed for 249 of the world's large airlines, and airline production and financial performance aggregated by ICAO region. The relationship between ownership, production and profitability has been identified for each region, and ownership patterns have been associated with the specific and emerging business models found in the various region. The analysis has shown that dominant shareholding patterns vary considerably from one region to the next. Somewhat stylized estimates of the relationship between airline equity ownership and the application of classical theory in each region have been measured and discussed, an objective hampered by the confidentiality of financial policy in many of the world's aviation regions and an accompanying paucity of responses from airline CFOs. A key finding is that profitability does not follow a particular ownership structure, debunking a commonly-held belief in financial circles that private companies are always the most profitable. This is most strikingly illustrated by comparing results in Europe, where most profits come from listed companies, with the U.S., where listed companies lost more money than the rest of the world's combined profits over the 2004 – 2008 cycle.

A second key finding has been the existence of strongly dominant ownership patterns in the world's regions both in terms of production and profits. The dominance of family-owned airlines in Latin America, and Government owned airlines in the Middle East, for example, impact both the competitive landscape for their own and neighbouring regions, and must influence the investment analysis methods adopted.

The airline ownership analysis has led to recommendations for the application of primary valuation metrics, depending on the current and projected shareholding structure of the airline. Although a primary technique is recommended, in most cases either NPV or IRR can be used to advantage.

| Equity ownership | Primary technique | Reasoning and recommendations |
|---|---|---|
| **Closely held** | IRR | • Estimated project returns to be discussed validated with shareholders<br>• NPV sensitivity analysis to be used if fleet introductions change cash flow direction |
| **Other airline held** | IRR<br><br>NPV | • Budgetary approach using IRR with returns defined by the parent company<br><br>• NPV in the case of mixed shareholding or expected IPO, using cost of capital set by the parent |
| **Government** | NPV | • Lack of return requirement distorts airline competition<br>• Should adopt NPV as a means to attract private shareholders (eg., the Chinese big three airlines)<br>• Cost of capital benchmarking with peer airlines |
| **Institutionals** | NPV | • Cost of capital can be the institutions' own WACC if listed: otherwise, IRR as with closely held firms |
| **Listed** | NPV | • Classical technique developed for this ownership structure, 'perfect fit' methodologically. |

Table 8.3: Airline ownership and recommended primary valuation metric

The confidentiality that characterizes closely held firms to a great extent limits the available valuation metrics. Closely-held airlines such as IndiGo , Jet and Skymark in Asia, TACA and LAN in Latin America, and Virgin Atlantic in Europe, are controlled by very active individual/family shareholders. With the exception of the listed LAN, they do not generally practice financial transparency, and certainly do not disclose cost of capital. This and the absence of listed shares makes objective cost of capital-setting difficult, leading to the recommendation of this research to use IRR as the proper metric. Project returns expressed as a percentage can easily be discussed and sensitivity analysis performed with a variety of discount rates to determine project viability.

Similarly, airline subsidiaries such as Régional, JetStar, Silkair or American Eagle do not benefit from market-based cost of capital estimates, and further, often have revenue arrangements with parent companies which both secure the business and constrain revenue upside in the event of booming demand from passengers. The best approach for such airlines is a "budgetary" one, using IRR with target returns set by the corporate parent. NPV can be used in a similar way with a target cost of capital established by the parent airline, and becomes particularly interesting for airlines looking forward to IPOs, or ones with mixed shareholding (such as, for example, ClickAir and Vueling in Europe). As a monetary metric rather than a return percentage, NPV can be particularly useful in establishing target amounts for share offerings, giving financiers a clear amount of expected value creation to be divided into shares and sold on the market. One very specific case of private shareholder control is ownership by a tourism group, including such companies as Thomas Cook, XL Airways and Air Europa in Europe, as well as Hainan Airlines and Spring Airlines in China. Because much of the revenue to the airline is part of package tour package price, valuations based on revenue and costs are subject to arbitrary revenue allocations within the corporate parent, and hence, carry the same recommendations as the other-airline owned group.

The research has demonstrated that majority government ownership is not inconsistent with producing profits, and indeed, this ownership model dominates both production and profits in the Middle East region. Government-owned airlines around the world have widely divergent objectives, even if very few these days live a life where profit is not at least one of the airline's objectives. Even the Chinese "big three" airlines (Air China, China Eastern, and China Southern), which benefit from strong government support unconstrained by binding limits on equity subsidies such as those in the EU, have listed shares and are thus accountable for financial results. Many are 100% government owned, such as Emirates, Etihad, Air Madagascar and EgyptAir, and still have clear profit objectives, albeit within the overall economic development objectives of their home governments. These will benefit from a quasi-closely-held approach using NPV with benchmark cost of capital, allowing the government to best understand cost of capital requirements practiced in the industry. Governments seeking to privatize airlines such as Air India (perennially), Garuda (recent IPO), Aerolineas Argentinas and Biman, (periodically), will also benefit from establishing benchmark cost of capital and adopting NPV to demonstrate the viability of investment projects to current and prospective shareholders.

Institutional investors are relatively rare in the airline business, no surprise given the complexity of the business, its cyclicality and low returns: airlines such as Astraeus and Air Nostrum are the exception rather than the rule. Institutionals are driven by returns, and should have no trouble agreeing acceptable rates of return, allowing the use of either IRR or NPV.

The classical techniques were developed for the use of listed companies, which dominate airline production in North America and Europe. For many of these carriers, valuation with classical methods is a given: it is more a question of the way the techniques are applied and their position in the fleet planning process. This research has identified specific patterns of use and extensions of classical theory, grouped in this research as “paradigms.”

Three distinct aircraft investment analysis paradigms have been delineated through field research, and described in detail. The three paradigms reveal new ways of looking at investment among today’s airlines, and the resultant investment management practices, each with its strengths and weaknesses, have been discussed. The aircraft-as-commodity paradigm has been shown to go beyond classical valuation theory, with the goal of maximizing *airline* cash and market value, as opposed to the investment *project* value maximization of classical finance.

This research recommends use of each paradigm depending on the company’s state of maturity and its current, and perspective, ownership structure. Classical theory was developed for large, listed companies such as the European and U.S. majors. These companies are by definition mature and have access to capital markets with a wealth of financial products – shares, bonds, commercial paper – with which to finance the company’s growth. Mature listed airlines will thus benefit most from the neo-classical paradigm. The research recommends that unlisted major carriers should also (and often do) use this paradigm to evaluate projects. The non-listed (private or government-owned) airline has a wealth of market return benchmark information (discussed in detail in Chapter 4) available to assist with cost of capital estimation. The rigour of the neo-classical paradigm has several advantages for the owners of companies whose largest share block is not listed, airlines such as TACA, TAM, LAN and the Chinese big three. The paradigm forces management to carefully quantify the economics of investing in the airline business in a well-documented framework, and helps to establish performance metrics that can be used to evaluate on-going success within the airline. Thirdly, the use of neo-classical valuation helps the managers companies seeking private financing – such as EgyptAir and Air India, or most recently Garuda – to understand and adopt the financial metrics that financial markets use to make investment decisions.

The weakness of the neo-classical paradigm as practiced in European majors such as British Airways and Lufthansa is the lack of an objective method for adjusting valuations for risk. Subjective estimates and sensitivity analysis are hit-or-miss methods, whose efficacy depends on the experience and rigours of the practitioners. Compounding this problem are potential information asymmetries between fleet planners and financial analysts. As in any large company, departmental segmentation and rivalry (a phenomenon known as “silo” thinking and behaviour), can lead to excessive escalation of the required rate of return by financial managers seeking to compensate for the "unknown-unknown" risks of a project (i.e., to compensate for their lack of clear understanding of the fleet planning models).

This research recommends two measures to deal with this organizational dilemma. The first is the creation of multi-disciplinary groups to do the fleet financial evaluation, improving the understanding on both sides of the network and fleet methodology, with accompanying assumptions, risks and sensitivity analysis. This measure will improve the quality of the sensitivity analysis performed at the fleet level, which then feeds into the financial evaluation.

The second measure is the judicious application of Monte Carlo analysis to capture risk. This well-known method – central to the risk-quantification paradigm - should be applied at a relatively high level, i.e., after the detailed network and fleet build-up is performed. Fleet modelling is complex enough, and the risk that Monte Carlo at this stage will reduce the clarity of the analytical results sought from a fleet build-up. The financial model takes the outputs of the fleet study and uses them as inputs in order to project the cash flows generated: all practitioners interviewed use such a separate financial model. Due to the nature of the method, based on iterating the projections under uncertainty, applying Monte Carlo analysis to the relatively simple and transparent financial model can reveal the magnitude of the project sensitivities to assumptions in a more systematic and clearly quantified way than sensitivity analysis. It is thus best seen as a replacement for the unfortunate tendency to inflate discount rates used in analysis, and is best placed in the financial model to counter this tendency.

The risk quantification paradigm is best suited to companies having little knowledge of the potential market economics, either because of lack of experience or because of very rapid growth prospects (or both). This situation characterizes start-up LCCs including Air Asia X, the Gulf carriers and notably Emirates, and certain Indian carriers such as IndiGo, which are opening new markets with little a priori knowledge of the markets' potential. The emphasis in this paradigm on quantifying uncertainty has the distinct advantage of minimizing the need to undertake an exhaustive cost of capital estimate: the goal is not estimating returns, but grasping the variability of returns.

The aircraft as commodity paradigm is of greatest use for airlines approaching IPO/merger, or on the other hand in a situation of strategic endgame, head-to-head competition with new carriers with perceived and/or real structural advantages and momentum, such as the non-union low-cost airlines in Europe or the Gulf carriers, with their ideal geographical position for long-haul operations and low home landing fees. The paradigm places the highest value on cash itself, in a nearly “virtual airline” approach where – at the extreme – the company would hold no fixed assets at all, having sold all of its aircraft into the financial markets. Cash generated and held is a primary focus in any merger discussions or the preparation of an IPO, as potential investors comb the balance sheet for potential hidden or explicit value, with cash at the top of the second category. This paradigm would – again at the extreme – be the best solution for any airline that saw its own liquidation to shareholders as the logical final step in its evolution.

These recommendations suggest a life-cycle approach to the paradigms, with risk-quantification predominant in the early phases, shifting to neo-classical as listing is envisaged and achieved after which the company matures, and then to aircraft as commodity paradigm as the company begins to perceive an endgame, which could in a happy scenario end in the company’s merger with another airline. Given the current and on-going wave of consolidation in North and South America and Europe, this paradigm deserves careful study and consideration by airline managers in these regions.

The research investigated the uncertainties facing today’s fleet planners through an expert panel, establishing an up-to-date risk map for practitioners, with separate assessments of likelihood and impact of the uncertainties. In addition to identifying the overall assessments of uncertainty among the panel, differences between planners working in individual airlines and advisors working with a variety of different clients has been analysed.

Several key uncertainties identified in the panel have been used to model an aircraft family conversion option, using a Monte Carlo analysis and Real Options framework. The model developed has been applied to capture investment-financing interactions, as well as providing a concrete and hopefully clear description of the steps in application of ROA. This research has argued that the process proposed for using this succession of techniques builds upon the classical foundation and carries distinct benefits at each step, enriching the NPV-based valuation at its base. This thesis holds that the process is potentially more useful in managing investment uncertainties than the ultimate valuation of the conversion option itself. The recommended analytical process can aid practitioners in developing the “mental model” of the project dynamics cited by neo-classical practitioners.

The thesis research and has revealed many concrete issues faced by today’s airline practitioners. Critical questions such as whether the cost of debt should be adjusted based on financing conditions for specific aircraft, and whether such evaluation techniques are useful in such cyclical industries were posed. To the first question the answer is no, because the airline is evaluating alternative projects, not financing alternatives. The exception would be if the alternative project would have a material impact on the company's corporate risk (not impossible, but unlikely). To the second, the author has been surprised throughout the field research at the lack of cyclical assumptions built into market, network and fleet forecasts: nothing is preventing managers from modelling the demand and economic cycle, and indeed, such modelling is fundamental to the operating leasing business which supplies a huge amount of capital to airlines each year. Explicit modelling of the cycle for air transport demand is recommended.

The experience of this research shows that financial theory by itself holds no answers to critical questions such as these. The tools and methods proposed are indeed loaded with methodological gaps and require highly sensitive assumptions. Long-range fleet forecasts are filled with uncertainties, some known, many more unknown. The main benefit of applying financial theory rigorously to investment analysis is the management process of building a consensus within the company of the stakes, and the potential rewards and risks, of investment projects, to be presented and discussed with shareholder representatives at Board level. This research and its recommendations have been intended to facilitate such processes.

## 8.3. Opportunities for further research

### 8.3.1. Airline governance and agency problems

The most recent strain of research on agency and information asymmetries in finance removes the assumption that managers are acting in the interest of shareholders, developing a theory of contract design for financial managers. A definitive text on this area of corporate finance is Tirole (2006), based on the author's teachings at the Toulouse School of Economics and MIT.

The present research has been performed to capture the global scope of airline ownership and its immediate implications, rather than delving into one specific ownership typology, i.e., widely-held corporations. Implicitly, we have assumed that the firm's managers are acting in the owners' interest in applying financial theory (or not), as is the case in classical finance.

However, given the geo-political and strategic importance of the airline industry, one cannot assume that the profit motive is the primary objective of government shareholders. Neither can one assume that individual airline profitability as a stand-alone entity is the objective of private shareholders, most notably in the case of captive airline subsidiaries and airlines owned by travel groups, who may be seeking strategic benefits to the group, rather than the airline specifically.

Additional research into implications of the regional ownership patterns identified for contract design and management incentives would be useful. The first step in any such research would be to investigate the shareholder objectives that underlie each regional/ownership type developed in Chapter Four, and pictured in Table 4.2.

### 8.3.2. Potential applications of behavioural finance

The present research has been similarly "classical" in that it implicitly assumes the rationality of investors: that is, they prefer more terminal wealth to less, weigh losses and gains in equal measures, and can assign a priori probabilities to potential outcomes. A recent strain of financial economics relaxes or eliminates these assumptions, developing a theory of investor behaviour based on heuristics, which may in turn be based on fallacious notions of the nature of statistics, "irrational" mental mathematics valuing losses more heavily than equally probable gains, biases toward available and recent information, and the fallible memories of managers, as well as agency problems.

This strain of research has not been included in the present research, primarily because the theory primarily examines individual behaviour and investment decisions, rather than the complex organizational decision-making that characterizes investment appraisal. Secondly, the constructs are highly theoretical and based on controlled experimental design, while this research has been "biased" toward identification of practice in organizations.

However, the executive interviews performed for this research do indeed reveal certain of the mental constructs proposed and discussed by leading behavioural finance theoreticians such as Daniel Kahneman, Amos Tversky, and Hersh Shefrin. Subsequent research building on these findings should entail experimental design that can test the hypotheses of prospect theory in an organizational context.

### 8.3.3. Database refinement and updates

To support the continued development of understanding in the area of airline governance and investment valuation, a time-series database has been developed and used to analyse performance by region and governance type. This database is now indexed by ICAO code, and can be developed in two directions, the first being following the evolution of airline ownership and governance. Today's airline industry is characterized by extensive consolidation among major airlines, continuing state dominance combined with partial privatizations in several regions, and a multiplicity of privately-owned start-up carriers in all parts of the world. The database will track the evolutions in ownership of airlines in the world's regions. Secondly, the database will be enriched by updating data provided by airlines in succeeding years. The combined tracking of governance evolution and succeeding years' production and financial performance should yield additional insights into the relationship between airline ownership and economic performance.

Finally, this research should permit continuing improvement in application of valuation theory in the aeronautics field, particularly in certain growing markets where financial expertise remains to be fully developed.

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# Appendix A – Airline CFO Survey questionnaire & results

### Survey of investment analysis in the global airline business

Please complete the questionnaire below and fax to +33 562 121 120 before 31 October 2004.
All responses are anonymous and confidential. Survey results will be presented in aggregate only.

## I. Analyzing and appraising major investment projects (Capital Budgeting)

*Questions 1 - 4: how does your company analyze major investment projects?*

**1. How frequently does does your company use the following capital budgeting techniques?**

| Always | Sometimes | Never | | Always | Sometimes | Never | |
|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | Payback period of the investment | ☐ | ☐ | ☐ | Adjusted Present Value (APV) |
| ☐ | ☐ | ☐ | Accounting Rate of Return (Return on Investment) | ☐ | ☐ | ☐ | Real Options Analysis (ROA) |
| ☐ | ☐ | ☐ | Internal Rate of Return (IRR) | ☐ | ☐ | ☐ | Economic Value Added (EVA) |
| ☐ | ☐ | ☐ | Net Present Value (NPV) | ☐ | ☐ | ☐ | Other technique________________ |

**2. For which investments does your company prepare a capital budget?**

☐ All investments
☐ Investments that are risky enough to justify it
☐ For investments over (USD) ___________________
☐ We do not use capital budgeting techniques

**3. How frequently does your company compare actual results of investment projects with the original forecast?**

☐ More than once a year during the project
☐ Every year during the project
☐ Between two and ten years after starting the project
☐ At the end of the project life
☐ Other period__________ years
☐ We do not perform such comparisons

**4. Does your company use capital budgeting techniques to compare different financing alternatives?**

| Always | Sometimes | Never | | Always | Sometimes | Never | |
|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | Operating Lease vs. Purchase | ☐ | ☐ | ☐ | Internal vs. External financing |
| ☐ | ☐ | ☐ | Debt vs. Equity issuance | ☐ | ☐ | ☐ | Other alternatives_________________ |

## II. Cash-flow estimation and the discount rate

*Questions 5 - 10: How does your company estimate the various parameters and account for risk?*

**5. How does your company calculate the cash-flow used to analyse your investments?**
*Please choose the appropriate method from* *<u>each</u>* *column*

☐ Start with net income and add back depreciation (indirect method)
☐ Calculate cash flows directly (direct method)
☐ Analysis done before income tax (pre-tax)
☐ Analysis done before income tax (after-tax)

**6. What does your company use as the cost of capital (discount rate)?**

| Always | Sometimes | Never | | Always | Sometimes | Never | |
|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | Cost of debt | ☐ | ☐ | ☐ | A financing cost based on the intended financing of the investment |
| ☐ | ☐ | ☐ | Cost of equity capital | ☐ | ☐ | ☐ | A measure based on the riskiness of the project |
| ☐ | ☐ | ☐ | Weighted average cost of capital (WACC) | ☐ | ☐ | ☐ | A measure based on expected growth and dividend payouts |
| ☐ | ☐ | ☐ | A measure based on experience | ☐ | ☐ | ☐ | Other method ___________________ |

## Survey of investment analysis in the global airline business

Please complete the questionnaire below and fax to +33 562 121 120 before 31 October 2004.
All responses are anonymous and confidential. Survey results will be presented in aggregate only.

**7. Does your company use the following techniques to estimate the cost of equity capital?**

| Always | Sometimes | Never | | Always | Sometimes | Never | |
|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | Average historical returns on common stock listed on the market | ☐ | ☐ | ☐ | Government regulations or directives |
| ☐ | ☐ | ☐ | The Capital Asset Pricing Model (CAPM, the "beta" approach) | ☐ | ☐ | ☐ | Dividend discount model |
| ☐ | ☐ | ☐ | Inquire as to our investors' required returns | ☐ | ☐ | ☐ | A measure based on experience and industry norms |

**8. Does your company use different types of capital budgeting techniques for different levels of risk?**

☐ Yes

☐ No

**9. What does your company use to measure the level of risk in a project?**

| Always | Sometimes | Never | | Always | Sometimes | Never | |
|---|---|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | Use management's subjective evaluation of the level of risk | ☐ | ☐ | ☐ | Measure the probability of monetary loss (Value at Risk) |
| ☐ | ☐ | ☐ | Measure the risk of the cash flows using probability distributions | ☐ | ☐ | ☐ | Other assessment______________________ |
| ☐ | ☐ | ☐ | Measure the covariance of a project's cash flow with cash flows of other projects | ☐ | ☐ | ☐ | We do not take the level of risk into account |

**10. Which of the following does your company use to take risk into account in capital budgets?**

☐ Shorten the required payback period

☐ Raise the required rate of return

☐ Raise the discount rate used to calculate present values

☐ Other technique____________________________

## Survey of investment analysis in the global airline business

Please complete the questionnaire below and fax to +33 562 121 120 before 31 October 2004.
All responses are anonymous and confidential. Survey results will be presented in aggregate only.

## III. Corporate finance and project finance

*Questions 11 - 14: are there interactions between investment and financing decisions?*

**11. Does your company have a preference for project financing?**

*Assuming all sources were available to your company, please rank your preferences, 1 to 4 or choose, "no preference"*

- ☐ Prefer to use internally-generated funds
- ☐ Prefer to issue equity
- ☐ Prefer to minimise initial outlays, for example through operating leases
- ☐ Prefer to issue debt
- ☐ No preference

**12. Does your company have a target for the ratio of debt to equity capital?**

- ☐ No target
- ☐ Flexible target
- ☐ Strict target

**13. What factors does your company use to evaluate the appropriate amount of debt for the firm?**

| Always | Sometimes | Never | |
|---|---|---|---|
| ☐ | ☐ | ☐ | The tax-deductibility of interest payments |
| ☐ | ☐ | ☐ | Financial flexibility from using internally-generated funds |
| ☐ | ☐ | ☐ | The debt levels of other firms in our industry |
| ☐ | ☐ | ☐ | Restrictive covenants in financing contracts |
| ☐ | ☐ | ☐ | The volatility of our profits and cash flows |
| ☐ | ☐ | ☐ | Restrict debt so that profits can be fully captured by our shareholders |
| ☐ | ☐ | ☐ | Availability of debt compared to equity |

**14. Company dimensions, growth and ownership**

*Please fill in one square in each catetory that best describes your company*

**ICAO Region of your airline**

- ☐ Asia and Pacific
- ☐ Eastern and Southern Africa
- ☐ Europe and North Atlantic
- ☐ Middle East
- ☐ North America, Central America, Caribean
- ☐ South America
- ☐ Western and Central Africa

**Aircraft currently in operation**

- ☐ 10-29 aircraft
- ☐ 30-49 aircraft
- ☐ 50-74 aircraft
- ☐ Over 75 aircraft

**Number of aircraft types currently in operation**

- ☐ 1-2 aircraft types
- ☐ 3-5 aircraft types
- ☐ 6-10 aircraft types
- ☐ Over 10 aircraft types

**Approximate annual revenue in US$**

- ☐ Less than $50 million
- ☐ $51-99 million
- ☐ $100-250 million
- ☐ Over $250 million

**Historical annual revenue growth rate**

- ☐ Less than 3%
- ☐ 3 - 5% annual growth
- ☐ 6-15% annual growth
- ☐ Over 15% annual growth

**Largest shareholder in the company**

- ☐ Majority of shares trade on the stock market (bourse)
- ☐ Government or government agency
- ☐ Private investors
- ☐ Another airline

# Airline CFO Survey results

| Respondent | Region | Largest shareholder | | | | Preference (avg) | | | | | | | Frequency (count) | | | | Frequency (count) | | | | | | Preference (avg) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. only (anonymous) | | 14.Bourse | 14.Govt | 14.Private | 14.Airline | 1.PBK | 1.ARR | 1.IRR | 1.NPV | 1.APV | 1.ROA | 1.EVA | 2.All | 2.Risk | 2.Size | 2.Dont_use | 3.Under _1YR | 3.1YR | 3.2_10YR | 3.End | 3.Other | 3.Dont | 4.Lease_purchase | 4.Debt_equity | 4.Int_ext |
| 1 | Middle East | | 1 | | | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | | | | 1 | | | | | | 1 | 1 | 2 |
| 2 | Europe | | | | 1 | 2 | 0 | 2 | 2 | 1 | 0 | 0 | 1 | | | | 1 | | | | | | 2 | | |
| 3 | Middle East | | 1 | | | 2 | | 1 | 1 | | | | 1 | | | | 1 | | | | | | 1 | | |
| 4 | North America | | | | | 2 | | | | | | 2 | 1 | | | | 1 | | | | | | 1 | | 2 |
| 5 | Middle East | | 1 | | | 2 | 1 | 2 | 2 | 0 | 0 | 0 | | | 1 | | 1 | | | | | | 2 | 1 | 2 |
| 6 | Africa | | 1 | | | | | | 2 | | | | 1 | | | | | 1 | | | | | 2 | 1 | 2 |
| 7 | Africa | | 1 | | | 2 | 2 | | | | | | | 1 | | | | | | | | 1 | 1 | | |
| 8 | Europe | | | 1 | | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | | | | | 1 | | | | | 2 | 2 | 2 |
| 9 | Europe | | | | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 1 | | | | | | | | | 1 | 1 | 0 | 1 |
| 10 | Europe | | | 1 | | 2 | 0 | 0 | 2 | 2 | 1 | 0 | | | 1 | | | 1 | | | | | 2 | 0 | 2 |
| 11 | Europe | 1 | | | | 2 | 2 | 2 | 2 | 0 | 0 | 1 | 1 | | | | | | | 1 | 1 | | 1 | 0 | 1 |
| 12 | Asia Pacific | 1 | | | | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | | | | | 1 | | | | | 2 | 1 | 1 |
| 13 | Europe | | 1 | | | 2 | 2 | 2 | 2 | 0 | 0 | 1 | | | 1 | | | | | 1 | 1 | | 1 | 0 | 1 |
| 14 | Europe | | | | 1 | 1 | 1 | 1 | 1 | | | 1 | | | 1 | | | 1 | | | | | 2 | 2 | 2 |
| 15 | Europe | 1 | | | | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 1 | | | | | | | | | 1 | 1 | 1 | 1 |
| 16 | Europe | | 1 | | | 2 | 1 | | 2 | 0 | 0 | 2 | 1 | | | | | | | | | 1 | 1 | 0 | 1 |
| 17 | North America | 1 | | | | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | | | | | | | | 1 | | 1 | 2 | 2 |
| 18 | Europe | | | 1 | | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 1 | | | | 1 | | | | | 2 | | | |
| 19 | North America | | | 1 | | 1 | 1 | 1 | 1 | 0 | 0 | 0 | | | 1 | | | | | 1 | | | 1 | 0 | 0 |
| 20 | North America | 1 | | | | 2 | 1 | 2 | 2 | 0 | 1 | 1 | | | 1 | | | | | 1 | | | 2 | 2 | 2 |
| 21 | Europe | | | 1 | | 2 | | | 2 | | | | 1 | | | | 1 | | | | | | 1 | 1 | 1 |
| 22 | Europe | | | | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 1 | 1 | | | | | | | 1 | | | 1 | 0 | 2 |
| 23 | Europe | | | | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | | | 1 | | | | 1 | | | | 2 | 2 | 2 |
| 24 | Europe | | | 1 | | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | | | | 1 | | | | | | 1 | 0 | 1 |
| 25 | Europe | | | 1 | | | | 1 | 2 | | | | 1 | | | | 1 | | | | | | 2 | | 1 |
| 26 | Europe | | | 1 | | 1 | 0 | 1 | 2 | 0 | 0 | 0 | | | 1 | | | 1 | | | | | 2 | 1 | 1 |
| 27 | Europe | | | 1 | | 2 | 1 | 2 | 2 | 0 | 0 | 0 | | | 1 | | | 1 | | | | | 2 | 1 | 1 |
| 28 | Middle East | | 1 | | | 1 | 2 | 2 | 2 | 0 | 0 | 0 | 1 | | | | | 1 | | | | | 2 | 2 | 2 |
| 29 | Africa | | 1 | | | 1 | 1 | 1 | 1 | 0 | 1 | 1 | | | 1 | | | 1 | | | | | 2 | 0 | 0 |
| 30 | Asia Pacific | | | 1 | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | | 1 | | | | | | | | 1 | 1 | 0 | 1 |
| 31 | Europe | | | 1 | | 1 | 2 | 2 | | | | | | | 1 | | 1 | | | | | | 1 | 1 | |
| 32 | Africa | | 1 | | | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | | | | 1 | | | | | | 2 | | |
| 33 | Europe | | | 1 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | | | 1 | 1 | | | | | | 1 | 0 | 1 |
| 34 | North America | | | | 1 | 1 | 0 | 0 | | | | | 1 | | | | | | 1 | | | | 2 | 0 | 1 |
| 35 | Asia Pacific | | 1 | | | 2 | 2 | 1 | 2 | 1 | 0 | 1 | 1 | | | | 1 | | | | | | 2 | 1 | 2 |
| 36 | Asia Pacific | | | 1 | | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | | | | 1 | | | | | | 2 | 1 | 1 |
| 37 | Europe | | 1 | | | 1 | | | | | 1 | | | 1 | | | | 1 | | | | | 1 | | |
| | | 5 | 12 | 13 | 6 | 1.543 | 1.129 | 1.161 | 1.625 | 0.444 | 0.357 | 0.414 | 22 | 3 | 11 | 1 | 14 | 10 | 2 | 5 | 3 | 7 | 1.500 | 0.793 | 1.367 |
| | | 14% | 32% | 35% | 16% | | | | | | | | 59% | 8% | 30% | 3% | 38% | 27% | 5% | 14% | 8% | 19% | | | |

| Respondent | Region | Frequency | | | | Preference (avg) | | | | | | | | Preference (avg) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. only (anonymous) | | 5a.Indirect | 5a.Direct | 5b.Pretax | 5b.Aftertax | 6.Kd | 6.ke | 6.WACC | 6.Experience | 6.Financing | 6.Riskiness | 6.Growth_Div | 6.Other | 7.ShareReturns | 7.CAPM | 7.Investors | 7.GovtRegs | 7.DivDiscount | 7.Experience |
| 1 | Middle East | | 1 | | 1 | 1 | | 1 | | 2 | 0 | 0 | 0 | 1 | 0 | | 0 | 0 | 1 |
| 2 | Europe | | 1 | | 1 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 3 | 0 | 0 | 2 | 0 | 0 | 2 |
| 3 | Middle East | | 1 | | | 1 | | 1 | | | | | | | | | | | |
| 4 | North America | | | 1 | | 1 | | | | | | | | | | | | | |
| 5 | Middle East | | 1 | | 1 | 2 | 0 | 2 | 0 | 1 | 1 | 1 | | 0 | 0 | 0 | 0 | 0 | 2 |
| 6 | Africa | | 1 | | | | | | | | 2 | | | | 2 | | | | |
| 7 | Africa | | 1 | | | 1 | 0 | 0 | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | Europe | | 1 | | | 2 | 2 | 2 | 1 | 1 | 1 | 1 | | 1 | 2 | 0 | 1 | 1 | 1 |
| 9 | Europe | | 1 | | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 10 | Europe | 1 | | | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 11 | Europe | | 1 | | | | | 2 | | | | | | | 2 | | | | |
| 12 | Asia Pacific | 1 | | | | 2 | | | | | | | | 2 | | 1 | | | |
| 13 | Europe | | 1 | | | 1 | 0 | 2 | 0 | 0 | 0 | 0 | | | | | | | |
| 14 | Europe | 1 | | 1 | | 2 | 2 | 2 | | | | | | | 2 | | | | |
| 15 | Europe | | 1 | 1 | | | | 2 | | | | | | | 2 | | | | |
| 16 | Europe | 0 | 1 | 1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | | 0 | 1 | 0 | 0 | 0 | 0 |
| 17 | North America | | 1 | | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 |
| 18 | Europe | | 1 | | 1 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 |
| 19 | North America | | | | 1 | | | | 1 | | | | | | | | | | 1 |
| 20 | North America | 1 | 1 | 1 | | | | 2 | | 1 | | | | 2 | 2 | | | | |
| 21 | Europe | 1 | | | 1 | | | 2 | | | | | | | 1 | | | | |
| 22 | Europe | 1 | | 1 | | 2 | 0 | 1 | 0 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 |
| 23 | Europe | 1 | | | 1 | | | 2 | | | 2 | | | | | 2 | | 2 | |
| 24 | Europe | | 1 | | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 |
| 25 | Europe | | 1 | 1 | | | | | | 1 | | | | | | 2 | | | |
| 26 | Europe | | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 0 | | 1 | 2 | 1 | 0 | 0 | 1 |
| 27 | Europe | | 1 | 1 | | 1 | | 1 | 1 | | 2 | | | | | | | | 2 |
| 28 | Middle East | | 1 | | | 2 | | | | | | | | | | | | | |
| 29 | Africa | 1 | | 1 | | 1 | 0 | 1 | 0 | 1 | 0 | 0 | | 1 | 0 | 0 | 0 | 0 | 0 |
| 30 | Asia Pacific | | 1 | 1 | | 1 | 1 | 0 | 1 | 1 | 1 | 0 | | 0 | 0 | 0 | 1 | 0 | 1 |
| 31 | Europe | | 1 | | | | | 2 | | 1 | | | | | | 2 | | | |
| 32 | Africa | | 1 | 1 | | 1 | 0 | 0 | 1 | 2 | 2 | | | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | Europe | 1 | | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 34 | North America | | 1 | | 1 | 1 | | 2 | | | | | | 1 | 1 | | | | 1 |
| 35 | Asia Pacific | 1 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 0 | 1 | 0 | | | |
| 36 | Asia Pacific | 1 | | | | 0 | 0 | 2 | 0 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 |
| 37 | Europe | | 1 | | | 1 | | | 1 | | 1 | | | | | | | | 1 |
| | | 11 | 25 | 12 | 13 | 1.000 | 0.350 | 1.300 | 0.571 | 0.739 | 0.708 | 0.158 | 0.571 | 0.455 | 0.885 | 0.455 | 0.111 | 0.158 | 0.909 |
| | | 30% | 68% | 32% | 35% | | | | | | | | | | | | | | |

| Respondent | Region | Frequency | Preference (average) | | | | | | | | | Frequency (count) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. only (anonymous) | | 8.Technique _Risk | 9.Subjective | 9.ProbDist | 9.CFCovar | 9.VAR | 9.Other | 9.Dont | 9.Subjective estimate only | 9.Subjective & Govt owned | 9. Number of techniques used | 10.ShortenPBK | 10.RaiseIRR | 10.RaiseNPV | 10.Other | 10. Use PBK and Shorten PBK | 10. Use NPV and raise rate |
| 1 | Middle East | 1 | 1 | | 1 | | | | 0 | 1 | 2 | 1 | 1 | 1 | | 2 | 2 |
| 2 | Europe | 0 | | | | | | 1 | 0 | 0 | 1 | 0 | 1 | 1 | | | 2 |
| 3 | Middle East | 0 | | | 2 | | | | 0 | 0 | 1 | 1 | | | | 2 | |
| 4 | North America | 0 | 2 | | | | | | 1 | 0 | 1 | 1 | | 1 | | 2 | |
| 5 | Middle East | 1 | 2 | | | | | | 1 | 1 | 1 | 0 | | 1 | | | 2 |
| 6 | Africa | 1 | 2 | | | | | | 1 | 1 | 1 | | | 1 | | | 2 |
| 7 | Africa | 0 | 1 | | | | | 1 | 0 | 1 | 2 | | | | | | |
| 8 | Europe | 1 | 1 | 1 | 1 | 1 | | | 0 | 0 | 4 | | | 1 | | | 2 |
| 9 | Europe | 0 | 1 | | | | 1 | | 0 | 0 | 2 | | | | 1 | | |
| 10 | Europe | 0 | 1 | | | 1 | | | 0 | 0 | 2 | 1 | | 1 | | 2 | 2 |
| 11 | Europe | 0 | 2 | | | | | | 1 | 0 | 1 | 1 | 1 | | | 2 | |
| 12 | Asia Pacific | 1 | 1 | 2 | | | | | 0 | 0 | 2 | | 1 | | | | |
| 13 | Europe | 1 | 2 | 1 | | | | 2 | 0 | 1 | 3 | 1 | | | | 2 | |
| 14 | Europe | 0 | 1 | | | 1 | | | 0 | 0 | 2 | 1 | | | 1 | 1 | |
| 15 | Europe | 0 | 2 | | | | | | 1 | 0 | 1 | 1 | 1 | 1 | | 1 | 1 |
| 16 | Europe | 0 | 1 | | | | | | 1 | 1 | 1 | 1 | 1 | | | 2 | |
| 17 | North America | 1 | 2 | | | | | | 1 | 0 | 1 | 1 | | 1 | | 1 | 2 |
| 18 | Europe | 1 | 1 | | | 1 | | | 0 | 0 | 2 | | | 1 | | | 2 |
| 19 | North America | 0 | 2 | | | | | | 1 | 0 | 1 | | | | 1 | | |
| 20 | North America | 1 | 1 | 1 | | | | | 0 | 0 | 2 | 1 | 1 | 1 | | 2 | 2 |
| 21 | Europe | 0 | | | | | 1 | | 0 | 0 | 1 | | | | 2 | | |
| 22 | Europe | 1 | 1 | 1 | | 2 | | | 0 | 0 | 3 | 1 | | 1 | | 2 | 2 |
| 23 | Europe | | | 2 | | 1 | | | 0 | 0 | 2 | | 1 | 1 | | | |
| 24 | Europe | 1 | | | | | | 2 | 0 | 0 | 1 | | | | | | |
| 25 | Europe | | 1 | | | | | | 1 | 0 | 1 | 1 | | | | | |
| 26 | Europe | 1 | 1 | 1 | | | | 1 | 0 | 0 | 3 | | | 1 | | | 2 |
| 27 | Europe | 1 | 2 | 1 | | | | | 0 | 0 | 2 | | | 1 | | | 2 |
| 28 | Middle East | 1 | 2 | | | | | | 1 | 1 | 1 | | | 1 | | | 2 |
| 29 | Africa | 0 | 1 | 1 | 1 | 1 | | | 0 | 1 | 4 | 1 | 1 | 1 | | 1 | 1 |
| 30 | Asia Pacific | 0 | 1 | 1 | 1 | | | 1 | 0 | 0 | 4 | 1 | | | | 1 | |
| 31 | Europe | 1 | 2 | | | | | | 1 | 0 | 1 | 1 | 1 | | | 1 | |
| 32 | Africa | 1 | 1 | | 1 | 2 | 1 | | 0 | 1 | 4 | | | 1 | | | 1 |
| 33 | Europe | 0 | 1 | | | | 1 | | 0 | 0 | 2 | | | | 1 | | |
| 34 | North America | 0 | 2 | | | | | | 1 | 0 | 1 | | 1 | | | | |
| 35 | Asia Pacific | 1 | 1 | 2 | 1 | 1 | | | 0 | 1 | 4 | | | | | | |
| 36 | Asia Pacific | 0 | 1 | | | | | 2 | 0 | 0 | 2 | | | 1 | | | 2 |
| 37 | Europe | 1 | | 1 | | | | | 0 | 0 | 1 | | 1 | | | | |
| | | 18 | 1.387 | 1.250 | 1.143 | 1.222 | 1.000 | 1.429 | 12 | 10 | | 16 | 12 | 19 | 6 | 47% | 64% |

| Respondent | Region | Ranking of preferences | | | | | Frequency | | | Preference (avg) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. only (anonymous) | | 11.Internal | 11.Equity | 11.MinCashOut | 11.Debt | 11.None | 12.NoTarget | 12.FlexibleTarget | 12.StrictTarget | 13.Tax | 13.InternalFlex | 13.OtherFirms | 13.BankCovenants | 13.OpLev | 13.ShareVal | 13.DebtAvailability |
| 1 | Middle East | 1 | | | | | | 1 | | | 1 | | 2 | 2 | 0 | 2 |
| 2 | Europe | 3 | 4 | 1 | 2 | | | 1 | | 2 | 2 | 1 | 2 | 2 | 1 | 2 |
| 3 | Middle East | 1 | | 2 | | | 1 | | | | | | | 1 | | |
| 4 | North America | | | 1 | | | | 1 | | | 2 | | | | | |
| 5 | Middle East | 1 | 2 | 3 | 4 | | | | 1 | 0 | 2 | 0 | 2 | 2 | 0 | 1 |
| 6 | Africa | 2 | | | 1 | | | 1 | | | 2 | 2 | | 2 | | 2 |
| 7 | Africa | 1 | 4 | 2 | 3 | | | 1 | | 1 | 1 | 0 | | 1 | | 1 |
| 8 | Europe | | | | 1 | | | 1 | | 2 | 1 | 1 | 1 | 1 | 1 | 2 |
| 9 | Europe | 1 | | 2 | 3 | | | | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 1 |
| 10 | Europe | 1 | | 2 | | | 1 | | | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| 11 | Europe | 1 | 4 | 2 | 3 | | | | 1 | | | 2 | | | | 2 |
| 12 | Asia Pacific | 1 | | | | | 1 | | | | 1 | | 2 | | | |
| 13 | Europe | 1 | | | | | 1 | | | | | | | | | |
| 14 | Europe | 3 | 4 | 2 | 1 | | | 1 | | | 1 | 1 | | | | 1 |
| 15 | Europe | | | | | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 16 | Europe | 1 | 4 | 2 | 3 | | | 1 | | 1 | 2 | 0 | 1 | 1 | 0 | 1 |
| 17 | North America | 3 | 4 | 1 | 2 | | | 1 | | 1 | 2 | 0 | 0 | 0 | 0 | 2 |
| 18 | Europe | 2 | 3 | 1 | 4 | | | | 1 | 2 | 1 | 0 | 2 | 2 | 0 | 1 |
| 19 | North America | 1 | | | | | | | 1 | | | | | | 1 | |
| 20 | North America | | | **1** | **1** | | | 1 | | 2 | 1 | 1 | 2 | 2 | 0 | 2 |
| 21 | Europe | | | | 1 | | | 1 | | | | | | | | |
| 22 | Europe | | | | | 1 | | 1 | | 0 | 1 | 0 | 1 | 2 | 2 | 1 |
| 23 | Europe | | | | 1 | | | 1 | | | 2 | | | | | 2 |
| 24 | Europe | 1 | | 2 | | | 1 | | | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| 25 | Europe | | | 1 | | | 1 | | | | 1 | | | 1 | | |
| 26 | Europe | 1 | 2 | 4 | 3 | | | 1 | | 1 | 1 | 0 | 0 | 2 | 0 | 1 |
| 27 | Europe | 1 | 4 | 2 | 3 | | | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | |
| 28 | Middle East | 1 | 4 | 3 | 2 | | | | 1 | | | | | 2 | | |
| 29 | Africa | 1 | 4 | 2 | 3 | | | 1 | | 0 | 2 | 1 | 2 | 2 | 1 | 1 |
| 30 | Asia Pacific | 4 | 3 | 1 | 2 | | 1 | | | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 31 | Europe | | | | 1 | | | 1 | | | | | 2 | 2 | | |
| 32 | Africa | 1 | 4 | 3 | 2 | | 1 | | | 0 | 2 | 2 | 2 | 2 | 0 | 1 |
| 33 | Europe | 2 | 4 | 1 | 3 | | | 1 | | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 34 | North America | | | 1 | | | | 1 | | 1 | | 1 | 2 | 2 | | |
| 35 | Asia Pacific | | | 1 | | | | 1 | | 0 | 1 | 1 | | 2 | 0 | 1 |
| 36 | Asia Pacific | | | | | | | | | 1 | 1 | 0 | 2 | 0 | 0 | 0 |
| 37 | Europe | | | 1 | | | | 1 | | | | | | 1 | | 1 |
| | | **1.500** | **3.600** | **1.760** | **2.227** | **2.000** | 8.000 | 22.000 | 7.000 | 0.909 | 1.321 | 0.680 | 1.435 | 1.414 | 0.500 | 1.192 |
| | | 1 | 4 | 2 | 3 | | 22% | 59% | 19% | | | | | | | |

# Appendix B – Airline ownership, production, revenue and profits, 2004-2008

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ethiopian Airlines** | Ethiopia | Africa | 100.00% | | | | | | 0.00% | 30,553 | 2,615 | 141 | 130 |
| **Kenya Airways** | Kenya | Africa | 22.00% | 32.50% | 4.36% | | | 26.00% | 15.14% | 35,524 | 3,958 | 444 | 149 |
| **South African Airways** | South Africa | Africa | 98.20% | | | | 1.80% | | 0.00% | 120,161 | 14,626 | 133 | 183 |
| **Air Austral** | Reunion | Asia-Pacific | | | 26.30% | 37.72% | | | 35.98% | 14,929 | 1,331 | 46 | 37 |
| **Air Calédonie International** | New Caledonia | Asia-Pacific | 50.28% | | 43.31% | 4.32% | | 2.09% | 0.00% | 5,606 | 0 | 0 | 0 |
| **Air China** | China | Asia-Pacific | 55.80% | 24.20% | | | | 20.00% | 0.00% | 292,374 | 28,788 | 1,538 | 145 |
| **Air Do** | Japan | Asia-Pacific | | | 96.07% | 3.93% | | | 0.00% | 5,060 | 0 | 0 | 0 |
| **Air India** | India | Asia-Pacific | 100.00% | | | | | | 0.00% | 93,900 | 10,787 | -16 | -1,073 |
| **Air Macau** | China | Asia-Pacific | 5.00% | | 5.00% | 90.00% | | | 0.00% | 13,242 | 0 | 0 | 0 |
| **Air Madagascar** | Madagascar | Asia-Pacific | 90.60% | | | | | 3.10% | 6.30% | 4,668 | 0 | 0 | 0 |
| **Air Mauritius** | Mauritius | Asia-Pacific | 52.87% | | | 15.50% | | 31.64% | -0.01% | 25,897 | 2,786 | 76 | -73 |
| **Air New Zealand** | New Zealand | Asia-Pacific | 76.50% | 12.90% | | 4.20% | | 6.30% | 0.10% | 131,694 | 13,796 | 865 | 609 |
| **Air Pacific** | Fiji | Asia-Pacific | 50.00% | | | | | 49.97% | 0.03% | 16,925 | 0 | 0 | 0 |
| **Air Tahiti Nui** | Fr Polynesia | Asia-Pacific | 64.42% | | 8.61% | 19.92% | | 7.05% | 0.00% | 15,689 | 0 | 0 | 0 |
| **AirAsia** | Malaysia | Asia-Pacific | | 43.50% | 21.60% | 30.90% | 4.00% | | 0.00% | 37,702 | 1,241 | 340 | -2 |
| **ANA Group** | Japan | Asia-Pacific | | 80.02% | 19.98% | | | | 0.00% | 295,484 | 63,831 | 3,114 | 1,289 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Asiana Airlines** | South Korea | Asia-Pacific | | | 9.63% | 90.37% | | | 0.00% | 111,006 | 17,056 | 452 | 312 |
| **Bangkok Airways** | Thailand | Asia-Pacific | | | | 100.00% | | | 0.00% | 5,670 | 894 | 28 | -8 |
| **Biman Bangladesh Airlines** | Bangladesh | Asia-Pacific | 100.00% | | | | | | 0.00% | 22,518 | 0 | 0 | 0 |
| **Cathay Pacific** | China | Asia-Pacific | | 25.00% | 24.84% | 40.00% | | 10.16% | 0.00% | 366,340 | 40,173 | 1,912 | 1,342 |
| **Cebu Pacific Air** | Philippines | Asia-Pacific | | | | 100.00% | | | 0.00% | 16,167 | 813 | 39 | 6 |
| **China Airlines** | Taiwan | Asia-Pacific | 70.05% | | | | | | 29.95% | 159,991 | 17,731 | 73 | -936 |
| **China Eastern Airlines** | China | Asia-Pacific | 50.30% | 38.38% | | 11.32% | | | 0.00% | 225,139 | 22,299 | -2,386 | -2,584 |
| **China Eastern Airlines Wuhan** | China | Asia-Pacific | | | | | | 100.00% | 0.00% | 16,201 | 0 | 0 | 0 |
| **China Southern Airlines** | China | Asia-Pacific | 50.30% | 49.70% | | | | | 0.00% | 333,050 | 28,558 | -741 | -630 |
| **China Xinhua Airlines** | China | Asia-Pacific | | | | 40.00% | | 60.00% | 0.00% | 26,066 | 0 | 0 | 0 |
| **Continental Micronesia** | Guam | Asia-Pacific | | | | | | 100.00% | 0.00% | 22,462 | 0 | 0 | 0 |
| **Deccan** | India | Asia-Pacific | | | | | | 100.00% | 0.00% | 6,283 | 0 | 0 | 0 |
| **Dragon Air** | China | Asia-Pacific | | | | | | 100.00% | 0.00% | 0 | 0 | 0 | 0 |
| **EVA Air** | Taiwan | Asia-Pacific | | 28.00% | | 72.00% | | | 0.00% | 116,302 | 13,828 | -291 | -506 |
| **Garuda Indonesia** | Indonesia | Asia-Pacific | 100.00% | | | | | | 0.00% | 75,117 | 6,846 | -82 | -61 |
| **GoAir** | India | Asia-Pacific | | | | 100.00% | | | 0.00% | 2,795 | 0 | 0 | 0 |
| **Hainan Airlines** | China | Asia-Pacific | | | 12.72% | 78.36% | | | 8.92% | 96,762 | 7,500 | -113 | -135 |
| **IndiGo Airlines** | India | Asia-Pacific | | | | 100.00% | | | 0.00% | 8,051 | 0 | 0 | 0 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Japan Airlines Corporation** | Japan | Asia-Pacific | | 100.00% | | | | | 0.00% | 467,859 | 98,004 | 769 | -756 |
| **Japan TransOcean Air** | Japan | Asia-Pacific | 12.90% | | | 17.00% | | 70.10% | 0.00% | 7,874 | 0 | 0 | 0 |
| **Jet Airways** | India | Asia-Pacific | | 20.00% | | 80.00% | | | 0.00% | 67,163 | 9,262 | -124 | -19 |
| **JetLite** | India | Asia-Pacific | | | | | | 100.00% | 0.00% | 8,124 | 0 | 0 | 0 |
| **Jetstar** | Australia | Asia-Pacific | | | | | | 100.00% | 0.00% | 37,154 | 0 | 0 | 0 |
| **Juneyao Airlines** | China | Asia-Pacific | | | | 100.00% | | | 0.00% | 3,213 | 0 | 0 | 0 |
| **Kingfisher Airlines** | India | Asia-Pacific | | | | 100.00% | | | 0.00% | 13,962 | 1,677 | -395 | -286 |
| **Korean Air** | South Korea | Asia-Pacific | | 61.14% | 21.49% | 12.13% | 5.24% | | 0.00% | 257,511 | 40,987 | 1,880 | -759 |
| **Lion Airlines** | Indonesia | Asia-Pacific | | | | 100.00% | | | 0.00% | 14,239 | 0 | 0 | 0 |
| **Malaysia Airlines** | Malaysia | Asia-Pacific | 72.05% | | 5.69% | | 10.72% | | 11.54% | 207,412 | 18,201 | -104 | -56 |
| **Nippon Cargo Airlines** | Japan | Asia-Pacific | | | | 100.00% | | | 0.00% | 0 | 5,056 | -197 | 1 |
| **Pakistan International Airlines** | Pakistan | Asia-Pacific | 87.00% | | | 13.00% | | | 0.00% | 70,878 | 5,649 | -641 | -997 |
| **Philippine Airlines** | Philippines | Asia-Pacific | 4.26% | | | 88.87% | 2.75% | | 4.12% | 81,107 | 6,278 | 87 | 150 |
| **Qantas** | Australia | Asia-Pacific | | 100.00% | | | | | 0.00% | 462,735 | 54,389 | 5,169 | 3,022 |
| **QantasLink** | Australia | Asia-Pacific | | | | | | 100.00% | 0.00% | 11,313 | 0 | 0 | 0 |
| **Royal Brunei Airlines** | Brunei | Asia-Pacific | 100.00% | | | | | | 0.00% | 18,037 | 0 | 0 | 0 |
| **Shandong Airlines** | China | Asia-Pacific | | 77.20% | | | | 22.80% | 0.00% | 24,798 | 2,436 | 98 | -7 |
| **Shanghai Airlines** | China | Asia-Pacific | 40.66% | 44.69% | 14.65% | | | | 0.00% | 49,667 | 6,486 | 45 | -196 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Shenzhen Airlines** | China | Asia-Pacific | | | | 75.00% | | 25.00% | 0.00% | 48,283 | 3,196 | 0 | 88 |
| **Sichuan Airlines** | China | Asia-Pacific | | | | 41.00% | | 59.00% | 0.00% | 34,499 | 0 | 0 | 0 |
| **SilkAir** | Singapore | Asia-Pacific | | | | | | 100.00% | 0.00% | 12,668 | 0 | 0 | 0 |
| **Singapore Airlines Group** | Singapore | Asia-Pacific | 54.70% | | 45.30% | | | | 0.00% | 431,098 | 46,640 | 4,475 | 5,093 |
| **Skymark Airlines** | Japan | Asia-Pacific | | | | 100.00% | | | 0.00% | 13,693 | 1,206 | -16 | -39 |
| **Skynet Asia Airways** | Japan | Asia-Pacific | 3.30% | 24.20% | | 57.60% | | 14.90% | 0.00% | 2,899 | 0 | 0 | 0 |
| **spiceJet** | India | Asia-Pacific | | 44.00% | 17.72% | 35.00% | | | 3.28% | 10,507 | 0 | 0 | 0 |
| **SriLankan Airlines** | Sri Lanka | Asia-Pacific | 51.05% | | | | 5.32% | 43.63% | 0.00% | 44,979 | 3,134 | -26 | -20 |
| **Thai Airways** | Thailand | Asia-Pacific | 53.76% | | 46.24% | | | | 0.00% | 275,420 | 24,353 | 1,162 | 171 |
| **Vietnam Airlines** | Vietnam | Asia-Pacific | 100.00 % | | | | | | 0.00% | 58,404 | 5,543 | 39 | 92 |
| **Virgin Blue** | Australia | Asia-Pacific | | | | 74.74% | | 25.26% | 0.00% | 83,534 | 7,453 | 768 | 505 |
| **Xiamen Airlines** | China | Asia-Pacific | 40.00% | | | | | 60.00% | 0.00% | 45,989 | 3,237 | 126 | 49 |
| **Adria Airways** | Slovenia | Europe | 76.00% | | 8.00% | 13.00% | 3.00% | | 0.00% | 4,449 | 0 | 0 | 0 |
| **Aegean Airlines** | Greece | Europe | | 23.60% | | 76.00% | | | 0.40% | 14,236 | 2,833 | 211 | 161 |
| **Aer Lingus** | Ireland | Europe | 28.82% | 28.29% | | | 16.76 % | 25.22% | 0.91% | 68,301 | 7,391 | 368 | -32 |
| **Aeroflot Russian Airlines** | Russia | Europe | 51.17% | | | 27.00% | 19.00 % | | 2.83% | 115,727 | 14,302 | 1,334 | 1,135 |
| **AeroSvit Airlines** | Ukraine | Europe | 22.00% | | | 78.00% | | | 0.00% | 17,055 | 0 | 0 | 0 |
| **Air Astana** | Kazakhstan | Europe | 51.00% | | | | | | 49.00 % | 16,683 | 1,529 | 74 | 60 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Air Berlin** | Germany | Europe | | 44.62% | 44.00% | 11.42% | | | -0.04% | 152,631 | 13,630 | 124 | -161 |
| **Air Europa** | Spain | Europe | | | | 100.00% | | | 0.00% | 71,117 | 6,827 | 116 | 71 |
| **Air France-KLM Group** | France | Europe | 18.70% | 81.30% | | | | | 0.00% | 973,826 | 148,038 | 5,181 | 2,623 |
| **Air Malta** | Malta | Europe | 98.00% | | | 2.00% | | | 0.00% | 11,813 | 1,701 | -18 | -19 |
| **Air Nostrum (Iberia Regional)** | Spain | Europe | | | 97.50% | | | 3.00% | -0.50% | 13,309 | 3,980 | 101 | 103 |
| **Air One** | Italy | Europe | | | | 99.00% | | | 1.00% | 18,136 | 3,036 | 97 | 35 |
| **airBaltic** | Latvia | Europe | 52.80% | | | | 47.20% | | 0.00% | 5,015 | 0 | 0 | 0 |
| **Alitalia** | Italy | Europe | 49.90% | | 12.41% | 35.69% | | 2.00% | 0.00% | 177,887 | 23,638 | -1,585 | -2,688 |
| **Astraeus** | UK | Europe | | | 51.00% | | 49.00% | | 0.00% | 11,688 | 0 | 0 | 0 |
| **Austrian Airlines** | Austria | Europe | | 58.50% | | | | 41.46% | 0.04% | 106,483 | 16,605 | -561 | -911 |
| **Austrian Arrows** | Austria | Europe | | | | | | 100.00% | 0.00% | 14,316 | 0 | 0 | 0 |
| **Azerbaijan Airlines** | Azerbaijan | Europe | 100.00% | | | | | | 0.00% | 1,770 | 0 | 0 | 0 |
| **Blue Panorama Airlines** | Italy | Europe | | | 66.60% | 33.40% | | | 0.00% | 15,138 | 0 | 0 | 0 |
| **Blue1** | Finland | Europe | | | | | | 100.00% | 0.00% | 5,904 | 0 | 0 | 0 |
| **bmi** | UK | Europe | | | | 50.01% | | 49.99% | 0.00% | 29,600 | 8,705 | 37 | -96 |
| **bmibaby** | UK | Europe | | | | | | 100.00% | 0.00% | 13,405 | 0 | 0 | 0 |
| **Brit Air** | France | Europe | | | | | | 100.00% | 0.00% | 10,704 | 0 | 0 | 0 |
| **British Airways** | UK | Europe | | 100.00% | | | | | 0.00% | 559,849 | 78,303 | 4,786 | 2,612 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Brussels Airlines** | Belgium | Europe | | | | 55.00% | | 45.00% | 0.00% | 28,400 | 5,501 | 40 | 30 |
| **Cargolux Airlines International** | Luxembourg | Europe | | 34.00% | 31.10% | | | 34.90% | 0.00% | 0 | 7,818 | 171 | 147 |
| **CityJet** | Ireland | Europe | | | | | | 100.00% | 0.00% | 4,616 | 0 | 0 | 0 |
| **Clickair** | Spain | Europe | | | | 80.00% | | 20.00% | 0.00% | 10,501 | 0 | 0 | 0 |
| **Condor Flugdienst** | Germany | Europe | | | | | | 100.00% | 0.00% | 111,137 | 0 | 0 | 0 |
| **Corsairfly** | France | Europe | | | | 100.00% | | | 0.00% | 58,379 | 0 | 0 | 0 |
| **Croatia Airlines** | Croatia | Europe | 96.30% | | 2.20% | 1.50% | | | 0.00% | 5,034 | 0 | 0 | 0 |
| **CSA Czech Airlines** | Czech Republic | Europe | 61.08% | | 4.33% | 34.59% | | | 0.00% | 37,620 | 5,175 | 88 | 34 |
| **Cyprus Airways** | Cyprus | Europe | 69.62% | | | 30.38% | | | 0.00% | 16,575 | 2,073 | -163 | -146 |
| **easyJet** | UK | Europe | | 49.90% | | 50.10% | | | 0.00% | 155,745 | 15,550 | 912 | 786 |
| **Edelweiss Air** | Switzerland | Europe | | | | | | 100.00% | 0.00% | 8,321 | 0 | 0 | 0 |
| **Eurofly** | Italy | Europe | | | 15.74% | 38.16% | | 46.10% | 0.00% | 0 | 1,387 | -88 | -94 |
| **Eurowings** | Germany | Europe | | | | 51.00% | | 49.00% | 0.00% | 13,019 | 4,767 | 59 | 51 |
| **Finnair** | Finland | Europe | 57.04% | 22.83% | 20.13% | | | | 0.00% | 92,463 | 13,300 | 227 | 185 |
| **flybe** | UK | Europe | | | | 50.00% | | 15.00% | 35.00% | 13,479 | 3,053 | 77 | 10 |
| **FlyGlobespan.com** | UK | Europe | | 100.00% | | | | | 0.00% | 15,722 | 1,189 | 7 | 3 |
| **Futura International Airways** | Spain | Europe | | | | 100.00% | | | 0.00% | 20,624 | 1,397 | 32 | 25 |
| **GB Airways** | UK | Europe | | | | | | 100.00% | 0.00% | 19,804 | 0 | 0 | 0 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **germanwings** | Germany | Europe | | | | | | 100.00% | 0.00% | 19,841 | 0 | 0 | 0 |
| **Hamburg International** | Germany | Europe | | | 50.01% | | 49.99 % | | 0.00% | 3,619 | 0 | 0 | 0 |
| **Hello** | Switzerland | Europe | | | | 100.00% | | | 0.00% | 1,624 | 0 | 0 | 0 |
| **Iberia** | Spain | Europe | | 72.40% | 17.60% | | | 10.00% | 0.00% | 254,591 | 34,231 | 937 | 1,434 |
| **Iberworld Airlines** | Spain | Europe | | | | 100.00% | | | 0.00% | 17,032 | 1,423 | 101 | 67 |
| **Icelandair** | Iceland | Europe | | 100.00% | | | | | 0.00% | 20,406 | 3,664 | 137 | -44 |
| **Jat Airways** | Serbia | Europe | 100.00 % | | | | | | 0.00% | 4,983 | 0 | 0 | 0 |
| **KrasAir** | Russia | Europe | 51.00% | | | 49.00% | | | 0.00% | 21,891 | 1,291 | 0 | 0 |
| **Livingston** | Italy | Europe | | | | 100.00% | | | 0.00% | 10,578 | 837 | -3 | -8 |
| **LOT Polish Airlines** | Poland | Europe | 67.97% | | | 25.10% | 6.93% | | 0.00% | 33,824 | 4,685 | 61 | 265 |
| **Lufthansa Group** | Germany | Europe | | 89.44% | 10.56% | | | | 0.00% | 566,249 | 135,832 | 7,243 | 5,234 |
| **Luxair** | Luxembourg | Europe | 23.10% | | 38.60% | | | 13.00% | 25.30 % | 4,920 | 2,404 | 24 | 82 |
| **Malév** | Hungary | Europe | | | 49.00% | 51.00% | | | 0.00% | 20,480 | 3,266 | -12 | 3 |
| **Martinair** | Netherlands | Europe | | | | | | 100.00% | 0.00% | 40,207 | 6,632 | -92 | -83 |
| **Meridiana** | Italy | Europe | | | | 84.00% | 16.00 % | | 0.00% | 14,470 | 2,670 | 22 | 27 |
| **Monarch Airlines** | UK | Europe | | | | 100.00% | | | 0.00% | 71,743 | 3,879 | 51 | 27 |
| **Monarch Scheduled** | UK | Europe | | | | | | 100.00% | 0.00% | 14,041 | 0 | 0 | 0 |
| **MyTravel Airways** | UK | Europe | | | | 100.00% | | | 0.00% | 57,795 | 0 | 0 | 0 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Norwegian** | Norway | Europe | | 100.00% | | | | | 0.00% | 21,346 | 2,594 | -38 | 14 |
| **Novair** | Sweden | Europe | | | | 100.00% | | | 0.00% | 14,478 | 0 | 0 | 0 |
| **Olympic Airlines** | Greece | Europe | 100.00 % | | | | | | 0.00% | 35,098 | 4,143 | 0 | 0 |
| **Onur Air** | Turkey | Europe | | | | 100.00% | | | 0.00% | 16,864 | 0 | 0 | 0 |
| **Régional** | France | Europe | | | | | | 100.00% | 0.00% | 11,627 | 0 | 0 | 0 |
| **Rossiya Airlines** | Russia | Europe | 100.00 % | | | | | | 0.00% | 0 | 0 | 0 | 0 |
| **Ryanair** | Ireland | Europe | | 81.24% | 14.26% | 4.50% | | | 0.00% | 204,220 | 14,684 | 2,379 | 2,069 |
| **S7 Airlines** | Russia | Europe | 25.50% | | | 74.50% | | | 0.00% | 62,069 | 5,063 | 104 | 7 |
| **SAS Group** | Denmark | Europe | 49.99% | 50.01% | | | | | 0.00% | 53,747 | 40,537 | 367 | -627 |
| **SATA International** | Portugal | Europe | 100.00 % | | | | | | 0.00% | 7,457 | 0 | 0 | 0 |
| **Silverjet** | UK | Europe | | | | 100.00% | | | 0.00% | 1,190 | 0 | 0 | 0 |
| **SkyEurope Airlines** | Slovakia | Europe | | 71.90% | 28.10% | | | | 0.00% | 12,197 | 0 | 0 | 0 |
| **Spanair** | Spain | Europe | | | | 5.10% | | 94.90% | 0.00% | 39,476 | 0 | 0 | 0 |
| **Sterling Airlines** | Denmark | Europe | | | | 100.00% | | | 0.00% | 0 | 2,309 | -35 | -64 |
| **SunExpress** | Turkey | Europe | | | | | | 100.00% | 0.00% | 21,148 | 0 | 0 | 0 |
| **Swiss** | Switzerland | Europe | | | | | | 100.00% | 0.00% | 117,857 | 0 | 0 | 0 |
| **Swiss European Air Lines** | Switzerland | Europe | | | | | | 100.00% | 0.00% | 3,156 | 0 | 0 | 0 |
| **TAP Portugal** | Portugal | Europe | 100.00 % | | | | | | 0.00% | 85,954 | 11,204 | -102 | -237 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TAROM** | Romania | Europe | 100.00% | | | | | | 0.00% | 8,957 | 1,765 | 77 | 94 |
| **Thomas Cook Airlines (UK)** | UK | Europe | | | | 100.00% | | | 0.00% | 86,919 | 3,356 | 258 | 172 |
| **Thomas Cook Airlines Belgium** | Belgium | Europe | | | | | | 100.00% | 0.00% | 10,414 | 0 | 0 | 0 |
| **Thomsonfly** | UK | Europe | | | | 100.00% | | | 0.00% | 104,072 | 0 | 0 | 0 |
| **THY Turkish Airlines** | Turkey | Europe | 48.25% | 51.75% | | | | | 0.00% | 128,531 | 15,459 | 1,013 | 1,373 |
| **Transaero** | Russia | Europe | | | | 20.00% | 80.00% | | 0.00% | 42,387 | 3,152 | 13 | 15 |
| **Transavia Airlines** | Netherlands | Europe | | | | | | 100.00% | 0.00% | 41,970 | 0 | 0 | 0 |
| **Travel Service Airlines** | Czech Republic | Europe | | | | 34.00% | | 66.00% | 0.00% | 10,593 | 0 | 0 | 0 |
| **TUIfly** | Germany | Europe | | | | 80.10% | | 19.90% | 0.00% | 39,667 | 0 | 0 | 0 |
| **Ukraine International Airlines** | Ukraine | Europe | 61.60% | | 15.90% | | | 22.50% | 0.00% | 10,192 | 0 | 0 | 0 |
| **Ural Airlines** | Russia | Europe | | 19.50% | 14.50% | 66.00% | | | 0.00% | 10,630 | 0 | 0 | 0 |
| **UTair Aviation** | Russia | Europe | | 24.31% | 75.69% | | | | 0.00% | 16,216 | 1,771 | 0 | 17 |
| **Uzbekistan Airways** | Uzbekistan | Europe | 100.00% | | | | | | 0.00% | 21,169 | 0 | 0 | 0 |
| **VIM Airlines** | Russia | Europe | | 25.00% | 75.00% | | | | 0.00% | 14,326 | 0 | 0 | 0 |
| **Virgin Atlantic Airways** | UK | Europe | | | | 51.00% | | 49.00% | 0.00% | 179,343 | 19,711 | 158 | 316 |
| **Volga-Dnepr Airlines** | Russia | Europe | | | 84.00% | | | 16.00% | 0.00% | 0 | 2,222 | 0 | 50 |
| **Vueling Airlines** | Spain | Europe | | 50.90% | 37.80% | | 11.30% | | 0.00% | 16,436 | 1,441 | -156 | -88 |
| **XL Airways France** | France | Europe | | | | 100.00% | | | 0.00% | 10,591 | 0 | 0 | 0 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **XL Airways UK** | UK | Europe | | | | 100.00% | | | 0.00% | 20,806 | 0 | 0 | 0 |
| **Air Algérie** | Algeria | Middle East | 100.00% | | | | | | 0.00% | 17,511 | 3,353 | 32 | 120 |
| **Air Arabia** | UAE | Middle East | 51.00% | | 49.00% | | | | 0.00% | 12,125 | 0 | 0 | 0 |
| **Atlas Blue** | Morocco | Middle East | 100.00% | | | | | | 0.00% | 2,682 | 0 | 0 | 0 |
| **Egyptair** | Egypt | Middle East | 100.00% | | | | | | 0.00% | 58,365 | 5,654 | 33 | 72 |
| **El Al** | Israel | Middle East | 21.97% | 31.36% | 39.50% | | | 8.12% | -0.95% | 81,490 | 8,736 | 128 | 46 |
| **Emirates** | UAE | Middle East | 100.00% | | | | | | 0.00% | 387,713 | 43,122 | 4,715 | 4,096 |
| **Etihad Airways** | UAE | Middle East | 100.00% | | | | | | 0.00% | 55,533 | 4,813 | 0 | 0 |
| **Gulf Air** | Bahrain | Middle East | 100.00% | | | | | | 0.00% | 76,387 | 6,349 | -321 | -293 |
| **Iran Air** | Iran | Middle East | 100.00% | | | | | | 0.00% | 45,912 | 2,779 | -64 | -42 |
| **Iran Aseman Airlines** | Iran | Middle East | 100.00% | | | | | | 0.00% | 8,934 | 0 | 0 | 0 |
| **Israir** | Israel | Middle East | | | | 100.00% | | | 0.00% | 1,803 | 0 | 0 | 0 |
| **Jazeera** | Kuwait | Middle East | | 70.00% | | 30.00% | | | 0.00% | 0 | 0 | 0 | 0 |
| **Kuwait Airways** | Kuwait | Middle East | 100.00% | | | | | | 0.00% | 36,490 | 4,279 | -123 | -452 |
| **Middle East Airlines (MEA)** | Lebanon | Middle East | 99.37% | | | | | | 0.63% | 11,332 | 2,042 | 297 | 248 |
| **Oman Air** | Oman | Middle East | 80.00% | | 20.00% | | | | 0.00% | 10,829 | 0 | 0 | 0 |
| **Qatar Airways** | Qatar | Middle East | 50.01% | | | 49.99% | | | 0.00% | 122,757 | 9,787 | 0 | 0 |
| **Royal Air Maroc** | Morocco | Middle East | 95.39% | | | | | 3.82% | 0.79% | 42,374 | 5,950 | 285 | 150 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Royal Jordanian Airlines** | Jordan | Middle East | 100.00% | | | | | | 0.00% | 30,424 | 3,642 | 95 | 67 |
| **Saudi Arabian Airlines** | Saudi Arabia | Middle East | 100.00% | | | | | | 0.00% | 144,051 | 20,783 | 124 | -104 |
| **Tunisair** | Tunisia | Middle East | 74.42% | 20.00% | | | | 5.58% | 0.00% | 27,165 | 3,596 | 39 | 95 |
| **ABX Air** | USA | North America | | 100.00% | | | | | 0.00% | 0 | 6,372 | 217 | 179 |
| **Aeroméxico** | Mexico | North America | | | | 100.00% | | | 0.00% | 74,744 | 12,038 | 162 | 137 |
| **Air Canada** | Canada | North America | | 25.00% | | 75.00% | | | 0.00% | 373,615 | 45,152 | 1,062 | 1,247 |
| **Air Canada Jazz** | Canada | North America | | | | | | 100.00% | 0.00% | 26,049 | 2,936 | 283 | 268 |
| **Air Caraibes** | Guadeloupe | North America | | | | 85.00% | | | 15.00% | 15,040 | 0 | 0 | 0 |
| **Air Jamaica** | Jamaica | North America | 100.00% | | | | | | 0.00% | 19,836 | 2,040 | 0 | 0 |
| **Air Transat** | Canada | North America | | | | 100.00% | | | 0.00% | 58,640 | 4,354 | 0 | 59 |
| **Air Wisconsin** | USA | North America | | | | 100.00% | | | 0.00% | 18,234 | 3,166 | 311 | 194 |
| **AirTran Airways** | USA | North America | | 100.00% | | | | | 0.00% | 112,422 | 9,246 | 152 | -199 |
| **Alaska Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 141,808 | 16,202 | -135 | -85 |
| **Allegiant Air** | USA | North America | | 100.00% | | | | | 0.00% | 16,333 | 0 | 0 | 0 |
| **Aloha Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 11,805 | 1,679 | -113 | -170 |
| **American Eagle Airlines** | USA | North America | | | | | | 100.00% | 0.00% | 60,284 | 0 | 0 | 0 |
| **AMR Corporation** | USA | North America | | 100.00% | | | | | 0.00% | 1,090,637 | 108,621 | -101 | -2,958 |
| ***ATA Airlines*** | USA | North America | | | | | | 100.00% | 0.00% | 48,126 | 4,073 | -573 | -1,249 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Atlantic Southeast Airlines** | USA | North America | | | | | | 100.00% | 0.00% | 37,412 | 0 | 0 | 0 |
| **Atlas Air** | USA | North America | | 100.00% | | | | | 0.00% | 0 | 4,647 | 299 | 256 |
| **Aviacsa** | Mexico | North America | | | | 100.00% | | | 0.00% | 10,046 | 0 | 0 | 0 |
| **Chautauqua Airlines** | USA | North America | | | | | | 100.00% | 0.00% | 25,297 | 0 | 0 | 0 |
| **Click Mexicana** | Mexico | North America | | | | | | 100.00% | 0.00% | 1,612 | 0 | 0 | 0 |
| **Comair** | USA | North America | | | | | | 100.00% | 0.00% | 42,480 | 0 | 0 | 0 |
| **Continental Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 632,626 | 63,553 | 573 | -214 |
| **Delta Air Lines** | USA | North America | | 89.30% | | | 10.70 % | | 0.00% | 956,620 | 90,215 | -12,469 | -22,531 |
| **Evergreen International Airlines** | USA | North America | | | | 100.00% | | | 0.00% | 0 | 1,939 | 172 | 28 |
| **ExpressJet** | USA | North America | | 100.00% | | | | | 0.00% | 74,476 | 6,246 | 74 | 32 |
| **FedEx** | USA | North America | | 100.00% | | | | | 0.00% | 0 | 110,397 | 7,431 | 0 |
| **Freedom Airlines** | USA | North America | | | | | | 100.00% | 0.00% | 2,850 | 0 | 0 | 0 |
| **Frontier Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 66,756 | 5,687 | -96 | -366 |
| **GoJet** | USA | North America | | | | 100.00% | | | 0.00% | 2,994 | 0 | 0 | 0 |
| **Hawaiian Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 57,374 | 4,671 | 202 | -76 |
| **Horizon Air** | USA | North America | | | | | | 100.00% | 0.00% | 20,716 | 0 | 0 | 0 |
| **JetBlue Airways** | USA | North America | | 49.00% | 15.00% | 17.00% | | 19.00% | 0.00% | 178,692 | 11,560 | 566 | 44 |
| **Kalitta Air** | USA | North America | | | | 100.00% | | | 0.00% | 0 | 1,554 | 7 | 6 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mesa Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 49,970 | 5,994 | 234 | 6 |
| **Mexicana** | Mexico | North America | | | | 100.00% | | | 0.00% | 74,799 | 4,100 | 0 | 0 |
| **Midwest Airlines** | USA | North America | | | | | | 100.00% | 0.00% | 26,693 | 2,929 | -570 | -572 |
| **North American Airlines** | USA | North America | | | 100.00% | | | | 0.00% | 13,559 | 0 | 0 | 0 |
| **Northwest Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 601,551 | 48,661 | 420 | -4,123 |
| **Omni Air International** | USA | North America | | | | 100.00% | | | 0.00% | 8,344 | 959 | 72 | 82 |
| **Pinnacle Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 33,883 | 3,954 | 319 | 174 |
| **Polar Air Cargo** | USA | North America | | 51.00% | | | | 49.00% | 0.00% | 0 | 1,263 | -36 | -31 |
| **Republic Airlines** | USA | North America | | 60.85% | 39.15% | | | | 0.00% | 11,583 | 5,361 | 957 | 273 |
| **Shuttle America** | USA | North America | | | | | | 100.00% | 0.00% | 20,331 | 0 | 0 | 0 |
| **SkyWest Airlines** | USA | North America | | | | | | 100.00% | 0.00% | 106,031 | 13,105 | 1,304 | 612 |
| **Southwest Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 526,373 | 44,084 | 3,453 | 2,119 |
| **Spirit Airlines** | USA | North America | | | 51.00% | 49.00% | | | 0.00% | 44,033 | 3,063 | -74 | -165 |
| **Sun Country Airlines** | USA | North America | | | 100.00% | | | | 0.00% | 16,018 | 0 | 0 | 0 |
| **Trans States Airlines** | USA | North America | | | | 100.00% | | | 0.00% | 9,153 | 0 | 0 | 0 |
| **United Airlines** | USA | North America | | 100.00% | | | | | 0.00% | 921,727 | 93,447 | -3,950 | -27,742 |
| **United Parcel Service (UPS)** | USA | North America | | 100.00% | | | | | 0.00% | 0 | 22,118 | 1,530 | 88 |
| ***US Airways Express*** | USA | North America | | | | | | 100.00% | 0.00% | 17,011 | 0 | 0 | 0 |

| Airline operation | Country | Region | Gov't | Listed | Institutional | Closely held | Employees | Other airline | Other/ Not stated | 5-year RPK | 5-year Revenue | 5-year Op. Profit | 5-year Net Profit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **US Airways Group** | USA | North America | | 100.00% | | | | | 0.00% | 382,648 | 53,102 | -1,421 | -2,327 |
| **USA 3000 Airlines** | USA | North America | | | | 100.00% | | | 0.00% | 5,195 | 0 | 0 | 0 |
| **WestJet Airlines** | Canada | North America | | 100.00% | | | | | 0.00% | 79,641 | 7,947 | 776 | 456 |
| **World Airways** | USA | North America | | | | | | 100.00% | 0.00% | 17,385 | 3,533 | 98 | 34 |
| **Aerolíneas Argentinas** | Argentina | South America | 20.00% | | | 77.00% | 3.00% | | 0.00% | 49,172 | 4,114 | 45 | -68 |
| **AeroRepública** | Colombia | South America | | | | | | 99.90% | 0.10% | 12,360 | 0 | 0 | 0 |
| **Austral Lineas Aereas** | Argentina | South America | 5.00% | | | | | 95.00% | 0.00% | 14,665 | 0 | 0 | 0 |
| **Avianca** | Colombia | South America | | | | 100.00% | | | 0.00% | 38,692 | 5,873 | 267 | 215 |
| **BRA Transportes Aéreos** | Brazil | South America | | | 20.00% | 80.00% | | | 0.00% | 5,702 | 0 | 0 | 0 |
| **Copa Airlines** | Panama | South America | | | | 51.00% | | 10.00% | 39.00 % | 33,314 | 3,394 | 598 | 453 |
| **GOL Transportes Aéreos** | Brazil | South America | | 100.00% | | | | | 0.00% | 75,860 | 9,586 | 717 | -100 |
| **Grupo TACA** | El Salvador | South America | | | | 100.00% | | | 0.00% | 31,300 | 3,546 | 0 | 0 |
| **LAN Airlines** | Chile | South America | | 26.80% | | 73.20% | | | 0.00% | 103,064 | 15,692 | 1,566 | 1,196 |
| **OceanAir** | Brazil | South America | | | | 100.00% | | | 0.00% | 2,877 | 0 | 0 | 0 |
| **SAM Colombia** | Colombia | South America | | | | 6.00% | | 94.00% | 0.00% | 2,546 | 0 | 0 | 0 |
| **TAM Linhas Aéreas** | Brazil | South America | | | | 100.00% | | | 0.00% | 132,956 | 17,446 | 777 | -227 |
| **Varig** | Brazil | South America | | | | | | 100.00% | 0.00% | 79,369 | 0 | 0 | 0 |

# Appendix C – Airbus and Boeing delivery forecast comparison

**Airbus and Boeing delivery forecasts 2009-2028 by airplane size and region**

| Airbus GMF | Single-aisle | Twin-aisle | VLA | Total Deliveries | Twin+VLA seats |
|---|---|---|---|---|---|
| Asia Pacific | 4,558 | 2,403 | 711 | 14,338 | 1,161,000 |
| North America | 4,564 | 823 | 64 | 14,463 | 316,850 |
| Europe | 4,581 | 1,206 | 281 | 13,683 | 548,550 |
| Middle East | 561 | 668 | 189 | 2,137 | 318,850 |
| Latin America | 1,340 | 299 | 19 | 3,862 | 113,200 |
| Russia and Central Asia | 733 | 154 | 14 | 2,496 | 60,200 |
| Africa | 640 | 249 | 40 | 2,251 | 105,150 |
| Totals | 16,977 | 5,802 | 1,318 | 30,175 | 2,623,800 |

| Boeing CMO | Single-aisle | Twin-aisle | VLA | Total Deliveries | Twin+VLA seats |
|---|---|---|---|---|---|
| Asia Pacific | 5,600 | 2,590 | 330 | 8,960 | 1,055,000 |
| North America | 5,630 | 1,130 | 40 | 7,690 | 413,500 |
| Europe | 5,310 | 1,480 | 200 | 7,330 | 608,000 |
| Middle East | 680 | 850 | 130 | 1,710 | 356,000 |
| Latin America | 1,260 | 290 | 10 | 1,640 | 106,000 |
| Russia and Central Asia | 610 | 170 | 20 | 1,050 | 68,500 |
| Africa | 370 | 190 | 10 | 620 | 71,000 |
| World | 19,460 | 6,700 | 740 | 29,000 | 2,678,000 |
| **Delta: GMF cf. CMO** | **-13%** | **-13%** | **78%** | **4%** | **-2%** |

| Forecast deltas Airbus higher/lower (-) than Boeing | Single-aisle | Twin-aisle | VLA | Total Twin+VLA | Total Deliveries |
|---|---|---|---|---|---|
| Asia Pacific | -1,042 | -187 | 381 | 194 | -848 |
| North America | -1,066 | -307 | 24 | -283 | -1,349 |
| Europe | -729 | -274 | 81 | -193 | -922 |
| Middle East | -119 | -182 | 59 | -123 | -242 |
| Latin America | 80 | 9 | 9 | 18 | 98 |
| Russia and Central Asia | 123 | -16 | -6 | -22 | 101 |
| Africa | 270 | 59 | 30 | 89 | 359 |
| Totals | -2,483 | -898 | 578 | -320 | -2,803 |

# Appendix D – Large civil aircraft delivery history

**COMMERCIAL JET AIRCRAFT DELIVERIES**

**1974-2009**

| | Total before 1974 | 1974 | 1975 | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | Total 1974 2008 | Grand total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TOTAL AIRBUS** | 0 | 5 | 9 | 13 | 16 | 16 | 25 | 37 | 37 | 46 | 36 | 48 | 42 | 29 | 32 | 61 | 105 | 95 | 163 | 157 | 138 | 123 | 124 | 126 | 182 | 229 | 294 | 311 | 325 | 303 | 305 | 320 | 378 | 434 | 453 | 483 | 320 | 5,820 | 5,820 |
| **TOTAL BOEING** | 2427 | 189 | 170 | 139 | 120 | 203 | 286 | 299 | 257 | 176 | 204 | 146 | 203 | 242 | 270 | 290 | 284 | 385 | 435 | 446 | 330 | 272 | 207 | 219 | 321 | 509 | 561 | 450 | 476 | 361 | 269 | 273 | 274 | 393 | 441 | 375 | 307 | 10,782 | 13,209 |
| **TOTAL DOUGLAS** | 1387 | 95 | 85 | 69 | 36 | 40 | 75 | 63 | 103 | 54 | 63 | 54 | 82 | 102 | 104 | 130 | 118 | 142 | 170 | 127 | 79 | 40 | 50 | 51 | 54 | 54 | 59 | 39 | 51 | 20 | 12 | 12 | 13 | 5 | 0 | 0 | 0 | 2,251 | 3,638 |
| | 3,814 | 289 | 264 | 221 | 172 | 259 | 386 | 399 | 397 | 276 | 303 | 248 | 327 | 373 | 406 | 481 | 507 | 622 | 768 | 730 | 547 | 435 | 381 | 396 | 557 | 792 | 914 | 800 | 852 | 684 | 586 | 605 | 665 | 832 | 894 | 858 | 627 | 18,853 | 22,667 |
| AIRBUS share | 0.0% | 1.7% | 3.4% | 5.9% | 9.3% | 6.2% | 6.5% | 9.3% | 9.3% | 16.7% | 11.9% | 19.4% | 12.8% | 7.8% | 7.9% | 12.7% | 20.7% | 15.3% | 21.2% | 21.5% | 25.2% | 28.3% | 32.5% | 31.8% | 32.7% | 28.9% | 32.2% | 38.9% | 38.1% | 44.3% | 52.0% | 52.9% | 56.8% | 52.2% | 50.7% | 56.3% | 51.0% | 30.9% | 25.7% |
| BOEING share | 63.6% | 65.4% | 64.4% | 62.9% | 69.8% | 78.4% | 74.1% | 74.9% | 64.7% | 63.8% | 67.3% | 58.9% | 62.1% | 64.9% | 66.5% | 60.3% | 56.0% | 61.9% | 56.6% | 61.1% | 60.3% | 62.5% | 54.3% | 55.3% | 57.6% | 64.3% | 61.4% | 56.3% | 55.9% | 52.8% | 45.9% | 45.1% | 41.2% | 47.2% | 49.3% | 43.7% | 49.0% | 57.2% | 58.3% |
| DOUGLAS share | 36.4% | 32.9% | 32.2% | 31.2% | 20.9% | 15.4% | 19.4% | 15.8% | 25.9% | 19.6% | 20.8% | 21.8% | 25.1% | 27.3% | 25.6% | 27.0% | 23.3% | 22.8% | 22.1% | 17.4% | 14.4% | 9.2% | 13.1% | 12.9% | 9.7% | 6.8% | 6.5% | 4.9% | 6.0% | 2.9% | 2.0% | 2.0% | 2.0% | 0.6% | 0.0% | 0.0% | 0.0% | 11.9% | 16.0% |
| **A300B1/2/4** | | 5 | 9 | 13 | 16 | 16 | 25 | 37 | 37 | 46 | 19 | 5 | 11 | 7 | 2 | | | | | | | | | 1 | | | | | | | | | | | | | | 249 | 249 |
| **A300-600** | | | | | | | | | | | | 14 | 5 | 3 | 9 | 1 | 3 | 2 | 1 | 1 | | | | | | | | | | | | | | | | | | 39 | 39 |
| **A300-600R/F** | | | | | | | | | | | | | | | | 16 | 21 | 17 | 24 | 21 | 22 | 23 | 17 | 13 | 6 | 13 | 8 | 8 | 11 | 9 | 8 | 12 | 9 | 9 | 6 | | | 273 | 273 |
| **A310-200** | | | | | | | | | | | 17 | 29 | 24 | 9 | | 5 | 1 | | | | | | | | | | | | | | | | | | | | | 85 | 85 |
| **A310-300** | | | | | | | | | | | | | 2 | 10 | 21 | 23 | 22 | 18 | 19 | 24 | 22 | 2 | 2 | 2 | 2 | 1 | | | | | | | | | | | | 170 | 170 |
| **A318-100** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 | 10 | 9 | 8 | 17 | 13 | 3 | 69 | 69 |
| **A319-100** | | | | | | | | | | | | | | | | | | | | | | | | 18 | 47 | 53 | 88 | 112 | 89 | 85 | 72 | 87 | 142 | 137 | 105 | 98 | 62 | 1,195 | 1,195 |
| **A320-100/200** | | | | | | | | | | | | | | | | 16 | 58 | 58 | 119 | 111 | 71 | 48 | 34 | 38 | 58 | 80 | 101 | 101 | 119 | 116 | 119 | 101 | 121 | 164 | 194 | 209 | 142 | 2,178 | 2,178 |
| **A321-100/200** | | | | | | | | | | | | | | | | | | | | | | 16 | 22 | 16 | 22 | 35 | 33 | 28 | 49 | 35 | 33 | 35 | 17 | 30 | 51 | 66 | 55 | 543 | 543 |
| **A330-200** | | | | | | | | | | | | | | | | | | | | | | | | | | 12 | 40 | 27 | 16 | 36 | 19 | 25 | 29 | 39 | 42 | 49 | 22 | 356 | 356 |
| **A330-300** | | | | | | | | | | | | | | | | | | | | | 1 | 9 | 30 | 10 | 14 | 11 | 4 | 16 | 19 | 6 | 12 | 22 | 27 | 23 | 26 | 23 | 24 | 277 | 277 |
| **A340-200** | | | | | | | | | | | | | | | | | | | | | 12 | 5 | 5 | 3 | 2 | 1 | | | | | | | | | | | | 28 | 28 |
| **A340-300** | | | | | | | | | | | | | | | | | | | | | 10 | 20 | 14 | 25 | 31 | 23 | 20 | 19 | 22 | 8 | 10 | 5 | 4 | 2 | 2 | 3 | | 218 | 218 |
| **A340-500** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | 9 | 5 | 4 | 1 | 2 | 1 | 29 | 29 |
| **A340-600** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 16 | 14 | 15 | 18 | 8 | 8 | 6 | 93 | 93 |
| **A38-800** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 12 | 5 | 18 | 18 |
| **707/720** | 872 | 21 | 7 | 9 | 8 | 13 | 6 | 3 | 2 | 8 | 8 | 8 | 3 | 4 | 9 | | 5 | 4 | 14 | 5 | | 1 | | | | | | | | | | | | | | | | 138 | 1,010 |
| **727-100/200** | 996 | 91 | 91 | 62 | 67 | 118 | 136 | 131 | 94 | 26 | 11 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | 835 | 1,831 |
| **737-100/200** | 334 | 55 | 51 | 41 | 25 | 40 | 77 | 92 | 108 | 95 | 82 | 60 | 32 | 21 | 24 | 7 | | | | | | | | | | | | | | | | | | | | | | 810 | 1,144 |
| **737-300** | | | | | | | | | | | | 7 | 83 | 120 | 137 | 141 | 89 | 67 | 69 | 57 | 54 | 54 | 52 | 37 | 65 | 52 | 29 | | | | | | | | | | | 1,113 | 1,113 |
| **737-400** | | | | | | | | | | | | | | | | 17 | 57 | 63 | 56 | 82 | 68 | 32 | 13 | 21 | 33 | 33 | 9 | 2 | | | | | | | | | | 486 | 486 |
| **737-500** | | | | | | | | | | | | | | | | | | 44 | 90 | 79 | 30 | 35 | 24 | 18 | 34 | 31 | 4 | | | | | | | | | | | 389 | 389 |
| **737-600** | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 24 | 6 | 4 | 5 | 6 | 3 | 3 | 10 | | | | 69 | 69 |
| **737-700** | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 92 | 121 | 88 | 101 | 82 | 84 | 115 | 98 | 118 | 107 | 66 | 33 | 1,108 | 1,108 |
| **737-800** | | | | | | | | | | | | | | | | | | | | | | | | | | 65 | 133 | 185 | 173 | 128 | 72 | 78 | 104 | 174 | 214 | 193 | 183 | 1,702 | 1,702 |
| **737-900/ER** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 21 | 8 | 11 | 6 | 4 | | 9 | 31 | 21 | 111 | 111 |
| **747-100/200** | 225 | 22 | 21 | 27 | 20 | 32 | 67 | 73 | 53 | 25 | 8 | 9 | 8 | 16 | 14 | 10 | 4 | 7 | 2 | | | | | | | | | | | | | | | | | | | 418 | 643 |
| **747-300** | | | | | | | | | | | 15 | 7 | 16 | 19 | 9 | 14 | | 1 | | | | | | | | | | | | | | | | | | | | 81 | 81 |
| **747-400/400F/ERF** | | | | | | | | | | | | | | | | | 41 | 62 | 62 | 61 | 56 | 40 | 25 | 26 | 39 | 53 | 47 | 25 | 31 | 27 | 19 | 15 | 13 | 14 | 16 | 14 | 6 | 692 | 692 |
| **757-200** | | | | | | | | | | 2 | 25 | 18 | 36 | 35 | 40 | 48 | 51 | 77 | 80 | 99 | 71 | 69 | 43 | 42 | 46 | 54 | 60 | 37 | 36 | 14 | 3 | 6 | 2 | | | | | 994 | 994 |
| **757-300** | | | | | | | | | | | | | | | | | | | | | | | | | | | 7 | 8 | 9 | 15 | 11 | 5 | | | | | | 55 | 55 |
| **767-200/ER** | | | | | | | | | | 20 | 55 | 29 | 25 | 19 | 24 | 14 | 8 | 15 | 5 | 1 | 5 | 5 | 1 | 2 | 1 | | | 3 | 7 | 1 | 2 | | 1 | 2 | 1 | 2 | | 248 | 248 |
| **767-300/ER/F** | | | | | | | | | | | | | | 8 | 13 | 39 | 29 | 45 | 57 | 62 | 46 | 36 | 36 | 41 | 41 | 47 | 44 | 25 | 25 | 21 | 22 | 9 | 13 | 10 | 11 | 8 | 7 | 695 | 695 |
| **767-400ER** | | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 8 | 13 | | | | | | | 1 | 38 | 38 |
| **777-200/ER/LR/F** | | | | | | | | | | | | | | | | | | | | | | | 13 | 32 | 59 | 60 | 66 | 51 | 58 | 41 | 30 | 24 | 17 | 25 | 30 | 14 | 25 | 545 | 545 |
| **777-300/ER** | | | | | | | | | | | | | | | | | | | | | | | | | | 14 | 17 | 4 | 3 | 6 | 9 | 12 | 19 | 40 | 53 | 47 | 31 | 255 | 255 |
| **DC-8** | 556 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 0 | 556 |
| **DC-9** | 709 | 48 | 42 | 50 | 22 | 22 | 39 | 18 | 16 | 10 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 267 | 976 |
| **DC-10-10** | 74 | 13 | 14 | 1 | 1 | 5 | 9 | 9 | 9 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | 64 | 138 |
| **DC-10-30** | 33 | 27 | 29 | 12 | 13 | 12 | 24 | 25 | 8 | 3 | 1 | 2 | | 5 | 3 | 8 | 1 | | | | | | | | | | | | | | | | | | | | | 173 | 206 |
| **DC-10-40** | 15 | 7 | | 6 | | 1 | 3 | 6 | 2 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | 42 |
| **KC-10** | | | | | | | | | 6 | 6 | 8 | 8 | 11 | 12 | 7 | 2 | | | | | | | | | | | | | | | | | | | | | | 60 | 60 |
| **MD-11** | | | | | | | | | | | | | | | | | | 3 | 31 | 42 | 36 | 17 | 18 | 15 | 12 | 12 | 8 | 4 | 2 | | | | | | | | | 200 | 200 |
| **MD-81/82/83/88** | | | | | | | | 5 | 62 | 33 | 51 | 44 | 71 | 85 | 91 | 106 | 102 | 115 | 125 | 80 | 43 | 23 | 18 | 12 | 16 | 8 | 26 | | | | | | | | | | | 1,116 | 1,116 |
| **MD-87** | | | | | | | | | | | | | | | 3 | 14 | 15 | 24 | 14 | 5 | | | | | | | | | | | | | | | | | | 75 | 75 |
| **MD-90** | | | | | | | | | | | | | | | | | | | | | | | 14 | 24 | 26 | 34 | 13 | 3 | | | | | | | | | | 114 | 114 |
| **717-200** | | | | | | | | | | | | | | | | | | | | | | | | | | | 12 | 32 | 49 | 20 | 12 | 12 | 13 | 5 | | | | 155 | 155 |
| **TOTAL** | 3,814 | 289 | 264 | 221 | 172 | 259 | 386 | 399 | 397 | 276 | 303 | 248 | 327 | 373 | 406 | 481 | 507 | 622 | 768 | 730 | 547 | 435 | 381 | 396 | 557 | 792 | 914 | 800 | 852 | 684 | 586 | 605 | 665 | 832 | 894 | 858 | 627 | 18,853 | 22,667 |

# Appendix E – Aircraft Investment model input and output

**Family conversion option: A319 -> A320**

| **Base cases** | **A319** | **A320** |
|---|---|---|
| Most likely project NPV ($m) | 12.72 | 13.55 |
| Switching cost ($m) | | 0.5 |

| **Market uncertainty** | |
|---|---|
| Fuel price ($/USG) | $2.00 |

| | | |
|---|---|---|
| Project volatility (Standard Deviation) | 63.35% | 75.81% |
| Risk free interest rate | 4% | |
| **Option value - thousands of USD** | **$673** | |

**Fuel price distribution for MC analysis**

**2005-2009**

| **Fuel Price Range** | **Midpoint** | **Freq. %** |
|---|---|---|
| <120 | $1.20 | 0.8% |
| <130 | $1.25 | 2.0% |
| <140 | $1.35 | 4.4% |
| <150 | $1.45 | 4.4% |
| <160 | $1.55 | 3.8% |
| <170 | $1.65 | 7.8% |
| <180 | $1.75 | 12.9% |
| <190 | $1.85 | 11.9% |
| <200 | $1.95 | 7.4% |
| <210 | $2.05 | 11.7% |
| <220 | $2.15 | 9.5% |
| <230 | $2.25 | 3.0% |
| <240 | $2.35 | 1.0% |
| <250 | $2.45 | 0.6% |
| <260 | $2.55 | 2.4% |
| <270 | $2.65 | 2.4% |
| <280 | $2.75 | 1.5% |
| <290 | $2.85 | 0.7% |
| <300 | $2.95 | 0.5% |
| <310 | $3.05 | 0.9% |
| <320 | $3.15 | 1.6% |
| <330 | $3.25 | 1.3% |
| <340 | $3.35 | 0.9% |
| <350 | $3.45 | 1.2% |
| <360 | $3.55 | 0.6% |
| <370 | $3.65 | 0.3% |
| <380 | $3.75 | 0.6% |
| <390 | $3.85 | 1.1% |
| <400 | $3.95 | 0.9% |
| >=400 | $4.05 | 1.7% |
| | Total: | 100.0% |

# Aircraft Investment Model

## Study parameters

| Study name and scenarios | | | | | | | |
|---|---|---|---|---|---|---|---|
| Study name | Real options analysis for WEG Ph.D Thesis | | | | | | |
| Scenarios | Scenario name | New aircraft name | Disposed aircraft name | NPV (USD m) | PV at Year 1 | PV at Year 0 | Year 1 return |
| First | A319 Purchase | A319 | | 12.7 | 13.9 | 12.7 | 8.58% |
| Second | A320 purchase | A320 | | 13.6 | 14.8 | 13.6 | 8.76% |
| | | | | | | | |

| Reference years | |
|---|---|
| Start year for study | 2010 |
| Project horizon in years | 20 |
| Last year of operations | 2030 |
| Base year for aircraft pricing | 2008 |
| Base year for revenues | 2010 |
| Base year for costs | 2010 |

| Units used in the study | |
|---|---|
| Weight unit | Tonr |
| Distance unit | Nautica |
| Pax yield or revenue unit | USD pe |
| Cargo yield or revenue unit | USD pe |
| Cost units | Thousands of U |
| Rounding decimals for output calculations | 2 |

| Economic environment | |
|---|---|
| Passenger traffic growth rate per year | 4.00% |
| Cargo growth rate per year | 0.00% |
| Aircraft price escalation rate | 3.0% |
| Default yield growth rate | -1.0% |
| Default revenue inflation rate | 3.0% |
| Default cost inflation rate | 3.0% |

| Financial environment | |
|---|---|
| Debt to total capital ratio | 50% |
| Cost of debt (Kd) | 6.00% |
| Cost of equity (Ke) | 12.00% |
| Discount rate: WACC or hurdle rate | 9.00% |

| | |
|---|---|
| Default fuel price in US$ per USg | $2.00 |
| Study currency (unit for all study results) | USD |
| Aircraft pricing currency | USD |
| Aircraft pricing currency per Study currency | 1.000 |
| Revenue & cost currency | USD |
| Revenue & cost currency per Study currency | 1.000 |
| US$ per Revenue & cost currency (for fuel) | 1.000 |

| Tax environment | |
|---|---|
| Effective Income tax rate | 35% |
| Capital gains tax rate | |
| Investment tax credit rate | |

| Depreciation policy | |
|---|---|
| Salvage value as a percentage of sales price | 20% |
| Depreciation period in years | 20 |

| | |
|---|---|
| Depreciation method | Straightline |

**Book values table**

| Year from delivery | Percent depreciated | Aircraft book value |
|---|---|---|
| 0 | 0.000% | 100.000% |
| 1 | 4.000% | 96.000% |
| 2 | 4.000% | 92.000% |
| 3 | 4.000% | 88.000% |
| 4 | 4.000% | 84.000% |
| 5 | 4.000% | 80.000% |
| 6 | 4.000% | 76.000% |
| 7 | 4.000% | 72.000% |
| 8 | 4.000% | 68.000% |
| 9 | 4.000% | 64.000% |
| 10 | 4.000% | 60.000% |
| 11 | 4.000% | 56.000% |
| 12 | 4.000% | 52.000% |
| 13 | 4.000% | 48.000% |
| 14 | 4.000% | 44.000% |
| 15 | 4.000% | 40.000% |
| 16 | 4.000% | 36.000% |
| 17 | 4.000% | 32.000% |
| 18 | 4.000% | 28.000% |
| 19 | 4.000% | 24.000% |
| 20 | 4.000% | 20.000% |
| 21 | 0.000% | 20.000% |
| 22 | 0.000% | 20.000% |
| 23 | 0.000% | 20.000% |
| 24 | 0.000% | 20.000% |
| 25 | 0.000% | 20.000% |
| Total | 80% | |

**Market value estimates and operating lease period**

| | |
|---|---|
| Lease period (years) | 5 |
| Average market value loss per year | 4% |

| Year from delivery | Pct. Loss in market value | Aircraft market value | Excess of market over book value | Market value for lease rate calculation |
|---|---|---|---|---|
| 0 | 0.000% | 100.0% | 0.0% | 100.0% |
| 1 | 4.000% | 96.0% | 0.0% | 100.0% |
| 2 | 4.000% | 92.0% | 0.0% | 100.0% |
| 3 | 4.000% | 88.0% | 0.0% | 100.0% |
| 4 | 4.000% | 84.0% | 0.0% | 100.0% |
| 5 | 4.000% | 80.0% | 0.0% | 80.0% |
| 6 | 4.000% | 76.0% | 0.0% | 80.0% |
| 7 | 4.000% | 72.0% | 0.0% | 80.0% |
| 8 | 4.000% | 68.0% | 0.0% | 80.0% |
| 9 | 4.000% | 64.0% | 0.0% | 80.0% |
| 10 | 4.000% | 60.0% | 0.0% | 60.0% |
| 11 | 4.000% | 56.0% | 0.0% | 60.0% |
| 12 | 4.000% | 52.0% | 0.0% | 60.0% |
| 13 | 4.000% | 48.0% | 0.0% | 60.0% |
| 14 | 4.000% | 44.0% | 0.0% | 60.0% |
| 15 | 4.000% | 40.0% | 0.0% | 40.0% |
| 16 | 4.000% | 36.0% | 0.0% | 40.0% |
| 17 | 4.000% | 32.0% | 0.0% | 40.0% |
| 18 | 4.000% | 28.0% | 0.0% | 40.0% |
| 19 | 4.000% | 24.0% | 0.0% | 40.0% |
| 20 | 4.000% | 20.0% | 0.0% | 20.0% |
| 21 | 4.000% | 16.0% | -4.0% | 20.0% |
| 22 | 4.000% | 12.0% | -8.0% | 20.0% |
| 23 | 4.000% | 8.0% | -12.0% | 20.0% |
| 24 | 4.000% | 4.0% | -16.0% | 20.0% |
| 25 | 4.000% | 0.0% | -20.0% | 0.0% |
| Total | 100% | | | |

| | A | B | C | D | E | F | G | H | I | J | K | L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **Aircraft Investment Model** | | | | | | | | | | | |
| 2 | **Operating assumptions** | | | | | | | | | | | |
| 3 | *Study name* | **Real options analysis for WEG Ph.D Thesis** | | | | | | | | | | |
| 4 | *Study horizon* | **2010 to 2030** | | | | | | | | | | |
| 5 | **Indicative NPV (USD m)** | | **12.7** | | | | | | **13.6** | | | |
| 6 | **Scenario** | | ***A319 Purchase*** | | | | | | ***A320 purchase*** | | | |
| 7 | **Aircraft** | | **New fleet** | | **Existing fleet** | | | | **New fleet** | | **Existing fleet** | |
| 8 | | | ***A319*** | | ***0*** | | | | ***A320*** | | ***0*** | |
| 9 | **No. of seats** | | **156** | | **0** | | | | **180** | | **0** | |
| 10 | **Cargo capacity (t)** | | **0** | | **0** | | | | **0** | | **0** | |
| 11 | | | | | | | | | | | | |
| 12 | **Sector** | | | | | | | | | | | |
| 13 | Sector length (nm) | | 500 | | | | | | 500 | | | |
| 14 | Number of sectors per year | | 2115 | | | | | | 2115 | | | |
| 15 | Block fuel consumption (t) per trip | | 3.201 | | | | | | 3.24 | | | |
| 16 | Fuel density (kg/litre) | | 0.803 | | | | | | 0.803 | | 0.803 | |
| 17 | Fuel price $ per USG - default is $2 | | $2.00 | | | | | | $2.00 | | | |
| 18 | *Fuel cost in thousands of USD per sector, base year 20* | | **$2.106** | | **$0.000** | | | | **$2.132** | | **$0.000** | |
| 19 | | | | | | | | | | | | |
| 20 | **Passengers and cargo carried per aircraft in base year 2010** | | | | | | | | | | | |
| 21 | Passengers carried per trip | | **110.0** | | | | | | 110.0 | | | |
| 22 | Passenger load factor | | **71%** | | **0%** | | | | **61%** | | **0%** | |
| 23 | Maximum pax load factor (spill LF) | | **98%** | | **85%** | | | | **98%** | | **85%** | |
| 24 | Cargo load factor in base year | | | | | | | | | | | |
| 25 | Maximum cargo load factor | | **90%** | | **90%** | | | | **90%** | | **90%** | |
| 26 | Cargo carried (t) in base year 2010 | | **2.5** | | **0.0** | | | | **0.0** | | **0.0** | |
| 27 | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | |
| 29 | **Revenue in base year 2010 USD** | Revenue inflation + yield growth rate | | | | | | | | | | |
| 30 | Passenger revenue | **2.0%** | USD (Units per RPK) | *Annual revenue per aircraft in USD m* | USD (Units per RPK) | *Annual revenue per aircraft in USD m* | | | USD (Units per RPK) | *Annual revenue per aircraft in USD m* | USD (Units per RPK) | *Annual revenue per aircraft in USD m* |
| 31 | | | 0.09 | 19.392 | | 0.000 | | | 0.09 | 19.392 | | 0.000 |
| 32 | Cargo revenue | **2.0%** | USD (Units per RTK) | | USD (Units per RTK) | | | | USD (Units per RTK) | | USD (Units per RTK) | |
| 33 | | | | 0.000 | | 0.000 | | | | 0.000 | | 0.000 |
| 34 | Other revenue | **2.0%** | Pct. of passenger revenue | | Pct. of passenger revenue | | | | Pct. of passenger revenue | | Pct. of passenger revenue | |
| 35 | | | | 0.000 | | 0.000 | | | | 0.000 | | 0.000 |
| 36 | | | | | | | | | | | | |
| 37 | **Costs in base year 2010 USD** | Cost inflation rate | USD (Thousands per sector) | *Annual cost per aircraft in USD m* | USD (Thousands per sector) | *Annual cost per aircraft in USD m* | | | USD (Thousands per sector) | *Annual cost per aircraft in USD m* | USD (Thousands per sector) | *Annual cost per aircraft in USD m* |
| 38 | Fuel | 3.00% | **2.106** | 4.454 | **0.000** | 0.000 | | | **2.132** | 4.509 | **0.000** | 0.000 |
| 39 | Maintenance : mature cost | 3.00% | 0.864 | 1.827 | | 0.000 | | | 0.920 | 1.946 | | 0.000 |
| 40 | Cockpit crew | 3.00% | 0.802 | 1.696 | | 0.000 | 0.53467 | $ | 0.802 | 1.696 | | 0.000 |
| 41 | Cabin crew | 3.00% | 0.544 | 1.151 | | 0.000 | cabin cre | 85 | 0.544 | 1.151 | | 0.000 |
| 42 | Passenger services (110 pax) | 3.00% | 0.362 | 0.766 | | 0.000 | 250.625 | | 0.417 | 0.882 | | 0.000 |
| 43 | Landing fees | 3.00% | 0.619 | 1.309 | | 0.000 | | | 0.631 | 1.335 | | 0.000 |
| 44 | Navigation fees | 3.00% | 0.517 | 1.093 | | 0.000 | | | 0.522 | 1.104 | | 0.000 |
| 45 | Handling fees | 3.00% | 2.555 | 5.404 | | 0.000 | | | 2.793 | 5.907 | | 0.000 |
| 46 | Other operating costs | 3.00% | | 0.000 | | 0.000 | | | | 0.000 | | 0.000 |
| 47 | Total Cash Operating Costs | | | 17.701 | | 0.000 | | | | 18.529 | | 0.000 |
| 48 | Flying Contribution (pct. of revenue) | | | **9%** | | **0%** | | | | **4%** | | **0%** |
| 49 | | | | | | | | | | | | |
| 50 | **Fuel degradation mark-up parameters** | | | | | | | | | | | |
| 51 | Age of aircraft for mark-up | | **12** | | **12** | | | | **12** | | **12** | |
| 52 | One-time cost mark-up | | **2%** | | **3%** | | | | **2%** | | **3%** | |
| 53 | | | | | | | | | | | | |
| 54 | **Ageing curve for fuel and maintenance costs** | | Fuel | Maintenance | Fuel | Maintenance | | | Fuel | Maintenance | Fuel | Maintenance |
| 55 | | **Age of the aircraft in years** | Percent of base cost | Percent of mature cost | Percent of base cost | Percent of mature cost | | **Age of the aircraft in years** | Percent of base cost | Percent of mature cost | Percent of base cost | Percent of mature cost |
| 56 | | 0 | 100% | 33% | 100% | 100% | | 0 | 100% | 33% | 100% | 100% |
| 57 | | 1 | 100% | 51% | 100% | 100% | | 1 | 100% | 51% | 100% | 100% |
| 58 | | 2 | 100% | 69% | 100% | 100% | | 2 | 100% | 69% | 100% | 100% |
| 59 | | 3 | 100% | 83% | 100% | 100% | | 3 | 100% | 83% | 100% | 100% |
| 60 | | 4 | 100% | 93% | 100% | 100% | | 4 | 100% | 93% | 100% | 100% |
| 61 | | 5 | 100% | 96% | 100% | 100% | | 5 | 100% | 96% | 100% | 100% |
| 62 | | 6 | 100% | 97% | 100% | 100% | | 6 | 100% | 97% | 100% | 100% |
| 63 | | 7 | 100% | 98% | 100% | 100% | | 7 | 100% | 98% | 100% | 100% |
| 64 | | 8 | 100% | 99% | 100% | 100% | | 8 | 100% | 99% | 100% | 100% |
| 65 | | 9 | 100% | 100% | 100% | 100% | | 9 | 100% | 100% | 100% | 100% |
| 66 | | 10 | 100% | 100% | 100% | 100% | | 10 | 100% | 100% | 100% | 100% |
| 67 | | 11 | 100% | 100% | 100% | 100% | | 11 | 100% | 100% | 100% | 100% |
| 68 | | 12 | 100% | 100% | 100% | 100% | | 12 | 100% | 100% | 100% | 100% |
| 69 | | 13 | 102% | 100% | 103% | 100% | | 13 | 102% | 100% | 103% | 100% |
| 70 | | 14 | 102% | 102% | 103% | 100% | | 14 | 102% | 102% | 103% | 100% |
| 71 | | 15 | 102% | 102% | 103% | 100% | | 15 | 102% | 102% | 103% | 100% |
| 72 | | 16 | 102% | 102% | 103% | 100% | | 16 | 102% | 102% | 103% | 100% |
| 73 | | 17 | 102% | 102% | 103% | 100% | | 17 | 102% | 102% | 103% | 100% |
| 74 | | 18 | 102% | 102% | 103% | 100% | | 18 | 102% | 102% | 103% | 100% |
| 75 | | 19 | 102% | 102% | 103% | 100% | | 19 | 102% | 102% | 103% | 100% |
| 76 | | 20 | 102% | 102% | 103% | 100% | | 20 | 102% | 102% | 103% | 100% |
| 77 | | 21 | 102% | 102% | 103% | 100% | | 21 | 102% | 102% | 103% | 100% |
| 78 | | 22 | 102% | 102% | 103% | 100% | | 22 | 102% | 102% | 103% | 100% |
| 79 | | 23 | 102% | 102% | 103% | 100% | | 23 | 102% | 102% | 103% | 100% |
| 80 | | 24 | 102% | 102% | 103% | 100% | | 24 | 102% | 102% | 103% | 100% |
| 81 | | 25 | 102% | 102% | 103% | 100% | | 25 | 102% | 102% | 103% | 100% |
| 82 | | 26 | 102% | 100% | 103% | 100% | | 26 | 102% | 102% | 103% | 100% |
| 83 | | 27 | 102% | 100% | 103% | 100% | | 27 | 102% | 102% | 103% | 100% |
| 84 | | 28 | 102% | 100% | 103% | 100% | | 28 | 102% | 100% | 103% | 100% |
| 85 | | 29 | 102% | 100% | 103% | 100% | | 29 | 102% | 100% | 103% | 100% |
| 86 | | 30 | 102% | 100% | 103% | 100% | | 30 | 102% | 100% | 103% | 100% |
| 87 | | 31 | 102% | 100% | 103% | 100% | | 31 | 102% | 100% | 103% | 100% |
| 88 | | 32 | 102% | 100% | 103% | 100% | | 32 | 102% | 100% | 103% | 100% |
| 89 | | 33 | 102% | 100% | 103% | 100% | | 33 | 102% | 100% | 103% | 100% |
| 90 | | 34 | 102% | 100% | 103% | 100% | | 34 | 102% | 100% | 103% | 100% |
| 91 | | 35 | 102% | 100% | 103% | 100% | | 35 | 102% | 100% | 103% | 100% |
| 92 | | | | | | | | | | | | |
| 93 | **Traffic / passenger growth trend** | | | | | | | | | | | |
| 94 | Year | Traffic Growth rate | Passengers per trip | Annual Revenue | Passengers per trip | Annual Revenue | Year | Traffic Growth rate | Passengers per trip | Annual Revenue | Passengers per trip | Annual Revenue |
| 95 | 2010 | | 110.0 | 19.392 | 0.0 | 0.000 | 2010 | | 110.0 | 19.392 | 0.0 | 0.000 |
| 96 | 2011 | 4.00% | 114.4 | 20.168 | 0.0 | 0.000 | 2011 | 4.00% | 114.4 | 20.168 | 0.0 | 0.000 |
| 97 | 2012 | 4.00% | 119.0 | 20.975 | 0.0 | 0.000 | 2012 | 4.00% | 119.0 | 20.975 | 0.0 | 0.000 |
| 98 | 2013 | 4.00% | 123.7 | 21.814 | 0.0 | 0.000 | 2013 | 4.00% | 123.7 | 21.814 | 0.0 | 0.000 |
| 99 | 2014 | 4.00% | 128.7 | 22.686 | 0.0 | 0.000 | 2014 | 4.00% | 128.7 | 22.686 | 0.0 | 0.000 |
| 100 | **2015** | **4.00%** | **133.8** | **23.594** | **0.0** | **0.000** | **2015** | **4.00%** | **133.8** | **23.594** | **0.0** | **0.000** |
| 101 | 2016 | 4.00% | 139.2 | 24.538 | 0.0 | 0.000 | 2016 | 4.00% | 139.2 | 24.538 | 0.0 | 0.000 |
| 102 | 2017 | 4.00% | 144.8 | 25.519 | 0.0 | 0.000 | 2017 | 4.00% | 144.8 | 25.519 | 0.0 | 0.000 |
| 103 | 2018 | 4.00% | 150.5 | 26.540 | 0.0 | 0.000 | 2018 | 4.00% | 150.5 | 26.540 | 0.0 | 0.000 |
| 104 | 2019 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2019 | 4.00% | 156.6 | 27.601 | 0.0 | 0.000 |
| 105 | 2020 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2020 | 4.00% | 162.8 | 28.705 | 0.0 | 0.000 |
| 106 | 2021 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2021 | 4.00% | 169.3 | 29.854 | 0.0 | 0.000 |
| 107 | 2022 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2022 | 4.00% | 176.1 | 31.048 | 0.0 | 0.000 |
| 108 | 2023 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2023 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |
| 109 | 2024 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2024 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |
| 110 | 2025 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2025 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |
| 111 | 2026 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2026 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |
| 112 | 2027 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2027 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |
| 113 | 2028 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2028 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |
| 114 | 2029 | 4.00% | 152.9 | 26.952 | 0.0 | 0.000 | 2029 | 4.00% | 176.4 | 31.098 | 0.0 | 0.000 |

## Aircraft Investment Model

### Operating Cash Flows

*All monetary amounts in millions of USD*

*Study name* **Real options analysis for WEG Ph.D Thesis**

*Study horizon* **2010 to 2030**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario: A319 Purchase** | | | | | | | | | | | | | | | | | | | | | |
| ***Number of aircraft in operation*** | | | | | | | | | | | | | | | | | | | | | |
| *A319* | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total aircraft in operation | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***Profit and loss statement*** | | | | | | | | | | | | | | | | | | | | | |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | |
| Passenger | | | | | | | 27.6 | 29.3 | 31.1 | 32.2 | 32.9 | 33.5 | 34.2 | 34.9 | 35.6 | 36.3 | 37.0 | 37.7 | 38.5 | 39.3 | 40.0 |
| Cargo | | | | | | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | | | | | | |
| Total revenue | | | | | | | 27.6 | 29.3 | 31.1 | 32.2 | 32.9 | 33.5 | 34.2 | 34.9 | 35.6 | 36.3 | 37.0 | 37.7 | 38.5 | 39.3 | 40.0 |
| ***Cash operating costs*** | | | | | | | | | | | | | | | | | | | | | |
| Fuel | | | | | | | 5.3 | 5.5 | 5.6 | 5.8 | 6.0 | 6.2 | 6.4 | 6.5 | 6.7 | 6.9 | 7.1 | 7.4 | 7.6 | 8.0 | 8.2 |
| Maintenance | | | | | | | 0.7 | 1.1 | 1.6 | 2.0 | 2.3 | 2.4 | 2.5 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.4 |
| Cockpit crew | | | | | | | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 |
| Cabin crew | | | | | | | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 2.0 | 2.0 | 2.1 |
| Pax services | | | | | | | 1.2 | 1.2 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 1.9 |
| Landing fees | | | | | | | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.2 | 2.2 | 2.3 | 2.4 |
| Navigation fees | | | | | | | 1.3 | 1.3 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 1.9 | 2.0 |
| Handling fees | | | | | | | 6.5 | 6.6 | 6.8 | 7.1 | 7.3 | 7.5 | 7.7 | 7.9 | 8.2 | 8.4 | 8.7 | 8.9 | 9.2 | 9.5 | 9.8 |
| Other cash operating costs | | | | | | | | | | | | | | | | | | | | | |
| Total COC | | | | | | | 19.9 | 21.0 | 22.1 | 23.1 | 24.0 | 24.8 | 25.6 | 26.4 | 27.2 | 28.0 | 28.9 | 29.7 | 30.6 | 31.7 | 32.7 |
| Flying contribution | | | | | | | 7.7 | 8.3 | 9.0 | 9.1 | 8.8 | 8.7 | 8.6 | 8.5 | 8.4 | 8.2 | 8.1 | 8.0 | 7.9 | 7.5 | 7.3 |
| ***Fixed fleet costs*** | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | | | | | | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
| Lease payments | | | | | | | | | | | | | | | | | | | | | |
| Interest expense | | | | | | | 1.9 | 1.8 | 1.8 | 1.7 | 1.7 | 1.6 | 1.5 | 1.5 | 1.4 | 1.3 | 1.2 | 1.1 | 1.0 | 0.9 | 0.8 |
| Other fixed fleet costs | | | | | | | | | | | | | | | | | | | | | |
| Total fixed fleet costs | | | | | | | 3.4 | 3.3 | 3.3 | 3.2 | 3.1 | 3.1 | 3.0 | 2.9 | 2.9 | 2.8 | 2.7 | 2.6 | 2.5 | 2.4 | 2.3 |
| Operating Contribution | | | | | | | 4.4 | 5.0 | 5.8 | 5.9 | 5.7 | 5.6 | 5.6 | 5.6 | 5.5 | 5.5 | 5.4 | 5.4 | 5.4 | 5.2 | 5.0 |
| **Overhead (input in USDm per year)** | | | | | | | | | | | | | | | | | | | | | |
| Operating profit/loss | | | | | | | 4.4 | 5.0 | 5.8 | 5.9 | 5.7 | 5.6 | 5.6 | 5.6 | 5.5 | 5.5 | 5.4 | 5.4 | 5.4 | 5.2 | 5.0 |
| Gain/(loss) on sale of aircraft | | | | | | | | | | | | | | | | | | | | | |
| Income tax | | | | | | | 1.5 | 1.8 | 2.0 | 2.1 | 2.0 | 2.0 | 2.0 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.9 | 1.8 | 1.8 |
| Net profit | | | | | | | 2.8 | 3.3 | 3.8 | 3.9 | 3.7 | 3.7 | 3.6 | 3.6 | 3.6 | 3.6 | 3.5 | 3.5 | 3.5 | 3.4 | 3.3 |
| Net profit margin | | | | | | | 10% | 11% | 12% | 12% | 11% | 11% | 11% | 10% | 10% | 10% | 10% | 9% | 9% | 9% | 8% |
| **Scenario: A319 Purchase** | | | | | | | | | | | | | | | | | | | | | |
| ***Operating cash flow*** | | | | | | | | | | | | | | | | | | | | | |
| Flying contribution | | | | | | | 7.7 | 8.3 | 9.0 | 9.1 | 8.8 | 8.7 | 8.6 | 8.5 | 8.4 | 8.2 | 8.1 | 8.0 | 7.9 | 7.5 | 7.3 |
| - Cash fixed fleet costs | | | | | | | | | | | | | | | | | | | | | |
| - Overhead | | | | | | | | | | | | | | | | | | | | | |
| - Income tax | | | | | | | ( 2.7) | ( 2.9) | ( 3.2) | ( 3.2) | ( 3.1) | ( 3.0) | ( 3.0) | ( 3.0) | ( 2.9) | ( 2.9) | ( 2.8) | ( 2.8) | ( 2.7) | ( 2.6) | ( 2.6) |
| + Increase in current liabilities | | | | | | | | | | | | | | | | | | | | | |
| - Increase in current assets | | | | | | | | | | | | | | | | | | | | | |
| Total Operating cash flow | | | | | | | 5.0 | 5.4 | 5.9 | 5.9 | 5.7 | 5.7 | 5.6 | 5.5 | 5.4 | 5.4 | 5.3 | 5.2 | 5.1 | 4.9 | 4.8 |

## Aircraft Investment Model

**Operating Cash Flows**

*All monetary amounts in millions of USD*

*Study name* **Real options analysis for WEG Ph.D Thesis**

*Study horizon* **2010 to 2030**

| Year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario: A320 purchase** | | | | | | | | | | | | | | | | | | | | | |
| ***Number of aircraft in operation*** | | | | | | | | | | | | | | | | | | | | | |
| *A320* | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Total aircraft in operation | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ***Profit and loss statement*** | | | | | | | | | | | | | | | | | | | | | |
| ***Revenue*** | | | | | | | | | | | | | | | | | | | | | |
| Passenger | | | | | | | 27.6 | 29.3 | 31.1 | 33.0 | 35.0 | 37.1 | 39.4 | 40.2 | 41.0 | 41.9 | 42.7 | 43.5 | 44.4 | 45.3 | 46.2 |
| Cargo | | | | | | | | | | | | | | | | | | | | | |
| Other | | | | | | | | | | | | | | | | | | | | | |
| Total revenue | | | | | | | 27.6 | 29.3 | 31.1 | 33.0 | 35.0 | 37.1 | 39.4 | 40.2 | 41.0 | 41.9 | 42.7 | 43.5 | 44.4 | 45.3 | 46.2 |
| ***Cash operating costs*** | | | | | | | | | | | | | | | | | | | | | |
| Fuel | | | | | | | 5.4 | 5.5 | 5.7 | 5.9 | 6.1 | 6.2 | 6.4 | 6.6 | 6.8 | 7.0 | 7.2 | 7.5 | 7.7 | 8.1 | 8.3 |
| Maintenance | | | | | | | 0.8 | 1.2 | 1.7 | 2.1 | 2.4 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 | 3.3 | 3.4 | 3.6 |
| Cockpit crew | | | | | | | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 | 2.5 | 2.6 | 2.6 | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 |
| Cabin crew | | | | | | | 1.4 | 1.4 | 1.5 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 2.0 | 2.0 | 2.1 |
| Pax services | | | | | | | 1.3 | 1.4 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.9 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 |
| Landing fees | | | | | | | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 2.0 | 2.0 | 2.1 | 2.1 | 2.2 | 2.3 | 2.3 | 2.4 |
| Navigation fees | | | | | | | 1.3 | 1.4 | 1.4 | 1.4 | 1.5 | 1.5 | 1.6 | 1.6 | 1.7 | 1.7 | 1.8 | 1.8 | 1.9 | 1.9 | 2.0 |
| Handling fees | | | | | | | 7.1 | 7.3 | 7.5 | 7.7 | 7.9 | 8.2 | 8.4 | 8.7 | 8.9 | 9.2 | 9.5 | 9.8 | 10.1 | 10.4 | 10.7 |
| Other cash operating costs | | | | | | | | | | | | | | | | | | | | | |
| Total COC | | | | | | | 20.8 | 22.0 | 23.1 | 24.2 | 25.2 | 26.0 | 26.8 | 27.7 | 28.5 | 29.4 | 30.3 | 31.2 | 32.1 | 33.3 | 34.3 |
| Flying contribution | | | | | | | 6.8 | 7.4 | 8.0 | 8.8 | 9.8 | 11.1 | 12.6 | 12.6 | 12.5 | 12.5 | 12.4 | 12.4 | 12.3 | 12.1 | 11.9 |
| ***Fixed fleet costs*** | | | | | | | | | | | | | | | | | | | | | |
| Depreciation | | | | | | | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lease expense | | | | | | | | | | | | | | | | | | | | | |
| Interest expense | | | | | | | 2.5 | 2.4 | 2.4 | 2.3 | 2.2 | 2.1 | 2.0 | 1.9 | 1.8 | 1.7 | 1.6 | 1.5 | 1.4 | 1.2 | 1.1 |
| Other fixed fleet costs | | | | | | | | | | | | | | | | | | | | | |
| Total fixed fleet costs | | | | | | | 4.5 | 4.4 | 4.3 | 4.3 | 4.2 | 4.1 | 4.0 | 3.9 | 3.8 | 3.7 | 3.6 | 3.5 | 3.3 | 3.2 | 3.0 |
| Operating Contribution | | | | | | | 2.3 | 2.9 | 3.6 | 4.5 | 5.6 | 7.0 | 8.6 | 8.7 | 8.7 | 8.8 | 8.8 | 8.9 | 9.0 | 8.9 | 8.8 |
| **Overhead (input in USDm per year)** | | | | | | | | | | | | | | | | | | | | | |
| Operating profit/loss | | | | | | | 2.3 | 2.9 | 3.6 | 4.5 | 5.6 | 7.0 | 8.6 | 8.7 | 8.7 | 8.8 | 8.8 | 8.9 | 9.0 | 8.9 | 8.8 |
| Gain/(loss) on sale of aircraft | | | | | | | | | | | | | | | | | | | | | |
| Income tax | | | | | | | 0.8 | 1.0 | 1.3 | 1.6 | 2.0 | 2.5 | 3.0 | 3.0 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 |
| Net profit | | | | | | | 1.5 | 1.9 | 2.4 | 2.9 | 3.7 | 4.6 | 5.6 | 5.6 | 5.7 | 5.7 | 5.7 | 5.8 | 5.8 | 5.8 | 5.8 |
| Net profit margin | | | | | | | 5% | 7% | 8% | 9% | 10% | 12% | 14% | 14% | 14% | 14% | 13% | 13% | 13% | 13% | 12% |
| **Scenario: A320 purchase** | | | | | | | | | | | | | | | | | | | | | |
| ***Operating cash flow*** | | | | | | | | | | | | | | | | | | | | | |
| Flying contribution | | | | | | | 6.8 | 7.4 | 8.0 | 8.8 | 9.8 | 11.1 | 12.6 | 12.6 | 12.5 | 12.5 | 12.4 | 12.4 | 12.3 | 12.1 | 11.9 |
| - Cash fixed fleet costs | | | | | | | | | | | | | | | | | | | | | |
| - Overhead | | | | | | | | | | | | | | | | | | | | | |
| - Income tax | | | | | | | ( 2.4) | ( 2.6) | ( 2.8) | ( 3.1) | ( 3.4) | ( 3.9) | ( 4.4) | ( 4.4) | ( 4.4) | ( 4.4) | ( 4.3) | ( 4.3) | ( 4.3) | ( 4.2) | ( 4.2) |
| + Increase in current liabilities | | | | | | | | | | | | | | | | | | | | | |
| - Increase in current assets | | | | | | | | | | | | | | | | | | | | | |
| Total Operating cash flow | | | | | | | 4.4 | 4.8 | 5.2 | 5.7 | 6.4 | 7.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.0 | 8.0 | 7.8 | 7.7 |

## Aircraft Investment Model

### Cash Flow Summary

All monetary amounts in millions of USD

*Study name* **Real options analysis for WEG Ph.D Thesis**

*Study horizon* **2010 to 2030**

| **Year** | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | **2020** | **2021** | **2022** | **2023** | **2024** | **2025** | **2026** | **2027** | **2028** | **2029** | **2030** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Scenario: A319 Purchase** | | | | | | | | | | | | | | | | | | | | | |
| ***Economic cash flow and NPV*** | | | | | | | | | | | | | | | | | | | | | |
| Operating cash flow | | | | | | | 5.0 | 5.4 | 5.9 | 5.9 | 5.7 | 5.7 | 5.6 | 5.5 | 5.4 | 5.4 | 5.3 | 5.2 | 5.1 | 4.9 | 4.8 |
| Investing cash flow | | | | | | ( 36.9) | | | | | | | | | | | | | | | 14.8 |
| Tax impact of investing and financing | | | | | | | 1.2 | 1.2 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 1.0 | 1.0 | 0.9 | 0.9 | 0.9 | 0.8 | 0.8 |
| Economic cash flow | | | | | | ( 36.9) | 6.2 | 6.6 | 7.0 | 7.1 | 6.8 | 6.7 | 6.6 | 6.5 | 6.4 | 6.3 | 6.2 | 6.1 | 6.0 | 5.8 | 20.3 |
| Verify no more than 1 sign change for IRR: | | | | | | | 1.0 | | | | | | | | | | | | | | |
| **Net Present Value (NPV) at year-end 2010** | **12.7** | | | | | A319 CF 2015 | A319 CF 2016 | A319 CF 2017 | A319 CF 2018 | A319 CF 2019 | A319 CF 2020 | A319 CF 2021 | A319 CF 2022 | A319 CF 2023 | A319 CF 2024 | A319 CF 2025 | A319 CF 2026 | A319 CF 2027 | A319 CF 2028 | A319 CF 2029 | A319 CF 2030 |
| **Profitability index (NPV/Investment)** | **0.4** | | | | | | | | | | | | | | | | | | | | |
| **Internal Rate of Return** | **16.68%** | | | | | | | | | | | | | | | | | | | | |
| ***Breakeven NPV analysis*** | | | | | **PV at T1** | ( 26.1) | 4.0 | 3.9 | 3.8 | 3.5 | 3.2 | 2.8 | 2.6 | 2.3 | 2.1 | 1.9 | 1.7 | 1.5 | 1.4 | 1.2 | 4.0 |
| Annual PV's during the project | | | | | **PV at T0** | ( 24.0) | 3.7 | 3.6 | 3.5 | 3.3 | 2.9 | 2.6 | 2.4 | 2.1 | 1.9 | 1.7 | 1.6 | 1.4 | 1.3 | 1.1 | 3.6 |
| Cumulative NPV | | | | | | ( 24.0) | ( 20.3) | ( 16.7) | ( 13.2) | ( 9.9) | ( 7.0) | ( 4.4) | ( 2.1) | 0.1 | 2.0 | 3.7 | 5.3 | 6.7 | 8.0 | 9.1 | 12.7 |
| | | | | | | A319 NPV 201! | A319 NPV 201 | A319 NPV 201 | A319 NPV 201 | A319 NPV 201 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 202 | A319 NPV 203 |
| **Scenario: A320 purchase** | | | | | | | | | | | | | | | | | | | | | |
| ***Economic cash flow and NPV*** | | | | | | | | | | | | | | | | | | | | | |
| Operating cash flow | | | | | | | 4.4 | 4.8 | 5.2 | 5.7 | 6.4 | 7.2 | 8.2 | 8.2 | 8.1 | 8.1 | 8.1 | 8.0 | 8.0 | 7.8 | 7.7 |
| Investing cash flow | | | | | | ( 49.2) | | | | | | | | | | | | | | | 19.7 |
| Tax impact on investing and financing | | | | | | | 1.6 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.4 | 1.4 | 1.3 | 1.3 | 1.3 | 1.2 | 1.2 | 1.1 | 1.1 |
| Economic cash flow | | | | | | ( 49.2) | 6.0 | 6.3 | 6.7 | 7.2 | 7.8 | 8.7 | 9.6 | 9.5 | 9.5 | 9.4 | 9.3 | 9.2 | 9.2 | 9.0 | 28.5 |
| **Net Present Value (NPV) at year-end 2010** | **13.6** | | | | | A320 CF 2015 | A320 CF 2016 | A320 CF 2017 | A320 CF 2018 | A320 CF 2019 | A320 CF 2020 | A320 CF 2021 | A320 CF 2022 | A320 CF 2023 | A320 CF 2024 | A320 CF 2025 | A320 CF 2026 | A320 CF 2027 | A320 CF 2028 | A320 CF 2029 | A320 CF 2030 |
| **Profitability index (NPV/Investment)** | **0.3** | | | | | | | | | | | | | | | | | | | | |
| **Internal Rate of Return** | **14.52%** | | | | | | | | | | | | | | | | | | | | |
| ***Breakeven NPV analysis*** | | | | | **PV at T1** | ( 34.9) | 3.9 | 3.8 | 3.7 | 3.6 | 3.6 | 3.7 | 3.7 | 3.4 | 3.1 | 2.8 | 2.6 | 2.3 | 2.1 | 1.9 | 5.5 |
| Annual PV's during the project | | | | | **PV at T0** | ( 32.0) | 3.6 | 3.5 | 3.4 | 3.3 | 3.3 | 3.4 | 3.4 | 3.1 | 2.8 | 2.6 | 2.3 | 2.1 | 1.9 | 1.7 | 5.1 |
| Cumulative NPV | | | | | | ( 32.0) | ( 28.4) | ( 25.0) | ( 21.6) | ( 18.3) | ( 15.0) | ( 11.6) | ( 8.2) | ( 5.1) | ( 2.3) | 0.3 | 2.7 | 4.8 | 6.7 | 8.5 | 13.6 |
| | | | | | | A320 NPV 201! | A320 NPV 201 | A320 NPV 201 | A320 NPV 201 | A320 NPV 201 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 202 | A320 NPV 203 |