Use-Oriented Business Models and Flexibility in Industrial Product-Service Systems

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Abstract

Today's corporate environments are characterized by growing dynamics and uncertainties. Here, flexibility gains importance as a critical success factor. This is especially true for long-term customer-supplier relationships. As a solution to the mentioned uncertainties connected with such a business relationship, one can think of flexible systems. The contribution at hand focuses on contracts to control for customer-supplier relationships. By reallocating property rights in use-oriented business models it is possible to distribute incentives and risks to better balance the interests of customers and suppliers. Our contribution points out the importance of flexibility and describes the opportunity to detect the optimal degree of flexibility of an IPS².

Keywords:

Use-oriented business models, Industrial Product-Service Systems, incomplete contracts, flexibility

1 INTRODUCTION

The change from a mere product business to selling customized problem solutions has lead to the establishment of terms such as business models, performance contracts, life cycle costs and product-service systems. This conception, which focuses on securing sustained earnings through services besides the one-off sale of products, originates in the change of customers' requirements and is driven to a great extent by the reallocation of risks and incentives. In a business environment characterized by increased uncertainty, the aspects "availability" and "flexibility" of an Industrial Product-Service System are thus of special significance.

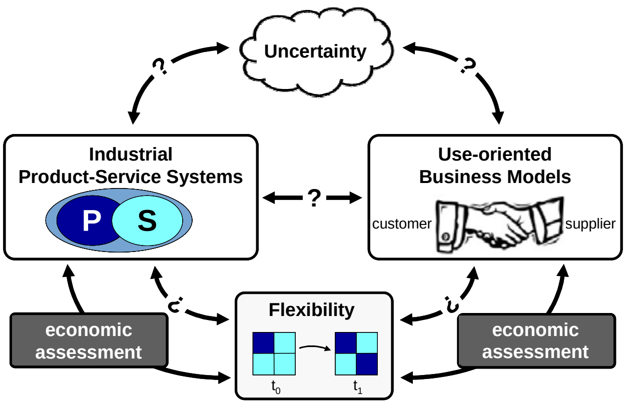

Figure 1: Questions

Here, the classical term "production system" is consciously replaced by the term "Industrial Product-Service System" (IPSS) which, according to its definition, is characterized by a life-cycle-oriented integration of the industrial supply of products and service parts **[1]**. This substitution of the term which is discussed both in academic and in industrial circles as well as a currently high publication density regarding the issue of use-oriented business models raises the following questions (**figure 1**):

- What is the relationship between uncertainty, use-oriented business models and IPSS?
- What is the significance of the aspect flexibility in use-oriented business models and how can flexibility be integrated into IPSS?
- How can IPSS be designed in an economically sensible way and how can you quantify the value of flexibility of IPSS?

2 UNCERTAINTY, USE-ORIENTED BUSINESS MODELS AND IPSS

Contracts, which create an institutional framework within which rights, obligations and responsibilities are regulated, constitute the basis of a business relationship between the supplier and the customer. Thus, contracts determine business models and, depending on these, they can be of formal and/or informal nature, i.e. explicitly stipulate terms and/ or include implicit agreements. The design of contracts and, thus, of business models is, in particular, characterized by the factor "uncertainty". On account of "uncertainty", long-term contracts have to remain "incomplete" so that they provide room for opportunistic behaviour and therefore influence the players' incentive to behave in the sense of the business relationship. Besides the negative consequences related to this uncertainty regarding conduct, the contracts' incompleteness offers the possibility to flexibly react to future environmental situations. Thus, uncertainty does not only generate risks, but also, most importantly, chances.

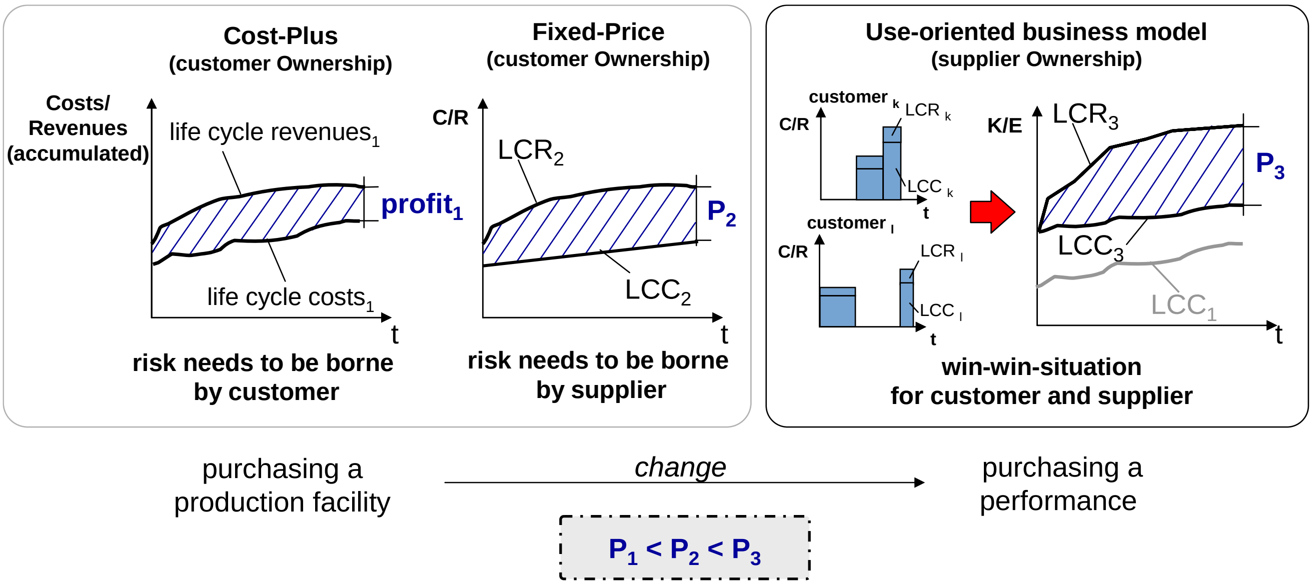

Figure 2: Costs, revenues and profits of selected business models

It is the aim of innovative business models to evenly spread risks, chances and incentives between the supplier and the customer **[2].** In **figure 2**, the evolution of business models is depicted. The expansion of the spectrum of business models from the cost-plus to the use-oriented business model is rendered possible through innovative technologies, the rearrangement of the ownership of capital goods (customer ownership versus supplier ownership) and, in particular, through the expansion of industrial services. This directly affects the flows of accumulated costs (LCC_i), revenues (LCR_i) and profits (P_i).

In cost-plus offers, industrial services are mainly only intended as add-on and are limited to the maintenance and servicing of certain components of the production system. Further services are merely optional, as the customer is the owner of the machine and is responsible for the availability of the machine. In this business model, the financial risk caused by a system failure is the responsibility of the customer and results in fluctuating life-cycle costs (LCC_1) (**figure 2**). As the supplier does not assume any risk in this business model, he has no incentive to carry out sustained changes to the machine and to thus reduce the life-cycle costs.

Fixed-price models, however, include the customer's requirement that the product's life-cycle costs are guaranteed, depicted in the linear course of the LCC_2 curve in **figure 2**. This leads to the transition from a transaction-oriented, short-term business relationship to a relational, long-term business relationship **[3]** in which a substantial proportion of the risk of a failure is transferred to the supplier. In order to determine and/or reduce the risk of a failure and the costs related herewith, the supplier expands his industrial service offer and provides condition-oriented maintenance and servicing especially aligned to the machine. In the contrary to the cost-plus business model, it is necessary to integrate the development of products and services in this case. Through bundling product and industrial services, incentives have now, however, been created for the supplier to reduce the product-service system's life-cycle costs, but not to increase the productivity of this system. Likewise, the customer has no incentive to operate the technical system in "manner which protects the material".

The comparison of cost-plus and fixed-price business models leads to the conclusion that a one-sided distribution of risks and incentives is no basis for solving the problem in a way which is ideal for both parties. Use-oriented business models which go beyond existing approaches such as "use-oriented maintenance" **[4]** offer an approach for achieving an efficient distribution of risks and incentives. The difference lies in the title to the machine, whereby it no longer becomes the customer's property but remains the property of the supplier. In this case, the range of the offer of these contracts reaches up to the "temporary availability" of a partial production system, at least in theory. Similar to the basic principle of a car rental service, it is intended to sell an availability service within a determined time interval to various customers in this case (**figure 2**). The temporary availability includes both the system's guaranteed quantitative operational readiness and its availability in terms of location and time. Besides adapting the technical system, it is also necessary to extend the industrial service portfolio (logistics, ramp up, etc.) in order to ensure this. Through aligning the business partners' interests, incentives are now created for the supplier to not only improve the service offer's quality but also its productivity, whereby the flexibility of the product-service system required for implementing this business model takes advantage of the incompleteness of contracts. It becomes clear that product-service systems and use-oriented business models are not to be understood as synonyms, but that they complement one another.

3 RELATED LITERATURE: CLOSING THE GAP

A great deal of literature has been dedicated to the problem of contract design both in the literature of economics and with regard to supply chain management. In the area of research of economics the theory of incomplete contracts deals with the question of how to design an optimal contractual relationship, so as to induce efficient transaction-specific investments (for a literature review see Schmitz **[5]**). According to this theory investments are made with aim of either reducing production costs or increasing the value of the good. The term "investment" does not only refer to financial aspects, but is used to describe all activities which increase the profitability of a business relationship. Selfish and

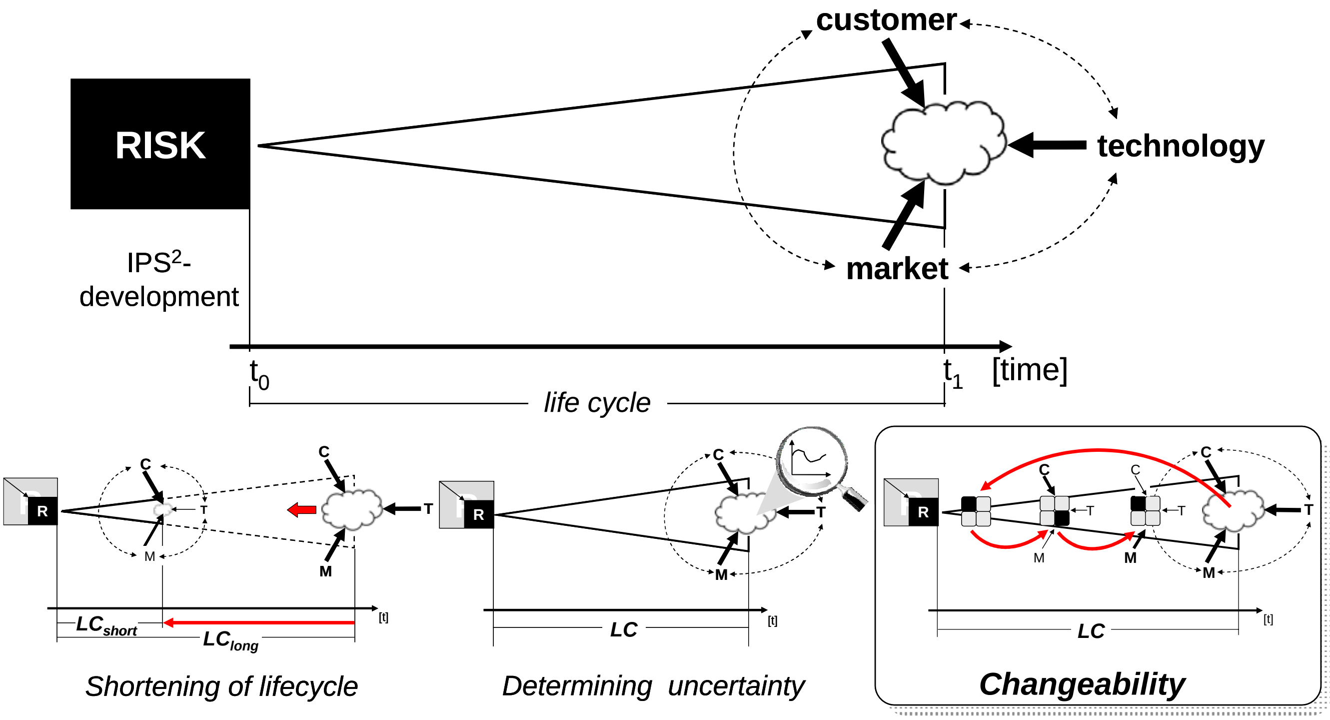

Figure 3: Development risks and possibilities to reduce risks

cooperative investments need to be distinguished. While selfish investments from the supplier's point of view aim at reducing production costs, cooperative investments result in an increased value of the good. Industrial services such as maintenance and repair can in this regard be classified as cooperative investments.

Renegotiations which take place after uncertainties regarding the environment have dissolved implicate underinvestments in this theory. These result from the fact, that while the investing party needs to cover the costs of its investment alone, it has to share the surplus by renegotiation with the other party (hold-up problem). Renegotiations therefore may have negative economic consequences.

Contrary to this, contract analysis in supply chain management (SCM) focuses on investments in capacity and inventory (for an overview over supply chain contracts see Tsay, Nahmias and Agrawal **[6]**). The basic difference between these lines of argumentation is the modeling of renegotiations which forms no part of the SCM-literature. Rather, in return to a commitment customers obtain the flexibility to revise their initial decision conditional on updated information in subsequent periods. Risks are thereby implicitly transferred to the supplier. For example with so called „quantity flexibility contracts" customers have to communicate ex ante forecasts of their estimated demands to suppliers. These can be adjusted ex post after the market demand has been realized. To earn this right the customer has to ex ante commit to a minimum purchase quantity. Other contract forms distinguish between the reservation of capacity and its actual usage.

As is the case in the SCM-literature, aspects of flexibility and contract design are a central part of our contribution. In contrast to an analysis on the level of components, which is the focus of the previously described literature, we concentrate on the system's level. In this context, in addition to the reallocation of incentives and risks through contracts the problem of "product architecture" gains importance. Baiman et al. examine the interplay of performance measures for contract design, the product architecture and incentive efficiency in a supply chain **[7]**. Their results show that when choosing a product architecture not only consequences of manufacturability need to find consideration, but also the incentive efficiency of the whole supply chain. However, they do not consider aspects of flexibility and services in their contribution.

In the following, this article neglects the strategic interaction between supplier and customer and focuses on the development of the system and its flexibility. We motivate this approach because, as discussed in the previous chapter, the choice of the use-oriented business model creates the "right" incentives for suppliers. Consequently, the incomplete character of contracts is seen as an opportunity and not a risk of opportunistic behavior. What needs to be discussed is the degree of flexibility IPSS must have, in order to realize future opportunities when delivering the system.

4 SIGNIFICANCE OF FLEXIBILITY AND ITS INTERGATION INTO IPSS

Below, the aspect of "flexibility" which is frequently discussed in literature will be dealt with and brought into relation with IPSS (compare **[8]**). For the time being, we shall shelve the definition of the term in favour of a general contemplation.

Figure 3 points out the initial problem. In today's development decision (t_0), uncertain values of tomorrow (t_1) flow in along the life cycle which can be bundled in the development risk.

In this case, the interplay of the risk factors "technology", "market" and "customer" represent both endogenous and exogenous factors which will affect the industrial product-service bundle in future.

Here, it becomes evident that, besides aspects such as uncertainty regarding the further development of a technology or fluctuating sales volumes required by the market, in particular instable customer preferences increase the development risk **[9]**. In order to reduce this,

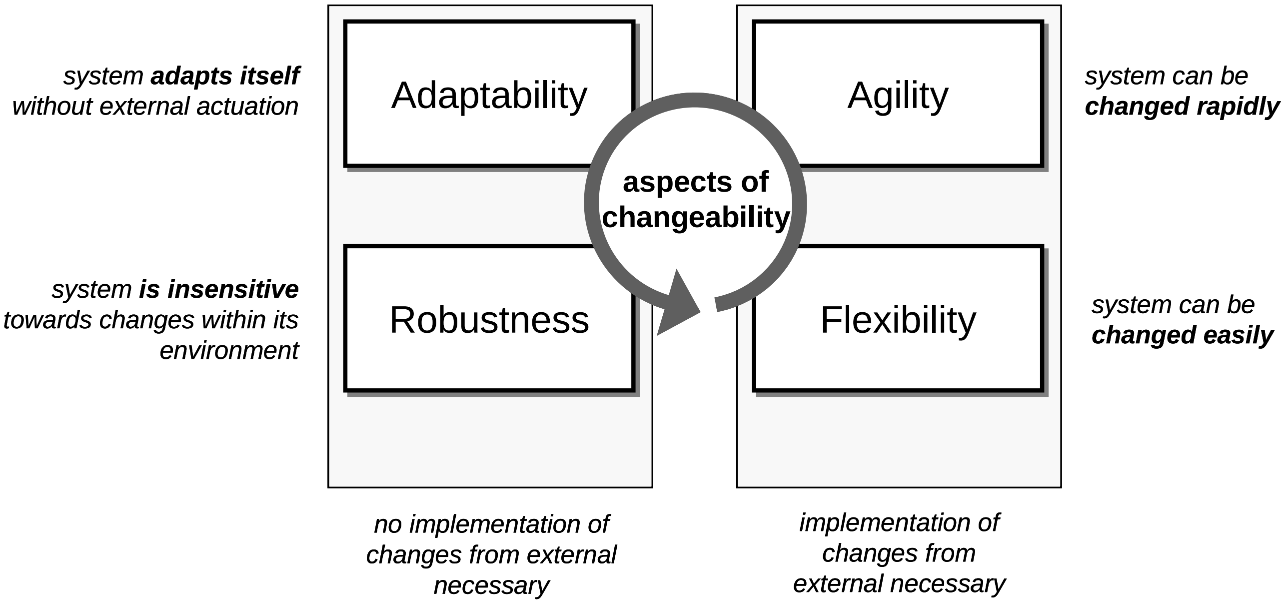

Figure 4: Four aspects of changeability

alternative solution mechanisms exist which are depicted in the bottom half of **figure 3**. On the one hand, the period of contemplation and/or the life cycle (on behalf of a service) can be shortened to, in particular, reduce the risk implied by the market and the technology. On the other hand, there is the possibility to invest more time into examining the uncertainty in order to take the likelihood of future environmental situations occurring as well as their effect into account when developing goods. On account of relational contracts' being of a long-term nature and the systems becoming more complex for integration reasons, these mechanisms are, however, not sufficient for reducing the risk involved in the development of Industrial Product-Service Systems.

In combination with the incompleteness of use-oriented service contracts, it is of great importance to take the third mechanism, the system's changeability, into account, whereby changeability is generally understood as the ability of a system to react to relevant changes induced by the system or the environment by means of available internal or external factors **[10]**. As you can see in **figure 4**, robustness, flexibility, adaptability and agility (flexibility in a broader sense) are immanent components of changeability according to Fricke and Schultz **[11]**. However, it only makes sense to use these differentiations regarding the terms, which are partially extended by the aspect of reconfigurability, in combination with defined system boundaries. As this article is based on a superordinate understanding of changeability and, in particular, the character of the possibility to act is intended to be emphasized, the term "flexibility" is used below.

There are many possibilities for integrating flexibility into a system, whereby especially the aspect of modularisation comes into the fore, besides principles such as the independence of the system's elements, the reduction of the system's complexity or non-hierarchic coupling **[11]**. As, according to Wiendahl **[12]**, modularisation is understood to be the substantial enabler of flexibility in production technology, the idea seems reasonable to also apply this approach with regard to designing the architecture of Industrial Product-Service Systems. Besides the production-oriented approaches of Schuh et al. **[13]**, the modularisation approach for industrial services according to Böhmann et al. **[14]** must be mentioned in this context, whereby the modularisation of Industrial Product-Service Systems also provides for integrated hybrid modules, besides mere products or service modules.

5 VALUE-ORIENTED DESIGN AND MANAGEMENT OF IPSS

To this point, the explanations have revealed that in particular in the context of Industrial Product-Service Systems increased significance is placed on the strategic success factor "flexibility" in product development. Generally, technical methods do, however, follow the simple heuristic "more flexibility is good". In this section, a superordinate reference value shall be introduced with the economic value by means of which the process of determining the ideal degree of flexibility, i.e. the assessment of the value contribution of flexibility, can be supported. Baldwin and Clark **[15]** stipulate in a similar context "Designers see and seek value flexibility in new designs" and Sullivan et al. **[16]** interpret the design and/or the development process to be "one of investing valuable resources under uncertainty with the goal of maximising value added". In this context, establishing flexibility in Industrial Product-Service Systems implies increased investments which are caused by an increased use of resources on the one hand and opportunity costs due to opportunities of alternative allocation of resources which have not been seized, on the other hand **(figure 2)**. The higher the economic costs for adapting a product are, the lower is flexibility. Thus, the ideal extent of flexibility is a parameter of the economic trade-off of high pre-production costs and low follow-up costs.

In this context, controlling has the task of planning, steering and coordinating the establishment of flexibility in development, whereby the challenge lies in assessing the economic value of flexibility, whereas it is relatively easy to quantify the costs related to establishing flexibility. The economic value of flexibility is the result of the ability to react to changing conditions in the future. Thus, the payment flows related to this depend on the uncertain future conditions.

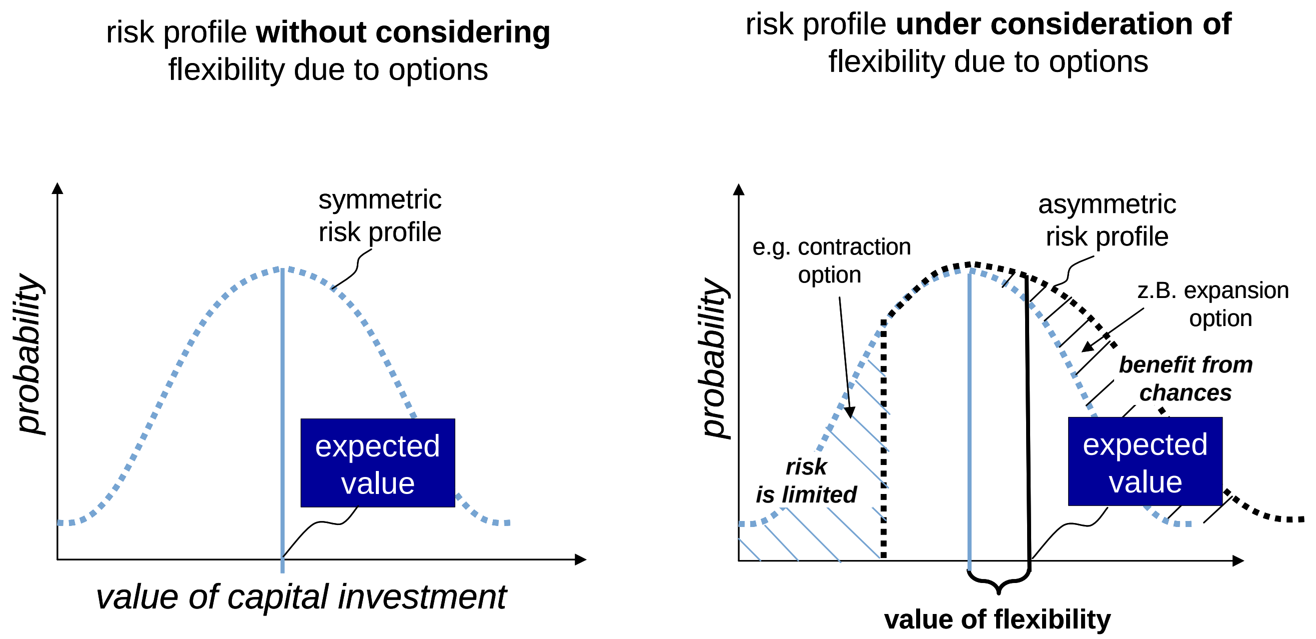

Figure 5: Taking flexibility through options into account

Traditional assessment procedures of investment planning and budgeting (e.g. net present value method) or of cost management (e.g. target cost management) are no longer sufficient against this setting, as assumptions regarding an expected scenario of payment flows are implicitly related with them **[17]**. The respective restrictions of these instruments, which literature classifies as deterministic, result in the investment object being systematically underrated and lead to the real option approach being recommended (**figure 5**). A key finding of this approach is that increased uncertainty of the payment flows triggered by the investment increases the value of flexibility and/or the value of the real option.

However, frequently there is a lack of flexibility to carry out actions at a later date at an adequate cost if the Industrial Product-Service System has not been designed for this purpose from the beginning. In the following section, the idea of the real option approach will be presented and transferred to the development of Industrial Product-Service Systems.

6 THE REAL-OPTION APPROACH FOR ASSESSING FLEXIBILITY

An option is defined as the right, but not the obligation to purchase (call) or sell (put) a specified asset (a share, a contract or a design) at a price stipulated in advance (basic price or exercise price) within an agreed period of time (term of the option). The right to only exercise an option if it is in the interest of the option holder implies an asymmetric spread of risks of payment flows (**figure 5**). Thus, options differ from contracts which include the obligation to purchase or sell an item of property at specified conditions in the future from today on **[18]**. Therefore symmetric payment flows, which can develop both positively and negatively are involved in contracts. Due to the options' asymmetric characteristic, risks can be limited on the one hand and chances arising in the future can be used on the other hand. Against this setting, there is the wish for more uncertainty so that the option's value increases.

On the contrary to financial options which are traded in financial markets and for which there are elaborate assessment procedures, real options relate to real items, such as design, technologies or production processes **[15]**. Typical options existing in business practice are:

- the defer option**,** which describes the possibility of deferring investment until new information is received,
- the abandonment option, with which the investment can be carried out stepwise and, if necessary, be called off,
- the expansion or contracting option, which provides the possibility of adapting the extent of the investment as well as,
- the switching option, which enables its holder to change the way an item of property functions (e.g. to the input or output of a flexible production plant) **[17]**.

There are certain similarities between financial and real options. For example, if the interim results did not meet expectations, the abandonment option of an r&d project can be compared with a call option in the financial market which has not been exercised if the value of the object offered under subscription is below the exercise price. Despite certain similarities, there are, however, significant differences in the investment environment which make it difficult to directly apply the assessment methods for financial options to real options **[18]**, as the application of these procedures requires a complete capital market in which the uncertainty of the investment through traded assets can be duplicated. The risk within the development processes is, however, of private nature and cannot be represented in the market. Thus, the approach of dynamic programming is pursued in literature - an approach which does not require this strict assumption, but which is, however, not able to determine the correct, risk-adjusted interest rate **[19]**. Finally, instead of looking at the assessment procedures, we shall examine how the idea of service bundling is dealt with in the context of an option-based conception.

The IPSS is to be understood as a portfolio of assets whose value is determined by options **[16]**. It is the aim to treat the flexibility of an IPSS as an option and therefore be able to quantify it easily. According to the explanations in section 3, options are generated through as system's architecture. As this is, however, frequently determined through technical decisions in practice, the maximization of the value added of an Industrial Product-Service System is possibly not given. Thus, the modularization does possess a value through creating a portfolio of options which, if you assume that the aggregated value function remains the same, supersedes the value of an option on a portfolio **[16]**. However, negative (economic) consequences must be expected with an over or under-modularisation **[20]**. By means of the real-option approach, the ideal strategy, i.e. the decision regarding the ideal number of modules can be supported here. Besides duplicating the options in form of a "mix & match" of modules, there is also the possibility to change this locally, i.e. to exercise the options described above on individual modules.

7 SUMMARY

The contracts for regulating customer-supplier relations which remain incomplete on account of being of a long-term nature and therefore being uncertain imply problems regarding incentives and thus inefficiencies. In particular, through re-allocating property rights it is possible to spread incentives and risks more evenly in use-oriented business models and to align the customer's and the supplier's interests. Thus, the leeway which exists thanks to the incompleteness of contracts is not understood as a risk, but rather as a chance which can be seized through correspondingly developing a flexible IPSS. The article reveals the significance of flexibility and describes the possibility of determining the value and therefore the ideal extent of flexibility of such a system by means of the real-option approach. In particular, through determining both the business model and the IPSS, it can be ascertained that these are not synonyms, but two constructs which complement one another.

Future research needs a combined view on IPSS and their related innovative business models. The objective is to have a better understanding of the relation between the (architecture of an) IPSS and the business model. A first approach was provided by Richter and Steven who specify the dominance of use- and result-oriented models subject to the complexity of product design **[21]**.

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