
**Jan Vašek**

# Commodity Reference Price Transparency: Conceptualization, Measurement Instrument Development, and Influence on Commodity Price Management

School of Management

PhD Thesis
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Supervisors:

Prof. Soroosh Saghiri and Prof. Michael Bourlakis

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This thesis is submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

# ABSTRACT

Commodity reference price (CRP) is potentially an important commodity price management influencing factor. However, despite its importance, it remains under-researched and poorly understood. Anchored in contingency theory and building on previous studies, this study (a) conceptualizes CRP contingency as CRP transparency, (b) creates a CRP transparency index as a tool for classifying and evaluating CRP, and (c) demonstrates the CRP transparency impact on CRP functions and CPM practices.

Intuitive and interpretive literature reviews are combined with nine directed expert interviews to uncover the CRP transparency attributes. Subsequently, 111 interviews with purchasing managers explore a purposive sample of 22 CRP to construct and populate the CRP transparency index and to explore its theoretical and practical relevance, in particular, how individual CRP transparency levels shape CRP functions and impact the availability, choice and performance of commodity price management practices.

The main contributions of this thesis to theory are (a) conceptualizing CRP transparency as a multi-dimensional construct composed of four measured attributes: accuracy, completeness, publication frequency, and methodology, (b) operationalizing these measured attributes into five transparency levels, (c) constructing CRP transparency index divided into five distinct and meaningful levels following a geological metaphor: black hole, opaque, translucent, transparent, dazzle. From a practitioner standpoint, this thesis provides actionable insights into (i) CRP transparency assessment and comparison with alternative CRP, (ii) how CRP transparency shapes the commodity price management practices and CRP functions and, (iii) offers an empirical toolbox for assessing, comparing, and configuring CRP to regulators and CRP issuers.

Keywords:

Commodity price management, Commodity reference price, Commodities, Contingency theory, Composite index

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| | |
|---|---|
| **CPM** | Commodity price management |
| **CRP** | Commodity reference price(s) |
| **CRPTI** | Commodity reference price transparency index |
| **LME** | London metal exchange |
| **PM** | Purchasing manager |
| **PRA** | Price reporting agency |
| **RF** | Reference price |
| **SP** | Strategic procurement / purchasing |
| **SCT** | Supply chain transparency |
| **TC** | Transaction costs |
| **TCE** | Transaction cost economy |

# 1. Introduction

## 1.1. Personal motivation for the research

Commodity price management (CPM) represents a fundamental skill for managing volatile commodities procured indirectly as an important cost driver of a final product or directly in the form of standard raw materials such as chemicals or metals. Most of the time, the CPM process is relatively straightforward and institutionalized. However, a mindful observer would immediately notice how extensively commodity reference prices inform and shape CPM, e.g., pegging the copper wire price to the monthly average settlement price informed by the London Metal Exchange, updating aluminium die-casting prices whenever the aluminium price on the commodity exchange exceeded 10%, studying commodity price updates in various market reports, leveraging or downplaying them in commercial negotiations, or observing energy prices on commodity exchanges and trying to take the right purchase decisions.

From the positions of commodity procurement specialist and director, the author noticed that most buyers hardly ever reflected on commodity reference prices (CRP)- their origin, motivation behind their issuance, or their quality and fitness for use. The author was also puzzled why some commodity reference prices were treated as undisputed contract references while others were ferociously challenged, frowned upon, or even seemingly ignored. Finally, the author was surprised to discover that these implicit CRP quality assessments were based on intuition, experience, or anecdotal evidence and may therefore lead to costly mistakes, e.g., CRP covering an important chemical became completely decoupled from the market during the recession. The reason appeared much later when the leading producers were fined for systematically manipulating the benchmark (Tadena and Cameron, 2013; European Commission, 2014).

Poor understanding of CRP and the absence of actionable CRP assessment tools becomes particularly salient during turbulent periods when existing CPM practices stop working and business partners may come up with new or less well-known commodity indices such as scrap and alloy surcharges for steel, billet premium for nickel, diesel floater for transport, or energy surcharge for production processes. As there is no simple way of assessing the quality of these new indices or comparing them to well-known CRP that would guide the proper business use, it often takes several months of tough negotiation and trial-and-error iterations before the right way of incorporating these new reference prices into CPM is found. And some CRP may not survive the scrutiny and are refused.

Considering these practical problems with CRP and their importance for CPM, the author engaged in an academic journey that resulted in this thesis.

## 1.2. Research background and rationale

Increased volatility and shortages of input factors in recent years increased interest in commodity price management (e.g., Fischl, Scherrer-Rathje and Friedli, 2014; Gaudenzi *et al.*, 2018). While there is a rich body of research on CPM practices (e.g., Jackson, 1980; Jones *et al.*, 2007; Finley and Pettit, 2011; Zsidisin and Hartley, 2012) and scholars identified multiple influencing factors (e.g., Jones *et al.*, 2007; Berg, Valiante and Egenhofer, 2013; Mayer and Gleich, 2015; Gaudenzi *et al.*, 2018), the relationship between contextual influencing factors and CPM practices is not well understood (Fischl, Scherrer-Rathje and Friedli, 2014) and is further complicated by the existence of factors with a contradictory impact (Jones *et al.*, 2007; Gaudenzi *et al.*, 2018).

The commodity reference price has not been explicitly recognized as an important influencing factor. However, its impact on CPM practices can be inferred from multiple contributions (e.g., Mussell *et al.*, 2003; Roebber, 1996; Maxwell, 2015). Furthermore, the level of CRP contingency is rarely considered, and its operationalisation is only rudimentary, e.g., liquid vs. illiquid commodity

exchanges (Gaudenzi *et al.*, 2018), or builds intuitively on price discovery mechanisms (; Maxwell, 2015). Considering the nascent phase of the CRP research, it is not surprising that few contributions explore the fit between the CRP contingency level and CPM practices (e.g., Roeber, 1996; Maxwell, 2015).

Practitioners understand the importance of quality CRP for CPM (e.g., Veerman *et al.*, 2016) and express concerns with CRP quality (e.g., Nguyen & Arnsdorf, 2013; Economist, 2014) which culminated in a set of recommendations for price reporting agencies (IOSCO, 2013, 2015) and other regulatory measures (e.g., EU, 2011, 2016). However, CRP are issued for various purposes (Johnson, 2017) and the well-meant regulatory effort towards one-size-fits all solutions may hamper the market. However, acknowledging that different levels of CRP quality coexist immediately calls for a relevant tool for assessing and comparing CRP.

An in-depth and theoretically grounded understanding of CRP contingency is also important theoretically. Firstly, it may complement and extend emerging research of important CPM influencing factors outlined by Fischl, Scherrer-Rathje and Friedli (2014) and Gaudenzi et al. (2018). Secondly, it may shed light on the fit between CRP quality and CPM practices, encourage the elaboration of hierarchical CPM practice models, and produce a set of actionable guidelines reflecting the CPM- CRP quality fit.

## 1.3. Positioning of the study and research objectives

This section shortly positions the study within existing research stream and outlines the research objectives.

### 1.3.1. Positioning of the study

This study is positioned within the Strategic purchasing/procurement (SP) field broadly defined as a set of tools and practices aimed at implementing firm strategies and achieving competitive advantage (Carr and Pearson, 2002; Patrucco, Luzzini and Ronchi, 2017). Zooming narrowly on the CRP contingency as a commodity price management influencing factor, this research is positioned

at the intersection of reference price contributions and commodity price management research. By focusing on information asymmetry triggered by the CRP contingency level, the thesis addresses several SP challenges: communication with suppliers and joint problem-solving (Patrucco, Luzzini and Ronchi, 2017), effective tools for managing the commodity price discovery, input factor volatility and price risk (Zsidisin and Hartley, 2012; Fischl, Scherrer-Rathje and Friedli, 2014; Gaudenzi *et al.*, 2018), cost savings generation through more informed procurement decisions (Schütz *et al.*, 2020).

There are compelling reasons to conceptualize CRP contingency as transparency and thus anchor it in the Supply chain transparency research stream. Firstly, CRP contingency constitutes a specific sub-group of price transparency, which in turn is a sub-group of market transparency which then belongs into the Supply chain transparency for Knowledge integration cluster (Montecchi, Plangger and West, 2021). Secondly, transparency research offers multi-dimensional conceptualizations (e.g., Schnackenberg, Tomlinson and Coen, 2021) and contingency-level operationalizations (e.g., Lamming *et al.*, 2001) relevant to CRP contingency conceptualization and operationalization. Thirdly, the term transparency has been used in the extant literature to denote different CRP contingency levels and measured attributes (e.g. Cinquegrana, 2008; Valiante, & Egenhofer, 2013; Maxwell, 2015) and will therefore face less terminological acceptance issues.

By anchoring the research in the Supply chain transparency literature and in particular its specific stream focused on supply chain transparency for knowledge integration (Montecchi, Plangger and West, 2021), this research advances our understanding of the price transparency processes, market transparency tools, and more broadly, knowledge integration and sharing within the supply chain and thus establishes the link with the strategic procurement challenges.

### 1.3.2. Research objectives

Internal reference prices have been extensively researched (see Lowengart (2002) for an overview). In contrast, external reference prices, particularly CRP, have so far remained outside the scope of systematic scientific scrutiny despite thousands of CRP being published, and billions of euros of transactions are concluded based on CRP every day (Johnson, 2017).

Similarly, many studies have focused on identifying CPM practices and contingency factors that shape their performance (e.g., Jones *et al.*, 2007; Gaudenzi *et al.*, 2018). However, CRP has so far not been explicitly recognized and explored as an important influencing factor despite numerous anecdotal mentions of CRP use in procurement practice (e.g. Zsidisin and Hartley, 2012; Moosmayer, Schuppar and Siems, 2012; Gaudenzi *et al.*, 2018), and its impact on CPM practices remains under-researched and scattered. Nevertheless, the previous section suggests that contemporary CPM is impossible without CRP, a fundamental influencing factor for the selection of CPM practices, availability and suitability. Considering these research gaps, the objectives of this study are:

- To conceptualize a CRP transparency construct and empirically identify its measured attributes,
- To develop a tool that operationalizes, measures, and compares CRP transparency levels,
- To demonstrate the practical and theoretical utility of the CRP transparency construct by establishing a link between CRP transparency levels and CPM practices as well as CRP functions.

Gaining insight into the CRP contingency is of importance for scholars interested in exploring the key contextual factors that shape CPM practices, managers engaged in commodity procurement and risk management, analysts mandated with commodity price forecasts, supply chain specialists seeking to improve communication and information sharing within the supply chain, CRP issuers seeking to assess and (re)configure their CRP, practitioners concerned about CRP quality and suitable use in business practice, and regulators focused on improving the CRP quality.

## 1.4. Research questions

A literature review of the CPM and CRP literature reveals multiple research gaps concerning empirical foundations of CPM practices, their definitions and generative mechanisms, understanding of the CRP construct and its importance as a CPM influencing factor, and finally, poorly understood fit between a CRP contingency level and CPM practices availability and suitability. It is impossible to address all these research gaps simultaneously in one study.

This research, therefore, focuses specifically on conceptualizing the CRP construct, exploring and operationalizing its measured attributes, creating an actionable tool for assessing a CRP transparency level, defining meaningful CRP contingency levels, and exploring the CRP transparency level impact on CRP functions as well as on availability and suitability of CPM practices.

To achieve this objective, the following two research questions were defined:

*RQ1: What is the suitable commodity reference price conceptualization and measured attributes?*

The specific outcomes of RQ1 are (i) a theoretically grounded CRP construct labelled *CRP transparency*, (ii) the list of four CRP transparency attributes (accuracy, completeness, methodology and publication frequency), and (iii) operationalization of each CRP transparency attribute into five contingency levels following the geological metaphor (blackhole, opaque, translucent, transparent, dazzle).

*RQ2: What are the relevant commodity reference price contingency levels?*

The specific outcomes of RQ2 are *(i) the Commodity reference price transparency index, (ii)* a tool for aggregating the CRP transparency attributes and thus assessing the CRP transparency level into five contingency levels following the geological metaphor (blackhole, opaque, translucent, transparent,

dazzle), *(iii)* establishment of meaningful cut off points that witness good intra-level homogeneity and cross-level heterogeneity, *(iv)* insight how CRP transparency level shapes the CRP functions and the availability and suitability of CPM practices.

## 1.5. Phenomenon of interest and unit of analysis

The phenomenon of interest for this study is the CRP. There are two units of analysis: individual CRP transparency attributes for the RQ1 and the aggregate CRP transparency level for the RQ2. The unit of reference is CPM. The reason for using CPM as a unit of reference is to (1) gain insight into CRP functions and measured attributes, (2) meaningfully operationalise the CRP transparency measured attributes and the CRP transparency levels, (3) explore CRP transparency utility for informing CPM practices.

## 1.6. Theoretical underpinnings

Contingency theory studies the relationship between contingency variables (contextual factors) and response variables (actions taken in response to contingency factors) which result in performance variables (dependent measures used to evaluate the fit between the contingency and response variables) (Zeithaml, Varadarajan and Zeithaml, 1988; Donaldson, 2001). Furthermore, contingency theory assumes that different levels of contingency can be identified and operationalized. It assumes contingency levels change over time and response variables must adjust to maintain fit.

Considering the Contingency theory focus and assumptions, it is particularly relevant for studying both research questions.

However, while contingency theory is a suitable theoretical lens, it may be biased because it a priori assumes the relationship between the variables. Hence,

the findings were investigated from a transaction cost theory (TCE) perspective to gain confidence that the influence is real. TCE is a particularly suitable “rival theory” because CPM practices can be understood as governance mechanisms and CRP transparency as uncertainty to which the governance mechanisms adapt. Furthermore, the "calculative" branch of the TCE (e.g., Hobbs, 1996; Dyer, 1997) focuses on quantifying the transaction costs, conveniently complements the contingency theory predictions and sheds additional light on the relative efficiency of CPM practices under different CRP transparency levels.

## 1.7. Conceptual framework

The conceptual framework (see Figure 1) is anchored in the contingency theory basic model and starts with individual CRP measured attributes (domain of RQ1), these measured attributes are subsequently aggregated into the aggregate CRP contingency index (domain of RQ2). Subsequently, the index informs the specific CRP contingency level, which impacts the availability and choice and availability of CRP (explored as a part of RQ2). Finally, CPM practices shape the commodity price management process in a company (out of the thesis scope).

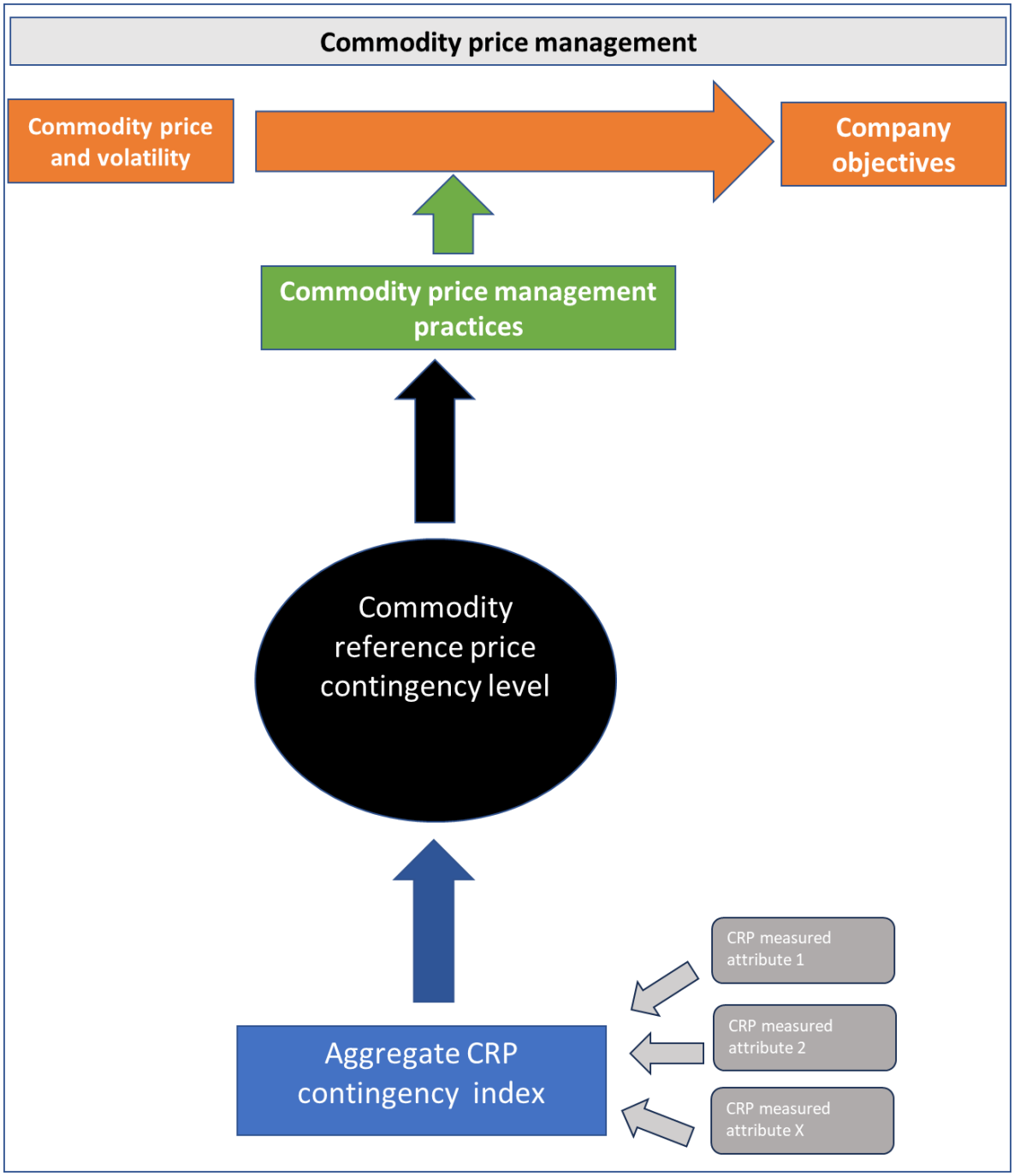



**Figure 1: Commodity price management conceptual framework. Source: Author.**

## 1.8. Research methodology and design

Considering the prior state of the theory following Edmondson and McManus (2007) and the nature of RQs, the qualitative research approach was selected to explore the CRP transparency measured attributes, operationalize them and construct the CRP transparency index (see Figure 2 for the overview of key research stages).

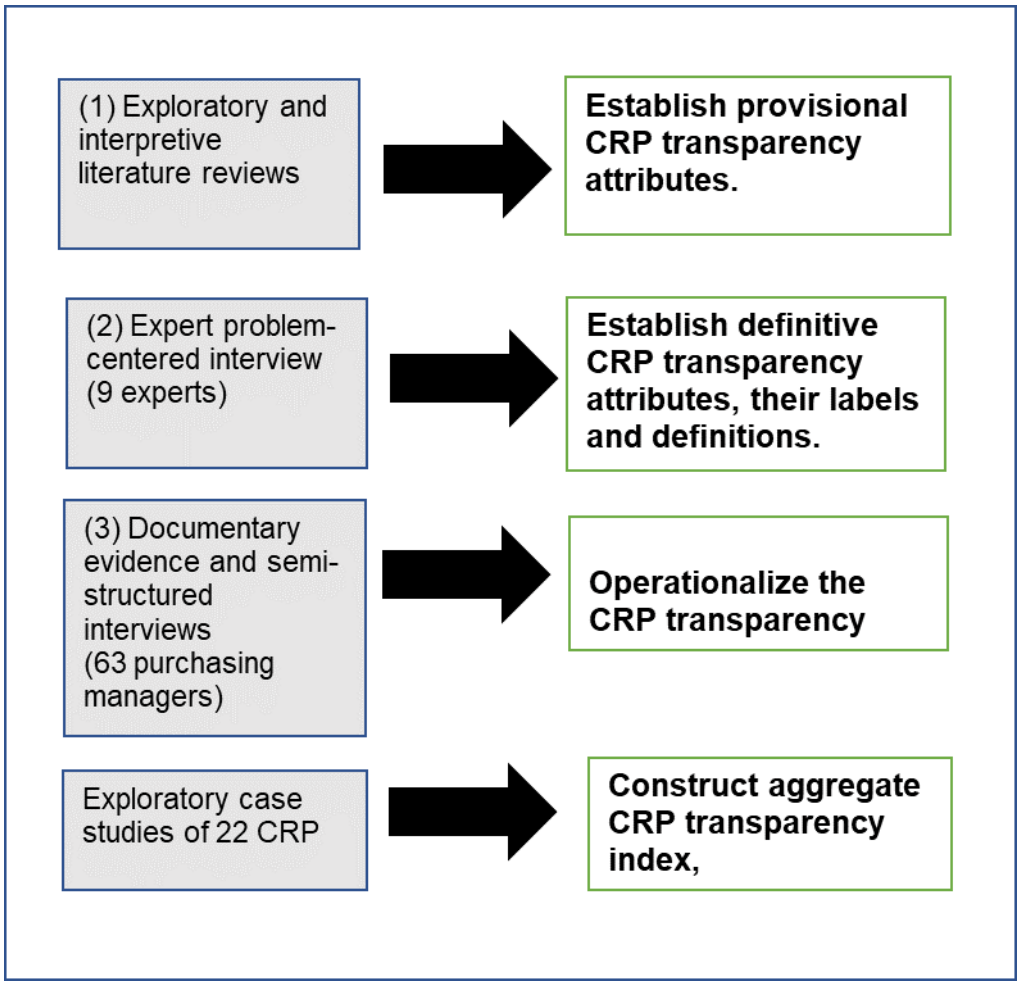



**Figure 2: Overview of key research stages. Source: Author.**

Data was collected via directed expert interviews and semi-structured interviews with procurement managers (PM). The expert interview target population comprised nine procurement directors with experience with multiple

CRP who have worked in organizations with sophisticated processes. A purposive sampling approach was adopted for selecting a sample of 22 CRP likely to represent different CRP transparency levels. Similarly, interviews that explored a sample of 22 CRP leveraged a purposive sample of PM, who are considered the best information source about CPM practices (e.g., Fischl et al., 2014; Gaudenzi et al., 2018; Jones et al., 2007), CRP and their transparency attribute levels. Only PMs with significant experience with commodity procurement and working in medium to large manufacturing companies were selected. Only respondents from the Czech Republic, Slovakia, Poland, Germany, and Austria were interviewed to avoid country bias. In total, 63 procurement managers were interviewed. As some respondents covered more than one commodity, two or three separate interviews were held, giving a total of 111 interviews.

The resulting data were analysed through a directed thematic analysis approach. A specific procedure relying on data triangulation and seeking maximum within-group homogeneity and cross-group heterogeneity was adopted for operationalizing the CRP transparency attributes, aggregating them into the CRP transparency index, and establishing the cut-off points.

## 1.9. Summary of research findings

This thesis focused on exploring, conceptualizing and operationalizing CRP contingency. While previous research did not recognize CRP as an important contingency, this research is the first attempt to (1) provide a grounded definition of CRP and outline its functions, (2) conceptualize the CRP contingency construct, (3) empirically explore its measured attributes, (4) operationalize them, (5) aggregate them into a comprehensive CRP transparency index, and (6) outline the impact of individual CRP transparency levels on CRP functions and CPM practices.

First, informed by contingency theory, CRP was identified as an important contingency variable that shaped CPM practices and was conceptualized as CRP transparency. Subsequently, four key CRP transparency attributes were identified, empirically confirmed, labelled, and defined: accuracy, completeness, publication frequency, and methodology. This multidimensional CRP transparency conceptualization provides a richer picture of the construct than conceptualizations based on price determination mechanisms (e.g., Strauss, 1992; Radetzki, 2013b; Maxwell, 2015).

Second, CRP transparency attributes were empirically operationalized into five distinct transparency levels following the geological metaphor conceived by Lamming *et al.* (2001). Empirical investigation revealed how different transparency attribute levels restricted or expanded CRP functions and, consequently, buyers' CPM options and price discovery efforts.

Third, commodity reference price transparency index (CRPTI) revealed five structurally different CRP levels. The exploration of within-group homogeneity and cross-group heterogeneity suggested uneven cut-off points. Four CRP with a perfect alignment of CRP attribute levels were identified as "archetypes" of balanced CRP. However, most CRP were marginally imbalanced and suggested trade-offs undertaken by the CRP issuers to accommodate the needs of CRP consumers or their own business objectives. Finally, three imbalanced CRP were identified where the transparency among CRP attributes differed by more than two levels. Despite their imbalance, these CRP were leveraged the same way as the other CRP occupying the same transparency level.

Fourth, the study provides the first theoretically anchored insight into how CRP transparency impacts CPM practices. It suggests that CRP transparency shapes the internal structure of CPM practices and influences their availability and suitability. It also strongly supports the hetero-fit prediction, suggesting that companies can improve CPM performance by moving to a higher CRP transparency level. Finally, the research nuances the ISO-fit hypothesis by showing that transaction-related costs vary in magnitude and type among the fitting CPM practices.

## 1.10. Summary of contributions

This section summarizes the main contributions of this research to theory and practice.

First, this study extended the CRP reference price research by identifying CRP as a specific type of reference price. It also extends the CPM research by providing a new taxonomy of CPM practices which emphasizes the ‘search’ and ‘adaptation’ CPM practices and thus offers a more comprehensive and structured practitioner toolbox.

Second, the study is the first to develop a holistic, multidimensional, complementary and operationalized conceptualization of CRP transparency, allowing researchers to study the structure, level and interplay of four CRP transparency attributes: accuracy, completeness, publication frequency, and methodology. From a practitioner's perspective, the CRP transparency construct allows CRP issuers and regulators to combine CRP transparency attributes to achieve the optimum fitness for the purpose of a CRP.

Third, the study empirically establishes a CRP transparency index, which is instrumental in studying CRP transparency as an independent contingency variable in contingency theory and as an uncertainty in transaction cost theory. Furthermore, from a practitioner's perspective, the transparency index represents a tool for assessing and comparing CRP quality.

Fourth, this research reveals five structurally different types of CRP, which is theoretically important for explaining why CRP embody different levels of functionality and inform CPM in a differentiated way.

## 1.11. Thesis structure

This thesis is divided into seven chapters. After a brief introductory Chapter 1, Chapter 2 introduces the main contingency theory principles that inform the structure of the literature review. Subsequently, commodity price management practices are reviewed and summarized into an extended taxonomy. Next, the commodity price influencing factors are investigated, and attention is focused on the commodity reference price as an important but so far unrecognized influencing factor. Finally, the research gaps are discussed, and the research questions are defined.

Chapter 3 outlines the methodological choices to answer the research questions. It first elaborates on the research paradigm. Subsequently, it focuses on the research method leveraged to establish the definitive CRP transparency attributes, their labels and definitions (answer RQ1). Finally, it outlines the research method leveraged to construct the aggregate CRP transparency index and establish meaningful cut-off points between individual CRP transparency levels (answer RQ2).

Chapter 4 seeks to conceptualize the CRP transparency construct. To achieve this objective, it starts with a CRP definition and an outline of its functions. Subsequently, the CRP contingency is conceptualized as transparency, and CRP transparency attributes are explored from three angles: the intuitive approach is based on the review of CRP literature; the interpretive approach analyses CRP deficiencies and corrective measures from which CRP transparency attributes are inferred; finally, the empirical approach leverages the voice of the CRP user and explores the suitable attributes, their labels and definitions. The chapter concludes with a list of definitive CRP transparency attributes.

Chapter 5 operationalizes and aggregates the four CRP transparency attributes into a CRP transparency index. Next, CRP transparency levels are described, and the observed CPM practices are briefly summarized. Furthermore, the within-group homogeneity and cross-group heterogeneity of

CRP transparency levels are explored. Finally, the impact of CRP transparency on CRP functions and CPM practices is examined.

Chapter 6 presents a discussion of the empirical findings. Firstly, it answers the research questions. Next, it considers how the findings fit within existing CRP research. Finally, it discusses the CRP transparency impact on CPM practices, which is fundamental for the theoretical and practical relevance of the CRP transparency construct.

Chapter 7 summarizes the main conclusions of this work including the implications for theory and practice, research limitations, and avenues for future research.

# 2. Literature review and theoretical underpinnings

The literature review explores the following main review question: *What is the commodity reference price (CRP) impact on commodity price management?*

It may be a bit unusual to start the literature review with the theoretical grounding of the research. However, this decision is justified by the clear research logic of contingency theory which forms the theoretical backbone of this research. Hence, after a brief positioning of the research in the strategic purchasing and supply chain transparency research domains, contingency theory and its main constructs and assumptions are briefly introduced and their relevance for the research outlined. Subsequently, the literature review is organized following the contingency theory logic (see Figure 3 for a visual outline).

The review starts with exploring commodity price management practices (number ① in Figure 3). Next, ② principal commodity price management (CPM) influencing factors are reviewed and classified. Subsequently, ③ attention shifts to CRP as an influencing factor and its impact on CPM practices. The next section is devoted to exploring different levels of CRP contingency ④, followed by the review of performance variables leveraged to evaluate the CPM practice fit ⑤. Finally ⑥, attention is focused on how scholars address the fit between CPM practices and the CRP contingency level. The chapter concludes with the formulation of the research gaps and the justification for the research questions.

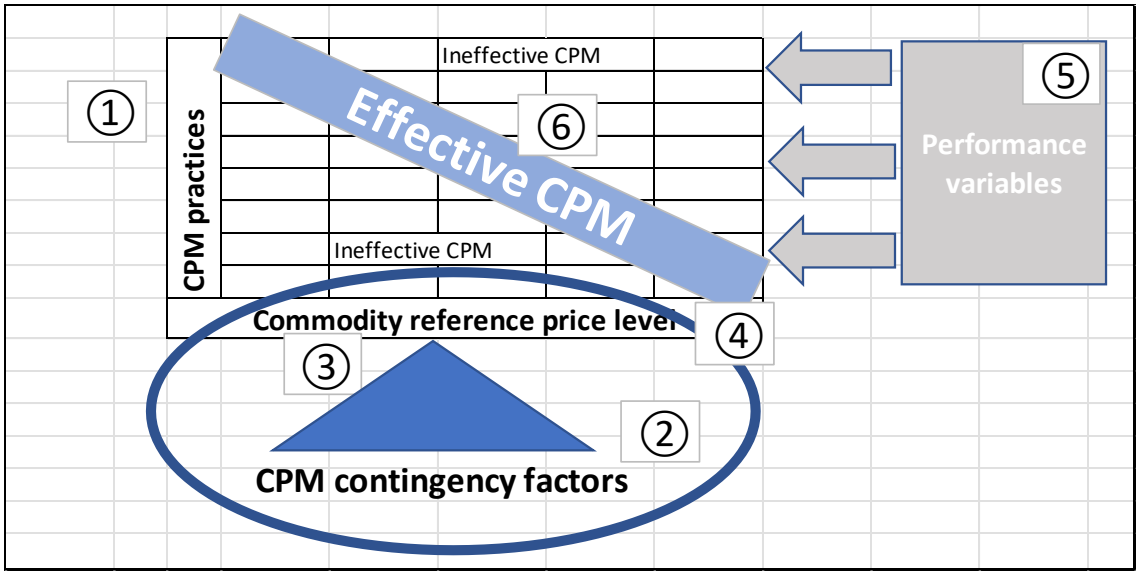



**Figure 3: Review structure following the contingency theory logic, adapted from Zeithaml, Varadarajan and Zeithaml, 1988;)**

## 2.1. Positioning the research within strategic purchasing and supply chain transparency streams

This section shortly positions the research within two major supply chain management streams: strategic purchasing and supply chain transparency.

### 2.1.1. Strategic purchasing/ procurement

The field of Strategic purchasing/procurement (SP) has been traditionally defined rather broadly as "the process of planning, implementing, evaluating, and controlling strategic and operating purchasing decisions for directing all activities of the purchasing function toward opportunities consistent with the firm's capabilities to achieve its long-term goals" (Carr and Smeltzer, 1997: 201). Coherent with this broad definition, SP is traditionally measured as the extent of purchasing involvement in overall firm strategy planning (e.g., Luzzini and Ronchi, 2016).

It follows from the definition that the SP scope is extremely broad, and it may be difficult to define a common research agenda, particularly when some smaller companies may struggle to introduce even the basic principles of SP (Coy, Adams and Kauffman, 2020) while more sophisticated organizations may already

focus resources on digital procurement transformation (Karttunen, Lintukangas and Hallikas, 2023) and organize procurement around advanced sustainability management (Marshall *et al.*, 2015) and resilience (Micheli, Johnson and Godsell, 2021).

Recognizing the increased volatility and uncertainty of many supply markets (Christopher and Holweg, 2011), the extant SP research focuses on the following SP challenges, which at the same time constitute a unique opportunity for gaining competitive advantage:

- Forster long-term relationships with suppliers and engage in open communication and joint problem solving (Patrucco, Luzzini and Ronchi, 2017),
- Stimulate joint product and process innovation (Prajogo, McDermott and Goh, 2008),
- Navigate increasing supply chain complexity (Ateş and Memiş, 2021),
- Reduce dependency and increase resilience and flexibility during supply disruptions (Birkie, Trucco and Fernandez Campos, 2017),
- Make use of digital procurement transformation and procurement 4.0 technologies (Fröhlich and Steinbiß, 2020; Herold *et al.*, 2023)
- Adopt advanced purchasing practices (Hesping and Schiele, 2015; Yeung, Cheng and Lee, 2015),
- Actively manage the commodity price risk (Zsidisin and Hartley, 2012; Fischl, Scherrer-Rathje and Friedli, 2014; Gaudenzi *et al.*, 2018),
- Invest in future by professionalizing the purchasing function and developing new buyer skills (Klézl *et al.*, 2022)
- Promote sustainability (Arora *et al.*, 2020),
- and achieve aggressive cost savings (Schütz *et al.*, 2020).

Considering the broad definition and scope, there is some misunderstanding and unclarity among practitioners of what SP means in practice, what instruments it entails, which priorities should be fostered (Paul, Brown and Ridde, 2020) and how it should be meaningfully implemented in the company context (Greer, Klasa and Van Ginneken, 2020).

Despite the vastness of the SP field and the thematic stretch, the essence of SP is perhaps best captured by researchers who conceptualize it as a key resource for implementing firm strategies and achieving competitive advantage (e.g., Carr and Pearson, 2002; Luzzini *et al.*, 2014; Yeung, Cheng and Lee, 2015; Patrucco, Luzzini and Ronchi, 2017). From this perspective, SP is about answering three basic questions better than the competition and in line with the company's broader strategy: what to buy, from whom, and how (Paul, Brown and Ridde, 2020). This thesis will concentrate predominantly on the "how" and restrict itself to the domain of commodity procurement, specifically "at what price" and "through what commodity price management practices" should the commodities be purchased.

Hence, this research will assist practitioners who may struggle with successful SP deployment for four reasons: information asymmetry (when a supplier or stakeholder has more information in purchasing decisions than the buyer), political power (when the purchaser has less power than the stakeholders and cannot put through decisions or enforce compliance), market power (due to the lack of competition or power imbalance between the buyer and the supplier), financial asymmetry (when the buyer does not have enough money compared to fellow buyers) (Greer, Klasa and Van Ginneken, 2020).

In particular, this thesis will focus on information asymmetry triggered by the CRP contingency level and will thus contribute to resolving several SP key challenges: Streamline communication with suppliers and improve joint problem-solving, equip commodity buyers with tools for tacking the CRP price discovery and management complexity and manage the commodity price risk, identify CPM practices that may increase the company's resilience to commodity price volatility, foster sophisticated procurement practices whenever the CRP transparency level warrants these, and finally, achieve cost savings stemming from more informed commodity procurement decisions, more efficient use of resources, and deployment of suitable CPM practices and strategies aligned to company's broader business strategy.

### 2.1.2. Supply chain transparency

This thesis conceptualizes the CRP contingency as transparency. Taking a hierarchical perspective (see Figure 4), this section demonstrates that the CRP contingency is strongly and logically anchored within the supply chain transparency research and the decision to coin the term *CRP transparency* is justified.

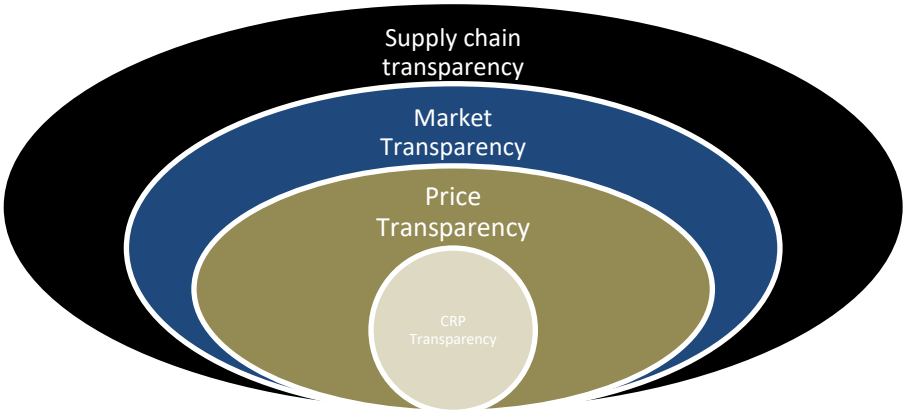



**Figure 4: Hierarchical relationship between CRP transparency, Price transparency, Market transparency and Supply chain transparency. Source: Author.**

#### 2.1.2.1. Supply chain transparency level

The concept of transparency gained prominence in scholarly and practitioner research in recent years and was even declared the word of the year by the Association of National Advertisers in 2016 (ANA, 2016). Scholars explored transparency in the context of corporate governance (Bandsuch, Pate and Thies,

2008), accounting (Canning and O'Dwyer, 2001), supply chain sustainability (Doorey, 2011), information (Granados, Gupta, & Kauffman, 2006), relationship (Eggert and Helm, 2003), commercial negotiation (Garcia, 2002), market (Granados, Gupta, & Kauffman, 2010), price (Soh, Markus and Goh, 2006), trading (Madhavan, 2000), or cost, technology, supply chain, and organization (Hultman and Axelsson, 2007).

Recent systematic literature reviews (Montecchi, Plangger and West, 2021; Faisal, Sabir and Sharif, 2023; Schäfer, 2023) documented the importance of research into supply chain transparency (SCT) and the steady growth of SCT-related publications (Montecchi, Plangger and West, 2021).

SCT can be defined as comprising *"corporate disclosure of: i) the names of the suppliers involved in producing the firm's products (i.e., traceability), ii) information about the sustainability conditions at these suppliers, and iii) the buying firms' purchasing practices"* (Egels-Zandén, Hulthén and Wulff, 2015:5). This definition contains fundamental features shared by most SCT definitions, namely sustainable supply chain information, involved stakeholders, and perspective of sustainable supply chain transparency (Schäfer, 2023).

On the downside, scholars note that transparency has been abusively conceptually stretched (Schnackenberg and Tomlinson, 2014) and has become a catch-all phrase that is poorly defined and lacks consensus about how it should be measured (Florini, 2007). This criticism seems to apply to SCT as well, as the six CST clusters identified by Montecchi, Plangger and West (2021) suggest that CST has been stretched since the seminal article by Marshall *et al.* (2016) which defined four CST dimensions: environmental (e.g. emissions or waste), membership (e.g. supply chain members), provenance (e.g. supply chain mapping), and social information (e.g. supplier's social sustainability level).

Returning to Montecchi, Plangger and West (2021), they classified current SCT research into six clusters: Technologies, Knowledge integration, Governance, Sustainability, Traceability, and Resilience. The SCT for Knowledge integration promotes knowledge integration between supply chain members and is therefore particularly relevant for this research because the information shared

among the supply chain partners in the form of CRP can be strategically leveraged to reduce costs (Xu and Jackson, 2019), limit informational asymmetry (Granados, Gupta and Kauffman, 2006; Granados, Gupta and Kauffman, 2010), reduce perceived risks (Gardner *et al.*, 2019), improve operational performance (Marshall *et al.*, 2016), and decision quality (Akkermans, Bogerd and Van Doremalen, 2004; Nahr, Nozari and Sadeghi, 2021).

CRP thus becomes a tool for increasing the market transparency level.

#### 2.1.2.2. Market transparency level

Market transparency is a critical prerequisite for a neoclassical perfect market (Friesenbichler, Clarke and Wong, 2014) and can be broadly defined as the availability, accessibility, amount, and timeliness of relevant market information to all market participants (Bessembinder & Maxwell, 2008; Granados et al., 2006; Veerman et al., 2016). It is conceptualized as a multidimensional construct with the following transparency attributes: price, product, supplier information (Granados et al., 2006), trading process (Madhavan, 2000), and any other important parameters influencing the price movements (Ahlers, Broll and Eckwert, 2013). Table 1 offers a brief definition of each attribute.

| Market transparency attribute | Definition |
|---|---|
| Supplier transparency | The availability of information about supplier identity and reputation, inventory, shipping costs, or delivery performance (Granados et al., 2006) |
| Product transparency | The availability of product attributes such as specification, quality, service availability (Granados et al., 2006) |
| Price transparency | The availability of information about the price level at which different market participants as willing to trade, such as quotes and transaction prices, as well as about the trading mechanism used for trading (Granados et al., 2006) |
| Trading process transparency | The quantity and quality of information disclosed to market participants during the trading process (Madhavan, 2000) |
| Transparency of other important parameters influencing price movements | The availability of information on weather, international market conditions, government interventions, production, or stocks (Ahlers, Broll and Eckwert, 2013) |

**Table 1: Overview of market transparency attributes**

CRP specifically mediates information about the price level of commodities. As demonstrated by Maxwell (2015) or Radetzki (2012), CRP contingency level may either reduce information asymmetry and streamline the price discovery process, or create a formidable barrier to effective price discovery.

#### 2.1.2.3. Price Transparency level

Price transparency is a specific sub-group of Market transparency and refers to the degree of information equivalence for all market players and how well they can get a precise, comprehensive, timely, and effortless overview of current prices (Diller, 1997). Extant literature distinguishes between low (unaided) price transparency, where market participants rely on their own knowledge and ability to manage prices, and high (aided) price transparency, where market participants rely on others (Hanna, Lemon and Smith, 2019).

Similar to market transparency, price transparency is a multi-dimensional construct with the following attributes inferred from the extant literature (see Table 2 for conceptualization of individual attributes): input transparency (Granados et al., 2006), contextual transparency (Hanna, Lemon and Smith, 2019), price adjustment transparency (Ferguson and Ellen, 2013), the degree of communication about other elements of pricing policy such as discounts and charges (Hewitt, 2003), and trading data transparency (Madhavan, 1996, 2000). All these attributes suggest that Price transparency forms a continuum with two extremes conceptualized as black hole and dazzle (Lamming et al., 2001) The blackhole price transparency applies to situations in which no price information is shared with market participants. In contrast, the dazzle price transparency refers to instances where all available price information is shared.

| Price transparency attribute | Definition |
|---|---|
| Input transparency | The quality of inputs about the price level at which the market participants are willing to trade (Granados et al., 2006) |
| Contextual transparency | The amount of information that organizes, explains, clarifies, or projects the contextual direction and/or rationale for the seller's pricing (Hanna, Lemon and Smith, 2019) |
| Price adjustment transparency | The level of disclosure of price increase and its explanation (Ferguson and Ellen, 2013) |
| Differentials transparency | The degree of communication about other elements of pricing policy, such as discounts and charges (Hewitt, 2003) |
| Trading data transparency | The availability of trading data before and after the trade occurs, such as market participants identity and their motivations, current or past prices or quotes, volumes, order flow, size and distribution of limit orders (Madhavan, 1996, 2000) |

**Table 2: Overview of price transparency attributes**

CRP contingency influences all price transparency dimensions: as already mentioned in the previous section, CRP contingency level directly impacts the price discovery process efficiency (e.g. Maxwell 2015; Radetzki 2012), it mediates more or less well the contextual information about the pricing context and the trading data (e.g. Cinquegrana, 2008, Madhavan, 2000), and it may be more or less lagged and accurate concerning the price adjustments and differentials (e.g., Granados, Gupta and Kauffman, 2010).

#### 2.1.2.4. CRP transparency level

The CRP transparency construct can be considered a specific constituent of the price transparency construct which is only applicable to commodities. More specifically, CRP transparency is an important price transparency enabler belonging to the high price transparency category because CRP is externally created and acts as a prosthetic device that informs and assists market participants in discovering the realization price (Caliskan, 2007, 2009):

Firstly, it represents an (imperfect) observable signal of current and/or future spot prices and thus impacts market informativeness (Broll and Eckwert, 2008). Secondly, CRP transparency is instrumental for the existence of futures contracts and contributes to overall price transparency by mediating relevant market information to market participants (Veerman *et al.*, 2016) who would otherwise have to engage in additional information collection and analysis (IEA et al., 2011). Thirdly, CRP transparency assists market participants in shaping the current price level, making-sense of it, and influencing its evolution (Caliskan, 2007).

In summary, insight into CRP transparency will advance our understanding of the CRP contingency, price transparency processes, the challenges of improving market transparency, and the research dedicated to supply chain transparency as knowledge integration and sharing.

## 2.2. Contingency theory

This section shortly explores the relevance of contingency theory for procurement research. Subsequently, the key contingency theory principles are summarized. Finally, the relevance of contingency theory for the review question is emphasized and the theory-informed outline of the review is presented.

### 2.2.1. Contingency theory in purchasing and supply management research

Grand theories are unified theories that provide a comprehensive view of reality by explaining variables and relationship between them, holistically aggregate and organize evolving knowledge, stimulate new research, and have practical implications (Swamidass, 1991; Spina et al., 2016). One of them is the contingency theory which was deemed to gain prominence as purchasing and supply management research moved away from the justification of the value of purchasing practices toward investigating contextual conditions under which purchasing practices were effective (e.g., Sousa & Voss, 2008). However, this promise remains somewhat unfulfilled and empirical data shows that the share of contingency theory anchored papers published in the Journal of Purchasing and Supply Management decreased between 2010-2018 (Zsidisin *et al.*, 2019). Similarly, the review of the sourcing literature suggests that only 2% of the papers are grounded in contingency theory (Giunipero et al., 2019).

Despite its moderate popularity, contingency theory remains highly relevant for exploring the relationship between purchasing practices and various contingency factors such as competitive priorities or supply market characteristics (Spina et al., 2016). Several recent papers have leveraged one of the main theoretical and practical contributions of contingency theory, which lie in identifying key contingency variables in a given context, distinguishing contexts based on these variables, and determining the most effective responses in a given context (Sousa and Voss, 2008) to gain insight into the impact of supply chain factors on firm resilience (Iftikhar et al. 2022), offshoring and back-shoring decisions (Henkel et al., 2022), supply chain sustainability (Silvestre et al., 2020), or firm performance (Yang and Jiang, 2023), to name only a few.

### 2.2.2. Contingency theory principles

Contingency theory is an approach to organizational design whose essence can be summarized by "It all depends …" (Schoonhoven, 1981:371). Hence, the

notion of *fit*, also conceptualized as *alignment*, *congruence*, *consistency* (Schoonhoven, 1981), and its impact on company performance, is central to contingency theory which assumes that there is no best way to manage organizations (Donaldson, 2001). The fit between the external environment, the internal arrangements, and the alignment of these arrangements determine the company's performance (van den Ven, 2013). It follows that superior performance is context-dependent and results from adopting the appropriate practice given the actual level of contingency (Spina *et al.*, 2016).

The key contingency theory variables are summarized in Figure 5. *Contingency variables* represent situational characteristics on which the focal company has only limited or indirect impact. *Response variables* are actions taken in response to contingency factors. *Performance variables* are dependent measures used to evaluate the fit between the contingency and response variables. Finally, the *area of Fit/Misfit* suggests the optimum/suboptimum alignment between the contingency and response variables as evaluated through the performance variables (Zeithaml, Varadarajan and Zeithaml, 1988; Donaldson, 2001).

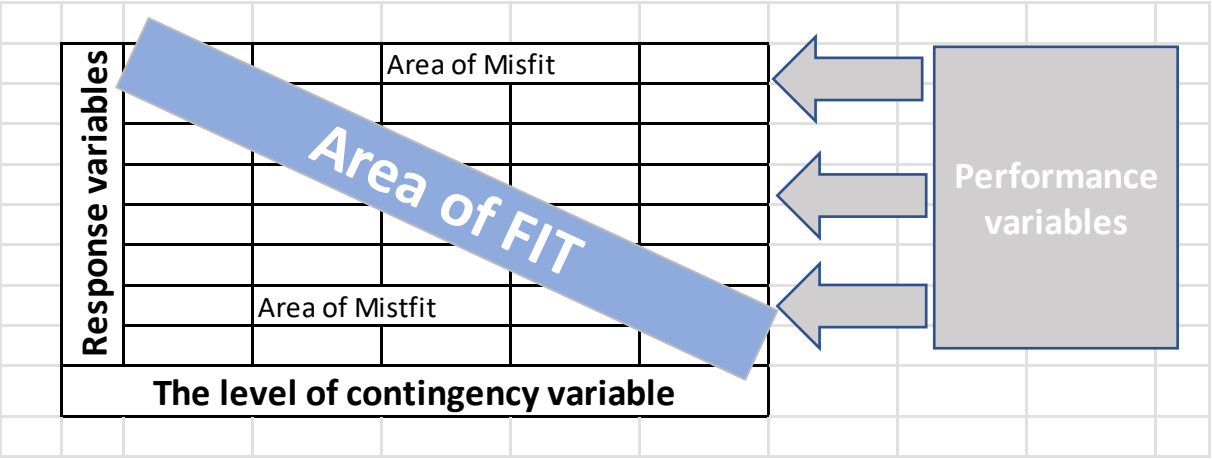



**Figure 5: Key contingency theory variables, adapted from Zeithaml, Varadarajan and Zeithaml (1988)**

Contingency theory assumes that not all contingency factors are equally important and may sometimes even be contradictory (Donaldson, 2001).

Consequently, the manager's task is to identify the relevant contingencies, prioritize and then find the optimum set-up to minimize the misfit. A negative misfit suggests that a company should improve its internal arrangements, while a positive misfit indicates that resources could be deployed more effectively (Wagner, Grosse-Ruyken and Erhun, 2012).

The original contingency theory conclusion about fit was rather deterministic and posited that there was only one optimum configuration for a given contingency level (Donaldson, 2001). However, the concept of *equifinality* (Drazin and Van de Ven, 1985) or ISO-performance (Donaldson, 2001) nuances the claim and argues that there is not a single best configuration for a given contingency level. Instead, several equally effective configurations to achieve the same level of performance exist (Van de Ven, Ganco and Hinings, 2013). While this perspective extends the contingency theory and implies strategic choice (Child, 1972), it precludes performance improvement. In contrast, the hetero-performance concept (Donaldson, 2001) suggests that organizations may deliberately increase a contingency variable and thus move onto a more performing fit curve.

In summary, the modern approach to contingency theory takes a dynamic equilibrium approach assuming that the optimum fit evolves and companies move from one fit to another in line with changes in contingency factors. For example, a company that has grown too big needs to change its structure to regain fit (Donaldson, 2001). This angle is particularly suitable for exploring the fit between the CRP and CPM practices and the impact of CRP contingency level change.

Returning to the notion of fit, there are three basic approaches: selection, interaction, and system (Drazin and Van de Ven, 1985), which were later refined and expanded into six forms of fit by Venkatraman (1989). The selection approach, corresponding to Venkatraman's fit as *matching*, establishes congruence between the context and response variable. The interaction approach, corresponding to Venkatraman's *moderation* and *mediation*, is somewhat more sophisticated and views the fit as the result of interaction between the context and response variables. Finally, the system approach, which

Venkatraman breaks down into *gestalts*, *profile deviation*, and *co-variation*, posits that multiple contingencies, response variables, and performance outcomes must be considered simultaneously to achieve internal consistency.

Considering the exploratory nature of this research, this thesis takes the fit-as-matching approach and draw initial inferences about the CRP – CPM link.

Despite its theoretical and practical utility, contingency theory has been criticized for lacking clarity and being no more than a set of interrelated propositions rather than a fully developed theory; for being based on unsound assumptions such as relations between contingencies being linear and symmetrical (Schoonhoven, 1981); for struggling with the fact that organizational design may be both deliberate and emergent (Van de Ven, Ganco and Hinings, 2013); and for unclear construct definitions, e.g., different conceptualizations of fit with serious implications for the choice of research methods (Venkatraman, 1989). However, the author believes that this criticism does not refute the theory's validity but rather calls for more rigor in definitions and research methods.

### 2.2.3. Contingency theory relevance for the research

The basic postulates of contingency theory (Donaldson, 2001) provide a powerful theoretical lens for this research:

- Contingencies, such as CRP, influence organizations´ structure or processes. Without the understanding of the CRP contingency relevance and impact, the choice of CPM practices becomes erratic and prone to misfit. Hence, contingency theory provides a frame for exploring the important contingency factors that shape organizations´ structures, processes, and behaviours (Flynn, Huo and Zhao, 2010; Silvestre, 2015) and, in extension, organizational performance (Donaldson, 2001).
- There are different levels of contingency. Hence, contingency theory requires the researcher to identify and operationalize different contingency levels of CPR.

- Depending on organizations´ alignment between CRP contingency and CPM practices, a *fit* or *misfit* is achieved, and subsequently low or high performance. Hence, contingency theory provides guidelines for defining the fit between CPM practices and CRP contingency, and for exploring the performance variables through which the fit is measured.
- Contingency levels change over time and organizational adjustment is necessary to maintain the required level of performance. Hence, contingency theory provides an explanation why the changes of CRP contingency are problematic for companies and why different CPM practices have to be leveraged.
- There is no universal level of high performance. Therefore, contingency theory provides a theoretically grounded explanation for differing CPM practices performance against different CRP contingency levels.

In summary, contingency theory is a suitable theoretical lens for the critical assessment of existing knowledge relating to CRP impact on CPM practices, identifying potential research gaps, and proposing a clear research agenda for the theoretically robust exploration of the relationship between CPM practices and CRP transparency. In particular, the assumption of different contingency levels of a contextual variable, the notions of equifinality and hetero-performance, and the fit-as-matching approach are the key theoretical underpinnings that shape this research.

### 2.2.4. Transaction cost theory

Scholars (e.g. Denzin and Lincoln, 2011) recommend exploring emerging findings from different theoretical perspectives that may reinforce, moderate, or contradict the emerging findings. The author agrees with this recommendation and, hence, searched for a rival theory that studies the link between a contingency factor and procurement practices. After some deliberation, the Transaction cost theory (TCE) was selected as the most suitable theoretical lens. This section first shortly outlines the key TCE constructs and predictions and considers the TCE relevance for this research.

Transaction cost theory (TCE) is the theory of governance (Williamson, 2002), and Transaction costs (TC) constitute the unit of analysis. The key variables are the specific assets, uncertainty and frequency (Williamson, 1979), whose interplay determines the nature and level of TC as, subsequently, the optimum governance set-up. The three underlying behavioural TCE assumptions are bounded rationality, opportunism and risk neutrality (Williamson, 1979).

This thesis is particularly interested in the uncertainty variable because it triggers governance-type selection problems and adaptation problems (Geyskens, Steenkamp and Kumar, 2006). Perfect contracts could be written without uncertainty, and all relevant contingencies specified ex-ante (Fan, 2000; Geyskens, Steenkamp and Kumar, 2006). Previous TCE research created multiple conceptualizations of uncertainty, which David and Han (2004) classify into Market conditions, such as demand or price changes, Technology, such as volatility or novelty, Behavioural, such as cross border transaction or supplier unpredictability, and Others, such as regulatory uncertainty or currency risk.

Relevant to this research, the CRP contingency level can be considered a special type of environmental, highly consequential, exogenous uncertainty unique to commodities that shapes the CPM practices.

TCE views companies and markets as governance structures for managing transactions (Williamson, 1996), where the governance structures are understood as control mechanisms designed to assure fairness among transactors (Dyer, 1997), mitigate conflict and realize mutual gain (Williamson, 2002). Scholars conceptualize governance structures as a continuum ranging from the Market through Hybrid to Hierarchy modes of governance (e.g., Peterson, Wysocki and Harsh, 2001; Williamson, 2008).

Relevant to this research, CPM practices can be considered a specific type of governance mechanism that business partners leverage to discover, agree and manage the transaction price.

TCE formulates strong predictions about the optimum link between the contingency level and governance set-up, such as the discriminating alignment

hypothesis (Williamson, 1991) posits that governance choice is driven by transaction costs (TC), and companies seek to adopt the most transaction cost-economizing set-up (Williamson, 1981) relative to alternative governances (Wang, 2007).

Transaction costs (TC) were originally conceptualized as the cost of carrying the transaction or using the price mechanism (Coase, 1937). From this perspective, TC relate to the search of suitable partners, price agreement, contract drafting, monitoring that the contract terms are respected, and contract enforcement if needed. TC drive the choice of contractual agreements, which in turn changes the nature and magnitude of TC (Wang, 2007).

Relevant to this research, the CRP contingency triggers different levels of TC depending on the contingency level, which, in line with the discriminating alignment hypothesis, shapes the CPM practices' availability and suitability.

Hobbs (1996:5) observes that attempts to measure TC exactly are problematic and suggests that "methodologies which identify the significant transaction costs and measure their importance (whether in absolute or relative terms) may suffice." Such qualitative assessment of TC is also advocated by Dyer (1997) and seems particularly relevant for investigating the link between CRP contingency and CPM practices because what matters is the relative magnitude of TC of different CPM practices market participants choose from.

#### 2.2.4.1. Transaction cost theory relevance for the research

TCE is a suitable complementary theoretical perspective because:

- It explores the link between a contingency factor (CRP contingency level) and governance set-up (CPM practices),
- It formulates predictions about the optimum link between a contingency factor (CRP contingency level) and governance set-up (CPM practices),
- Measurement of the relative magnitude of TC provides additional insight into the impact of different CRP contingency

## 2.3. Commodity price management practices

Building on Hesping & Schiele (2015), CPM practices are tactical building blocks, specific actions, or improvement activities through which the procurement functional and category strategies are executed and commodity price risk managed. Hence, CPM practices include *all activities through which the commodity price management objectives are realized.*

The interest in CPM practices varies over time. It becomes particularly salient when companies face rapid price increases in a wide range of commodities and increased volatility, typical for the expansion phase of the commodity super-cycle (Erten and Ocampo, 2013). Thus the late 70s and 2010s saw surges of CPM research (e.g., Gaudenzi et al., 2018, 2020; Hayenga, 1979; Hayenga & Schrader, 1980; Hofmann, 2011; Jackson, 1980; Zsidisin, Hartley, & Collins, 2013). These short-term surges of interest followed by a prolonged period of indifference prevent a systematic accumulation of knowledge. In addition, as the research is performed primarily during turbulent periods, there is only limited insight into CPM practices in stable contexts, and the overall breadth and frequency of CPM practices used by practitioners may be skewed towards CPM practices suitable for turbulent periods (e.g. global pandemics, energy commodity price turbulences, raw material volatility and supply disruptions).

### 2.3.1. Taxonomy of commodity price management practices

A review of CPM practices reveals a rich body of literature at different levels of analysis: some scholars explore a single strategy in great depth, e.g., natural hedging (Hofmann, 2011), others focus on a particular business exchange stage, e.g., price discovery (Mussell, 2003a), or adaptation (Zsidisin and Hartley, 2012), and still others take a holistic view of CPM practices in companies (e.g., Fischl, et al., 2014; Gaudenzi et al., 2018). This section reviews the main studies on CPM practices, and subsequently summarizes all CPM practices extracted from the literature review into a comprehensive taxonomy.

Jackson (1980) is perhaps the first attempt to systematize the available CPM practices. The paper insists on the contingent nature of CPM practices and that companies may adopt alternative approaches to address the same problem. For example, the gold price increase may be managed by a substitute, a product redesign to reduce usage, customer pass-through, or more frequent updates of the price lists.

Zsidisin & Hartley (2012) establish a hierarchical model of CPM practices suited to manage an expected price increase: find a substitute, share or pass through to the supplier/ customer, buy forward, hedge using futures, cross-hedge, absorb risk and reduce demand. If the first practice is unavailable, managers should opt for the next one. While the model is logical and actionable, it is unclear why only seven CPM practices were selected and why they should be leveraged in this particular order.

A comparison between Jackson (1980) and Zsidisin & Hartley (2012), two influential, practitioner-oriented papers divided by 32 years, suggests that the primary CPM practices toolkit remains relatively stable (see Table 3). The list of CPM practices suggests that buyers have three broad options to manage the expected commodity price increase: (a) fix the price in advance through spot or forward purchases, (b) actively manage consumption through substitutes, reduced use or demand, (c) or pass over the risk through escalator clauses, assignment of risk, or hedging. The author can only speculate why fixed price long-term contracts are missing from the Zsidisin & Hartley (2012) taxonomy. One possible explanation is the difficulty to negotiate them and their vulnerability to supplier default during turbulent periods. For example, some energy suppliers terminated/renegotiated fixed-price contracts or declared bankruptcy and most stopped offering annual fixed-price contracts during the steep increase of energy prices in 2022 (Dubcová, Komašková and Vašek, 2022).

| Jackson (1980) | Zsidisin & Hartley (2012) |
|---|---|
| Fixed price contracts/ price lists | N/A |
| Buy ahead | Forward buy |
| Substitutes | Substitutes |
| Assignment of risk (within supply chain), | Pass/ share with customer/ supplier, |
| Escalator clauses | Contractual clause |
| Reduce use | Absorb risk and reduce demand |
| Hedging | Acquire options/ futures, Cross-hedging |

**Table 3: Comparison of CPM practices by Jackson (1980) and Zsidisin & Hartley (2012)**

The stability of the primary CPM practices is further substantiated by Fischl et al. (2014), who document that these CPM practices are frequently mentioned in the literature and well-known to practitioners. In particular, hedging witnesses a vast and versatile body of research covering all important facets of this popular and widespread CPM practice: the theoretical ground, e.g., Aretz, Bartram, & Dufey (2007) a discussion of multiple and versatile reasons for hedging; surveys, e.g., Bodnar & Gebhardt (1999) compare the usage of hedging by US and German non-financial firms; systematic literature reviews, e.g., Carter et al. (2017) provide a systematic review of financial hedging by non-financial companies; insights into hedging practices, e.g., Ni et al. (2012) propose multi-stage hedging strategy that regularly rebalances a futures position to reduce the overall portfolio volatility; performance testing, e.g., Kouvelis & Turcic (2021) compare the effectiveness of cost hedging (where all input exposure is hedged) versus cash hedging (where only the residual cash exposure is hedged) and

conclude that *cash hedging* is significantly more effective because *cost hedging* is negatively impacted by demand fluctuation and is only marginally better than no hedging at all; or broader strategic perspective, e.g., Fu et al. (2012) seek to reconcile the input raw material hedging with output commodity hedging.

Mussell (2003a, 2003b) and Mussell et al. (2003) explore CPM practices used in the Canadian agricultural sector and identify 26 CPM practices. Following the underlying mechanism approach, CPM practices are reduced into eight higher-level CPM categories: market price plus premium contracts, cost-plus pricing, formula prices, tournament prices, direct negotiation, spot market pricing plus premium dependent on retail value, product pricing classified by end-use, and pricing dependent upon specific quality attributes. While some CPM practices are exclusively applicable to the agricultural sector, the paper's main contribution lies in an in-depth analysis of each CPM practice, including variants and typical contingencies under which a CPM practice is used.

Hallikas et al. (2004) also adopted the risk management perspective and defined five broad CPM practice categories: risk elimination, risk reduction, risk transfer, risk-taking, and the management of individual risks. Yet, the authors only list these objectives without any further elaboration. Therefore, it is impossible to attribute specific CPM practices to these objectives.

Finley & Pettit (2011) mention several CPM practices called tactics. They apply the portfolio approach to classify CPM practices into a two-by-two matrix with a competitive context (whether the price movement impacts all competitors similarly) and an economic impact (of adverse commodity price movement) as key influencing factors. Different CPM practices are then recommended depending on the contingency level.

Similar to Zsidisin & Hartley (2012) and Jackson (1980), the paper recommends self-insurance (do nothing, absorb, redesign, or substitute), physical and financial hedging (fixed contracts, operational, and financial hedges, backwards integration), and pass through (share along the supply chain, retain flexibility through short term stocks). In addition, the authors suggest managed trading where the buyer actively manages positions through a combination of

CPM practices outlined in other quadrants to maximize benefits. Unlike hedging, which is focused on value preservation, managed trading seeks to create value by leveraging superior CPM resources. Managed trading is reserved for commodities that affect competitors differently and do not have substitutes and at the same time represent a high economic impact for the focal company.

Fischl, Scherrer-Rathje, & Friedli (2014) apply a systematic literature review approach to explore the commodity price risk mitigation strategies which they understand as any purchasing practices that help companies mitigate the commodity price risk. However, the scope of the review is somewhat wider than CPM practices and the list of practices also contains strategies to manage the natural resource scarcity risk (e.g., Bell et al., 2012), various risks that increase the cost-of-doing-business (e.g., Oke & Gopalakrishnan, 2009), or general supply chain risks (Jüttner and Maklan, 2011) which are not relevant for the review question.

Fischl et al. (2014) anchor their study in the risk management perspective and segment CPM practices into distinct risk mitigation classes drawn from the previous research: (1) cooperation and portfolio management, which encompasses vertical integration, procurement alliances, or portfolio diversification, (2) product and process management leverages a wide range of CPM practices such as commodity substitution, product redesign, the improvement of efficiency or planning, (3) supply management CPM practices mitigate risk by forward buying, pass through or supplier development, (4) risk mitigation through demand management is realized through customer pass through, flexible pricing, or raw material exchange projects with customers, (5) financial hedging management leverages financial hedging or cross hedging, and (6) knowledge management CPM practices rely on the improvement of information exchange or purchasing team training.

The ensuing comprehensive list of 34 commodity price risk mitigation practices identified by Fischl et al. (2014) was subsequently investigated by a panel of 146 practitioners and eight semi-structured interviews. The study reveals that hedging, customer/supplier pass-through, cost models, and market price

forecasting are the most widely used CPM practices. However, the authors contend that their research is largely exploratory and view the classification and emerging findings as a starting point for future research into CPM practices' effectiveness. Even though not all practices mentioned in the paper are relevant for CPM and definitions of CPM practices are missing, the study provides a comprehensive insight into CPM practices.

Gaudenzi et al. (2018) provide an overview of CPM practices that they properly define and classify into three higher-level groups. Subsequently, they suggest in which contexts individual CPM practices perform the best. (1) Sourcing strategies such as purchase timing or commodity substitution seek to influence "the timing, quantity, sources of supply, and type of material" (Gaudenzi et al., 2018: 2). (2) Contracting strategies such as escalator clauses or piggy-back contracting encompass tactics to pass, share, or absorb commodity price volatility. (3) Finally, financing strategies such as financial hedging or cross-hedging leverage commodity markets and financial instruments to adapt to commodity volatility. Hence, procurement managers may choose in which phase of the procurement process they want to address commodity price volatility and choose from a portfolio of CPM practices. On the downside, the authors do not explain why these three groups of CPM practices were selected. Furthermore, each group contains several CPM practices, yet no guidance is provided on choosing the most suitable CPM practice within the category nor how to combine CPM practices for an improved effect. The authors are aware of this potential weakness and call for further research on the relationship between the influencing factors and CPM practices.

In addition to these comprehensive CPM contributions reviewed above, the author reviewed procurement literature dealing with commodities for any additional CPM practices (e.g., Halldórsson & Svanberg, 2013; Hayenga, 1979; Hofmann, 2011; Kingsman, 1986; Maxwell, 2015; Radetzki, 2013; Byrne & Power, 2014; Englyst, Jørgensen, Johansen, & Mikkelsen, 2008; Çagri Haksöz & Kadam, 2009; Helman, 2015; Kaynak & Hartley, 2008; Li, 2010; Lysons & Farrington, 2012; Manuj & Mentzer, 2008; Miletsky, 2005; Pennings & Leuthold,

2000; Sukagawa, 2010; Talus, 2021). A provisional long-list of 58 CPM practices was subsequently compiled and complemented with a working definition for each CPM practice. If available, the definitions were drawn from the literature, or created by the author based on his understanding of the CPM practice.

Next, the long-list was rearranged into second-degree categories which regroup structurally similar CPM practices (see Table 4). The new taxonomy builds on and expands previous CPM classifications (e.g., Fischl et al., 2014; Gaudenzi et al., 2018; Mussell et al., 2003). Most notably, the taxonomy was extended with the *search CPM practices* that cover market observation and interpretation and the *adaptation CPM practices* that deal with ex-post disturbances which were not accounted for in the original contract.

*Search CPM practices* concern all CPM practices related to market observation, data gathering, and interpretation. While the search category was not identified in the previous CPM extant literature, it highlights specific strategies undertaken to explore the market context and prices (e.g., Hobbs, 1997).

Active market observation and supply market intelligence focus on gathering relevant data (Kingsman, 1986; Halldórsson and Svanberg, 2013), which is subsequently interpreted through cost-models and fundamental and technical analyses (Zsidisin and Hartley, 2012; Mayer and Gleich, 2015). Market and price search may be significantly streamlined with benchmarks and commodity reports published by specialized price reporting bodies (Maxwell, 2015). Companies may also share market data with other supply chain members through specific information sharing platforms (Hofmann, 2011).

*Sourcing CPM practices* cover a broad range of CPM practices that directly impact the tendering approach, sources of supply, purchase timing and quantity (Gaudenzi *et al.*, 2018). Suitable/available tendering approaches may depend on the market structure, e.g., bilateral negotiation, producer-posted prices, competitive tenders and e-auctions, or commodity exchanges (Radetzki, 2013b). Some commodities warrant measures to strengthen buyers relative bargaining power prior to sourcing, such as volume aggregation, supply base diversification, new product development (Fischl et al., 2014), or even vertical integration

(Helman, 2015). Buyers may also decide to establish a centralized procurement function that manages complex commodities (Englyst et al., 2008) and even take over the purchase responsibility for their suppliers (Hofmann, 2011).

Furthermore, buyers may leverage a number of sourcing CPM strategies that influence the purchase timing, e.g., buying forward and stock-piling (Gaudenzi *et al.*, 2018), automatic purchase triggers (Kingsman, 1986; Lysons and Farrington, 2012), time budgeting, or leveraging the spot market (Lysons and Farrington, 2012). Finally, the optimum delivery quantity may be determined through the dynamic programming models (Kingsman, 1986) that consider multiple shipping and warehousing costs.

*Contracting CPM practices* encompass all a priori practices for managing commodity price volatility through contractual agreements (Gaudenzi *et al.*, 2018). Buyers employ a wide range of contracting CPM practices depending on their price management objectives. Some of these practices are intuitive and relatively straightforward, e.g. forward buy (Zsidisin and Hartley, 2012), transfer prices (Radetzki, 2013b), market price adjusted by a deduction/premium (Mussell et al., 2003), long-term contracts with an annual price revision clause (Li, 2010), formula prices (Mussell et al., 2003), and escalator clauses with (non-)automatic triggers (Zsidisin and Hartley, 2012), agreements designed as feedstock plus, index minus, or adjusted following the CRP movement (Finley and Pettit, 2011), or so-called piggy-back contracting (Gaudenzi et al., 2018).

In addition, market participants may also leverage less widely mentioned CPM practices like brick prices (Sukagawa, 2014), cost accounting models (Pullman and Dillard, 2010), price floors and windows (Mussell et al., 2003), establish pricing dependent upon specific quality attributes (Mussell et al., 2003) or product pricing classified by end-use (Mussell et al., 2003), design contracts based on spot market pricing plus premium dependent on retail value (Mussell et al., 2003), more or less complicated staggering contracts (Byrne and Power, 2014), or tournament pricing (Mussell et al., 2003),

Scholars also note that contracts should avoid naïve terms in the case of a contract breach (Haksöz & Kadam, 2009) and account for changed

circumstances through built-in robust ex-ante provisions (Talus, 2021) like a changed conditions clause, a termination clause, or force majeure (Miletsky, 2005) or even ex-ante abandonment clause (Haksöz & Seshadri, 2009).

The CPM *hedging practices* construct is wider than financial hedging by Gaudenzi et al. (2018) as it also encompasses non-financial hedging practices. CPM hedging practices encompass all risk management practices through which the company eliminates risk exposure, e.g., natural hedging (Hofmann, 2011), alignment of the upstream and downstream CPM practices (Pennings, 2004). Furthermore, companies should consider CPM practices that minimise commodity volatility impact on competitiveness and profitability and align CPM strategy to competitors (Hayenga, 1979) or price-in volatility into the product price (Finley and Pettit, 2011). Finally, companies may consider passing over the risk to a third party through financial hedging (Zsidisin and Hartley, 2012) or supplier/customer pass through provisions.

*Active trading CPM practices* build on Finley & Pettit (2011) who recommend sophisticated CPM strategies designed to create value through active CPM management. Therefore, based on the expected probability distribution of commodity prices (Hayenga, 1979), companies may enter speculative positions (Manuj and Mentzer, 2008), engage in profit-focused purchasing strategies (Jones et al., 2007), or leverage a wide-range of practices through managed trading (Finley and Pettit, 2011). In contrast to hedging, active trading CPM strategies result in open positions that increase a company´s risk exposure because the company does not only hedge its input risk but intentionally enters into speculative positions.

Companies leverage *Adaptation CPM practices* to address ex-post disturbances that were not or could not have been predicted in the original contract. The construct is based on the transaction cost theory in which adaptation costs are considered a major source of transaction costs (Williamson, 1985; Williamson, 2008). Extant literature suggests that companies should tackle ex-post adaptation by absorbing the price increase and reducing demand (Zsidisin and Hartley, 2012), redesigning the product (Jackson, 1980),

considering material substitution (Jackson, 1980), and setting-up effective internal coordination (Finley and Pettit, 2011). In contrast to pro-active contracting CPM practices, adaptation CPM strategies are reactive.

| CPM practice | Brief description |
|---|---|
| **Search CPM Practices** | |
| Active market observation (Kingsman, 1986) | Observes how new information changes the expectations of the market and the ensuing new equilibrium price level (Kingsman, 1986). |
| Price forecasting through technical analysis (Zsidisin and Hartley, 2012) | The price series analysis technique assumes that historical pricing patterns predict the future (Zsidisin and Hartley, 2012). |
| Price forecasting through fundamental analysis (Zsidisin and Hartley, 2012) | Examines factors affecting the supply and demand and how their change may affect the commodity price (Zsidisin and Hartley, 2012). |
| Cost models (Mayer and Gleich, 2015) | Mathematical equations or algorithms to determine a commodity's total cost structure and principal cost drivers and their sensitivity to changing circumstances. |
| Supply market intelligence (Halldórsson and Svanberg, 2013) | Gathers systematic knowledge about the supply market (Lorentz *et al.*, 2020) of a particular commodity. |
| Information sharing platform for suppliers (Hofmann, 2011) | Establishes a supplier platform where the focal company shares information about |

| CPM practice | Brief description |
|---|---|
| | commodity sources and prices and where suppliers can share commodity supplier offers (Hofmann, 2011). |
| Leverage benchmarks by specialized price reporting bodies (Maxwell, 2015) | Leverage prices or price ranges published by trade associations, price reporting agencies, or specialized journals that more or less reliably reflect the actual realization prices (Radetzki, 2013b). |
| **Sourcing CPM practices** | |
| Dynamic programming models (Kingsman, 1986) | Mathematical algorithm to determine the minimum cost delivery schedule considering the purchase price, economic transport costs, warehouse and money costs, etc. (Kingsman, 1986). |
| Producer prices (Radetzki, 2013b) | Leading producers publicly announce prices at which they are willing to sell, and the commodity is sold on a take-it-or-leave-it basis (Radetzki, 2013b). |
| Auctions (Radetzki, 2013b) | Sellers and buyers transact at irregular intervals within a formalized frame, and the prices are public and transparent (Radetzki, 2013b). |
| Leverage prices emanating from commodity markets (Radetzki, 2013b) | Uses prices continuously discovered and published on commodity exchanges for standardized products through a double-blind auction (Radetzki, 2013b), |

| CPM practice | Brief description |
|---|---|
| Bilateral contracting/ Direct negotiation, (Radetzki, 2013; Sukagawa, 2014; Mussell, 2003b, 2003a; Mussell et al., 2003) | The realization price is the result of a bilateral negotiation between the buyer and the seller (Radetzki, 2013b). |
| Switching volumes among suppliers (Kaynak and Hartley, 2008) | Moves purchase quantities among qualified suppliers based on the relative attractivity of their price offer (Gaudenzi et al., 2018). |
| Automatic purchase triggers such as Moving averages meeting point, Stop-loss, Dollar averaging, or Volume timing of purchases (Kingsman, 1986; Lysons and Farrington, 2012) | Approaches designed for non-specialists to manage commodity prices while minimizing the risk of a bad decision (Lysons & Farrington, 2012). |
| Purchase timing (Gaudenzi *et al.*, 2018) | Managers buy materials forward, store them if they expect prices to go up, and wait to buy if they expect prices to go down. |
| Centralized procurement function (Englyst et al., 2008) | Concentrates commodity responsibility in a separate department staffed with specialist buyers with expert knowledge of the commodity and its markets (Lysons and Farrington, 2012). |
| Controlled/directed purchases for the supplier (Hofmann, 2011) | Negotiates prices and terms on behalf of the supplier, and imposes the commodity sub-supplier to one's suppliers (Hofmann, 2011). |

| CPM practice | Brief description |
|---|---|
| Strengthen its's relative bargaining power (Fischl et al., 2014) | Takes measures such as long-term contracts, volume aggregation, diversification, product standardization, and new supplier development to improve one's relative strength (Gelderman and Van Weele, 2003). |
| Time budgeting/ Leverage the spot market (Lysons and Farrington, 2012) | Avoids long-term commitments and instead, turns to short-term markets for immediate delivery and transactions at actual spot prices (Lysons and Farrington, 2012). |
| Vertical integration (Helman, 2015) | A type of vertical supply chain coordination where the focal company acquires a business at a different stage of the supply chain (Hobbs and Young, 2000). |
| Raw material exchange projects with business partners (Fischl et al., 2014) | Buys/sells a commodity with a supply chain member to optimize cost/price or manage availability. |
| **Contracting CPM practices** | |
| Brick prices (Sukagawa, 2014) | Price aggregation technique where a portion of the volume is priced at last year's price and the rest at the current year's price as soon as it has been agreed (Sukagawa, 2014). |
| Leverage cost accounting model (Pullman and Dillard, 2010) | Calculates commodity price based on the actual or projected costs plus a profit plus |

| CPM practice | Brief description |
|---|---|
| | bonuses for achieving pre-agreed performance objectives (Pullman and Dillard, 2010). |
| Price floor (Mussell et al., 2003) | A minimum realization price is agreed. The buyer puts some revenue aside to compensate the seller if the market price falls below the floor (Mussell et al., 2003). |
| Price window (Mussell et al., 2003) | Minimum and maximum prices are set. If the market price fluctuates within the window, it becomes the realization price. If it is above or below the price window, the realization price is the average between the minimum/maximum window price and the market price (Mussell et al., 2003). |
| Transfer prices (Radetzki, 2013b) | Prices are set administratively to settle transactions between two entities of a vertically integrated company (Radetzki, 2013b) |
| Market price plus a deduction/ premium (Mussell et al., 2003) | Parties agree on a base price to which a premium is added or deduction applied based on pre-agreed qualitative criteria (Mussell et al., 2003). |
| Pricing dependent upon specific quality attributes (Mussell et al., 2003) | Premiums/Discounts are applied to the agreed price depending on whether the specified quality attributes have been met (Mussell *et al.*, 2003). |

| CPM practice | Brief description |
|---|---|
| Product pricing classified by end-use (Mussell et al., 2003) | The final selling price of a commodity varies depending on the end-use product, e.g., milk may be priced differently if used for butter or animal feed (Mussell *et al.*, 2003). |
| Spot market pricing plus premium dependent on retail value (Mussell et al., 2003) | A commodity supplier is paid upfront the spot market price and later a share of the retail value realized by the customer if any (Mussell *et al.*, 2003). |
| Feedstock plus, index minus, or follow the CRP movement (Finley and Pettit, 2011) | An arrangement where the realization price movement is contingent on a reference price value change (Figuerola-Ferretti and Gilbert, 2005). |
| Changed conditions clause, Termination clause, or Force majeure (Miletsky, 2005) | Applies contractual clauses that can be used in case of adverse commodity price movement. |
| Staggering contracts (Byrne and Power, 2014) | Uses contracts for different periods and quantities to achieve a smoothing effect (Gaudenzi et al., 2018). |
| Robust price review clauses (Talus, 2021) | Follows the principles for high-quality contractual clauses determining how the prices will be updated during the contract duration. |
| Piggy-back contracting (Gaudenzi et al., 2018) | Makes the contract terms available to suppliers using the same commodity (Gaudenzi et al., 2018). |

| CPM practice | Brief description |
|---|---|
| Avoid naïve terms in the case of contract breach (Haksöz & Kadam, 2009) | Avoids contractual clauses that allow parties to breach the contract without any fine or compensation to the other party (Haksöz & Kadam, 2009). |
| Formula prices (Mussell) / Escalator clauses (Zsidisin and Hartley, 2012) | Ex-ante agreed process for contingent price adjustments (Gaudenzi et al., 2018). |
| Long-term contracts with annual price revision clause (Li, 2010) | Adapts the contract price annually based on the benchmark price evolution adjusted for quality differentials between the benchmark and the underlying (Li, 2010). |
| Forward buy (Zsidisin and Hartley, 2012) | Locks in the price through physical delivery and storage the moment the contract is initiated (Zsidisin and Hartley, 2012). |
| Ex-ante abandonment clause (Haksöz & Seshadri, 2009) | Incorporates an explicit abandonment option into the contract (Haksöz & Kadam, 2009). |
| Tournament pricing (Mussell et al., 2003) | A pricing scheme with a basic price and premium/discount based on the relative commodity supplier performance. Hence suppliers who achieve above-average performance in a criterion important to the customer are paid a premium, while less performing suppliers get paid less (Mussell et al., 2003). |

| CPM practice | Brief description |
|---|---|
| **Hedging CPM practices** | |
| Align the upstream CPM and downstream CPM to eliminate exposure (Pennings, 2004) | Achieves zero cash exposure by aligning the cash flows generated by the purchase and sales contracts (Pennings, 2004). |
| Align CPM strategy to competitors (Hayenga, 1979) | Avoids the risk of competitive disadvantage by copying the CPM strategy pursued by competitors (Hayenga, 1979). |
| Pass the price risk to customers/suppliers (Zsidisin and Hartley, 2012) | Shares/transfers the commodity volatility risk with one's customers or suppliers (Zsidisin and Hartley, 2012). |
| Financial hedging (Zsidisin and Hartley, 2012) | Manages commodity volatility through standard derivative products traded on commodity exchanges (Gaudenzi et al., 2018). |
| Cross hedging (Zsidisin and Hartley, 2012) | Manages commodity volatility through standard derivative products traded on commodity exchanges of a commodity that is strongly correlated to the focal commodity (Zsidisin and Hartley, 2012). |
| Natural hedging (Hofmann, 2011) | Risk management technique in which exposures are hedged through physical, negatively correlated transactions (Hofmann, 2011). |

| CPM practice | Brief description |
|---|---|
| Price-in volatility into the product price (Finley and Pettit, 2011) | Sets a sufficient reserve in the selling price to account for adverse commodity price movements. |
| **Active trading CPM practices** | |
| Speculation (Manuj and Mentzer, 2008) | Buys a commodity for future use above hedging demand (Fattouh, Kilian and Mahadeva, 2013) with the hope that its price will move in a favourable direction. |
| Profit-focused purchasing (Jones et al., 2007) | Takes measures to increase profit without increasing supply risk or taking a calculated risk-reward trade-off (Jones et al., 2007). |
| Managed trading (Finley and Pettit, 2011) | Uses a wide portfolio of commodity price management practices to actively manage commodity positions and draw benefits from actively trading commodities (Finley and Pettit, 2011). |
| Expected probability distribution of commodity prices (Hayenga, 1979) | Simulates the range of commodity prices available to the company in the future and the probability with which these prices might occur (Hayenga, 1979). |
| **Adaptation CPM practices** | |
| Absorb the price increase and reduce demand (Zsidisin and Hartley, 2012) | Absorbs the impact of adverse commodity price volatility while taking measures to reduce the risk exposure for the future (Zsidisin and Hartley, 2012). |

| CPM practice | Brief description |
|---|---|
| Product redesign (Jackson, 1980) | Changes product features to reduce or eliminate the commodity (Jackson, 1980). |
| Material substitution (Jackson, 1980) | Uses alternative material following the adverse price movement of the current material (Gaudenzi et al., 2018). |
| Internal coordination (Finley and Pettit, 2011) | Manages commodity price management across company functions, e.g., procurement, production, marketing and sales, finance, and top management (Finley and Pettit, 2011). |
| Provisional prices (Sukagawa, 2010) | Last year's price is retroactively updated as soon as the new price is agreed (Sukagawa, 2010). |
| Partition prices (Sukagawa, 2010) | The first months are charged at the previous year's price and the rest at the new price (Sukagawa, 2010). |

**Table 4: Extended taxonomy of CPM practices**

## 2.4. Commodity price management influencing factors

In line with contingency theory assumptions, scholars observe that different commodities require different CPM practices (e.g., Jones et al., 2007), various industries choose different CPM practices, and even different companies within

the same sector choose diverse CPM practices (e.g., Jackson, 1980). Acknowledging that the choice of the suitable CPM practice is contingent upon various influencing factors, Fischl et al. (2014) call for their empirical investigation to derive robust recommendations for industry practice.

This section, therefore, focuses on a comprehensive review of the CPM influencing factors.

### 2.4.1. CPM influencing factors

There is a plethora of research that mentions individual influencing factors (see Table 5). However, these influencing factors remain mostly implicit, vaguely defined, and poorly justified. The following illustrative example demonstrates that the vagueness of CPM influencing factors makes it difficult for researchers to distil CPM influencing factors, explore their impact on CPM practices and leverage them for further empirical investigation.

Haksöz & Kadam (2009) develop a tool for assessing raw material procurement in the presence of supply risk. Yet, there is little clarity about influencing factors likely to trigger the contract breach, e.g. the 'availability of active liquid spot and futures markets' is only described as a comparison between the non-ferrous metals and commodities for which market liquidity is an issue such as steel, pulp or some chemicals. Similarly, 'seller opportunism' must be inferred from "the breach event … that is *ex post* intentional by the seller" (Haksöz & Kadam, 2009:61). 'Market evolution,' understood as the "systematic forces such as industry-wide business cycles or regional macro-economic shocks," (Haksöz & Kadam, 2009:68) seems also instrumental in shaping the contract breach probability and may be operationalised as price volatility, which can be inferred from "as the spot market prices began to plummet" (Haksöz & Kadam, 2009:61). Finally, 'buyer skills' and 'an organization's risk appetite' can be inferred as two latent variables that influence the saliency of this CPM practice.

Therefore, the review of CPM influencing factors focuses on four taxonomies that provide a holistic view of influencing factors and a useful basis for the classification of influencing factors.

| Influencing factors / Reference | Supply-side factors | Byer side factors | Business Environment factors | Product/ Commodity factors |
|---|---|---|---|---|
| Valiante, & Egenhofer, 2013 | Supply factors | | Demand factors<br>Exogenous factors. | Product factors |
| Mayer and Gleich, 2015 | Supply Risks | Vulnerability | Environmental risks | |
| Jones et al., 2007 | Service constraints | Company constraints | | Product constraints |
| Gaudenzi et al., 2018 | Supply chain factors | Buying firm factors | External environment factors | Product factors |
| Adam, Fernando, & Salas, 2017 | | Board characteristics,<br>CEO tenure, ownership type | | |
| Hobbs, 1997 | Negotiation costs, Socioeconomic and farm characteristics | | Information costs | Monitoring costs |
| Mussell et al., 2003<br>Mussel, 2003a | Supply market structure,<br>Distance from the retail stage | | | End-use of the final product,<br>Commodity type,<br>Degree of commodity homogeneity |
| Jackson, 1980 | Competitive conditions | Company context | Industry traditions, | |

| Influencing factors / Reference | Supply-side factors | Byer side factors | Business Environment factors | Product/ Commodity factors |
|---|---|---|---|---|
| | | | Changing circumstances | |
| Handfield, 2004 | | Company risk attitude | | |
| Pellegrino, Costantino, & Tauro, 2019 | Availability of alternative suppliers | | | Sunk costs needed to build flexibility,<br>existence of substitutes,<br>commodity price volatility,<br>long-term correlation of commodity prices |
| Zsidisin & Hartley, 2012 | | Company risk tolerance,<br>expertise in CPM | Expected direction of commodity prices,<br>industry habits concerning CPM | Availability and feasibility of substitutes,<br>commodity share of the total cost,<br>perishability / seasonality, commodity volatility likelihood and magnitude.<br>Availability of reliable index,<br>existence of commodity exchanges |
| Finley & Pettit, 2011 | | Economic impact | Competitive context | |
| Maxwell, 2015 | Supply market concentration | | Commodity price, availability to the public, and transparency | |
| Haksöz & Kadam, 2009 | Supplier willingness to | Buyer risk appetite | Market evolution | Availability of active liquid spot and futures markets |

| Influencing factors / Reference | Supply-side factors | Byer side factors | Business Environment factors | Product/ Commodity factors |
|---|---|---|---|---|
| | behave opportunistically<br>Supply market structure, | | | |
| Hayenga, 1979 | | Company business objectives, other company internal factors | Market price trend after the purchase decision | |
| Li, 2010 | | | Industry evolution, | |
| Sukagawa, 2010 | | | Industry evolution, | |
| Roeber, 1996 | | | CRP price discovery mechanism | |
| Radetzki, 2013 | | | Transparency of CRP price discovery mechanism | |
| Figuerola-Ferretti & Gilbert, 2005 | | | CRP information content | |
| Maxwell, 2015 | | | CRP price discovery mechanism | |
| Fattouh, 2011 | | | Price discovery mechanism | |
| Stewart (2013) | | | CRP price discovery mechanism | |
| Rauterberg & Verstein, 2013 | | | CRP quality,<br>CRP design,<br>CRP deficiencies | |
| Verstein, 2015 | | | CRP vulnerability to manipulation | |
| Cinquegrana, 2008 | | | CRP existence,<br>CRP quality | |

| Influencing factors / Reference | Supply-side factors | Byer side factors | Business Environment factors | Product/ Commodity factors |
|---|---|---|---|---|
| Hayenga & Schrader, 1980 | | | Existence of CRP,<br>CRP quality | |
| Moosmayer et al., 2012 | | | CRP existence | |
| Hobbs, 1997 | | | CRP existence | |

**Table 5: CPM influencing factors. Source: Author**

In their extensive review, Valiante, & Egenhofer (2013) provide the most comprehensive overview of the price formation influencing factors: Product, Supply, Demand, and Exogenous factors. *Product* characteristics indirectly impact price formation and the market structure and encompass factors like quality, storability, renewability, recyclability, substitutability, and usability. *Supply* factors affect the elasticity of supply to demand and are constituted by factors like capital intensity, degree of vertical integration, transportability, industry concentration, technological evolution, and supply peaks. *Demand* factors are crucial for commodity price formation and comprise the economic cycle, customer objectives and budgets, structural evolution of demand, or technological evolution. Finally, *exogenous factors* are factors imposed by the wider business environment, e.g., commodity financialization, subsidies, government regulation and interventions, or unpredictable events like the weather.

Valiante, & Egenhofer (2013) subsequently considers the impact of these influencing factors on the price formation of energy, industrial, and agricultural commodities. The relevance of these influencing factors for the CPM practices is substantiated by multiple references to CPM practices, e.g., *"Benchmark-based pricing mechanisms, which apply a discount or premium to a liquid reference price, rely on the liquidity of a reference contract, which is typically a front-month futures contract." (Valiante, & Egenhofer, 2013:288).*

The second taxonomy draws on the commodity criticality research which primarily focuses on primary raw materials and seeks to establish their supply and price risk and subsequently their potential impact on the company (Mayer and Gleich, 2015). The CPM influencing factors are regrouped into three broad categories: supply risk, environmental implications, and vulnerability (Graedel et al., 2012; Mayer and Gleich, 2015):

*Supply risk* is understood as the risk that a commodity becomes less available or more costly due to supply related factors such as geopolitical or producer concentration, mine extraction capacity and output, short- and long-term supply and demand trends, availability and efficiency of commodity recycling, product as a by-product, or the evolution of commodity production costs. The evolution of these factors may reshape the market structure and/or institutionalize different price discovery mechanisms which subsequently trigger a dramatic change of CPM practices as documented by Maxwell (2015) for lithium or Figuerola-Ferretti & Gilbert (2005) for aluminium.

*Environmental implications* focus on the commodity damage potential or its impact on climate change. The impact of these factors on CPM practices becomes particularly tangible after regulatory changes such as the introduction of mandatory emission certificates for electricity. For example, Kim, Chattopadhyay, & Park (2010) document the complexity of passing through the pollution certificates costs to the wholesale electricity price for coal power-stations.

The buyer side factors conceptualized as *Vulnerability* to supply restrictions is exacerbated by the commodity's economic or strategic relevance for the buyer, substitutability in the final product, the technological evolution of the input and output market, or the buyer's ability to drive through the price increase. Sudden disruptions have a particularly devastating impact on customary CPM practice. For example, the lack of some construction materials following the Russian attack on Ukraine rendered obsolete the fixed-price construction contracts and triggered painful discussion about moving towards price escalators, a more complex type

of CPM practice, as documented by public statements of the Slovak Public Procurement Office (UVO, 2022).

A review of commodity criticality studies (e.g., Graedel et al., 2012; Mayer and Gleich, 2015) reveals their focus on influencing factors while CPM practices are only mentioned in passing. For example, Duclos, Otto, & Konitzer (2010) mention several CPM practices suitable for tackling the most critical raw materials: long-term supply agreements with commodity suppliers, internal inventory buffers, consumption reduction, recycling, substitutes, or the entire system reassessment. However, the link between the influencing factors and CPM practices remains implicit, and the case study dedicated to GE's management of Rhenium, a critical material for turbines, focuses on managing raw material availability and optimized use rather than CPM.

The third taxonomy by Jones et al. (2007) investigated agricultural commodities and identified three broad groups of CPM influencing factors-*product*, c*ompany,* and *service* constraints.

*Product constraints* are related to the physical or market characteristics of the commodity, e.g., market efficiency, perishability, seasonality, storage requirements, or commodity cost share in the final product; *company constraints* stem from the idiosyncrasies or policies of the purchasing firm, e.g., budget constraints of the commodity procurement department, required volume to be purchased, involvement of multiple entities into the procurement decision, limited supply of a particular commodity grade, commodity volatility, sales forecast accuracy of the final product, or storage availability; finally, *Service Constraints* denote both the service requirements set by the buyer towards suppliers and service requirements by the focal company customers such as special promotions, or traceability.

On the downside, a panel of 12 respondents drawn from the agricultural sector with a narrow focus on agricultural commodities may not be representative enough to generalize the findings to other industries and commodity types. For example, it will not be surprising that respondents considered perishability and seasonality the most important influencing factors, while storage requirements

and the commodity share of total cost scored low. In contrast, industrial sectors and commodities may assess the influencing factors' importance differently. Despite these weaknesses, the study greatly enhances our understanding of the relationship between influencing practices and CPM practices.

The fourth taxonomy of CPM influencing factors is provided by Gaudenzi et al. (2018), who apply the grounded research methodology and segment the observed CPM practices into financial, sourcing, and contracting commodity price risk mitigation strategies:

*Product/Commodity* related factors consider the commodity share of total product cost and the degree of purchased commodity differentiation; *Buying organization* factors gauge the commodity percentage of total spend, procurement expertise, the ability to carry inventory, and intra-organizational relationships; *Supply chain factors* encompass heterogeneous factors like the power distribution and risk assignment within the supply chain, product price flexibility, or inter-organizational relationships; *External environment factors* consider the overall business environment through the PESTLE factors, market liquidity, and trading history on financial markets.

## 2.5. Commodity reference price as a CPM influencing factor

Numerous reviewed papers have highlighted the impact of CRP on CPM practices. This section, therefore, focuses on exploring this influencing factor in detail. To provide theoretical grounding, the CRP is first defined. Subsequently, research that directly or implicitly highlights the influence of CRP on CPM is reviewed. Finally, contributions that define and operationalize the level of CRP contingency are explored.

### 2.5.1. CRP conceptualization and definition

To get meaningful insights into the CRP construct and its impact on CPM practices, it is necessary to define the CRP construct, set its boundaries, and

identify its key attributes. This section, therefore, reviews CRP conceptualizations.

Despite 26 different conceptualizations of the term *reference price* that all share the basic notion of "established reference point information" (Lowengart, 2002: 146), the term *commodity reference price* (CRP) remains vaguely defined. In fact, only the International Swaps and Derivatives Association (IDSDA) provides an explicit CRP definition as "a method of determining the prices, levels or values relevant for the transaction" (ISDA, 2019:1). Other scholars do not provide an explicit definition (see Table 6 for overview arranged by the CRP features). Furthermore, scholars do not refer specifically to CRP but use alternative labels such as "reference price," (e.g., Radetzki, 2013, Figuerola-Feretti & Gilbert, 2005; Moosmayer, 2012), "international price reference for a commodity" (Mazighi, 2005), "world price" (Bukenya and Labys, 2005), and "market price" (Caliskan, 2007).

In the light of other conceptualizations, the ISDA (2019) definition seems somewhat reductionist, emphasising CRP as a transaction anchor but ignoring other important features such as CRP applicability exclusively to homogeneous products (Rauch, 1999), or the existence of different levels of reliability and transparency (Figuerola-Ferretti and Gilbert, 2005).

To advance and ground the CRP research, it is therefore necessary to revisit CRP conceptualization and provide a grounded CRP definition that would integrate all key CRP functions and clearly set the construct boundaries.

**Table 6** summarizes the terms used to denote the CRP and the specific CRP feature observed. A distinction is made between explicit definitions and features and implicit ones where the definition and feature have to be inferred by the Author.

| **Term used to denote CRP**<br>**Specific commodity reference price feature** | **Definition** | **Reference** |
|---|---|---|
| "Commodity reference price" | Explicit | (ISDA, 2019) |

| Term used to denote CRP<br>Specific commodity reference price feature | Definition | Reference |
|---|---|---|
| Monetary level at which a transaction is concluded<br>Assumes different forms | | |
| "Reference price"<br>The price of a homogenous, non-branded product listed in trade publications or discovered on organized exchanges | Implicit | Rauch (1999) |
| "International reference price for a commodity"<br>A standard with comparable properties<br>Commanding sufficient liquidity<br>Guided by supply and demand | Implicit | Mazighi, 2005 |
| "World price"<br>Coming to existence in different forms | Implicit | Bukenya & Labys, 2005 |
| "Reference price"<br>Coming to existence through different trade arrangements | Implicit | Radetzki, 2013 |
| "Market price"<br>Discovered at temporally and spatially distinct places<br>quotations around which buyers and sellers are willing to trade | Implicit | Caliscan, 2007 |
| "Reference price"<br>Commanding different levels of reliability and transparency | Implicit | Figuerola-Feretti & Gilbert, 2005; Radetzki, 2013; Maxwell, 2015 |
| "Reference price"<br>Benchmark for negotiations | Implicit | Moosmayer, 2012 |
| "Reference price"<br>Common reference for all transactions | Implicit | Figuerola-Feretti & Gilbert, 2005 |

**Table 6: Commodity reference price labels, definitions, and features**

### 2.5.2. Importance of CRP as an influencing factor

The review of the four taxonomies of influencing factors (see Section 2.3.1.) reveals that the CRP has not been recognized as an important CPM influencing factor. However, the Author believes that it logically fits the business environment factors of the Gaudenzi et al. (2018) taxonomy alongside the “market liquidity” factor. In contrast, there are multiple contributions where CRP was explicitly investigated as an influencing factor or where its impact on CPM practices can be inferred.

Mussell et al. (2003) provide some evidence of the CRP relevance and conclude that, depending on the CRP quality, market participants opt for different CPM practices: if a reliable CRP is available, market participants prefer CRP-based pricing mechanisms because they are less time and resource-intensive than negotiating. In contrast, if the CRP is not available, accessible, or biased, market participants by-pass the CRP and instead leverage cost-plus models that rely on internal production costs, direct negotiations, or tournament pricing, which is based on fixed compensation and relative production efficiency.

Furthermore, seven out of eight CPM practices used for trading agricultural commodities leverage the CRP (see Table 7). CRP is essential for the market price, formula prices, spot prices plus premium, product pricing by end-use, or quality contingent pricing. In contrast, it is only optional for the direct negotiation and the tournament deliberately by-passes the CRP. In addition, CRP impacts these CPM practices to a different degree and depending on CPM practice, CRP assumes different functions, e.g., information source, benchmark, or the representation of the transaction price.

| CPM Practice | CRP as influencing factor | CRP function |
|---|---|---|
| • Market price plus premium contracts | CRP represents the market price to which a premium is added | Representation of the transaction price |
| • Cost-plus pricing | CRP is not essential for the pricing mechanism but may serve as the basis for determining the value of a cost driver, e.g., commodities | Information source |
| • Formula prices | CRP changes inform the evolution of the contract price | Benchmark |
| • Tournament pricing | N/A, CRP is consciously by-passed | N/A |
| • Direct negotiation | CRP is not essential for the pricing mechanisms but may be leveraged in the negotiation process | Information source / Benchmark |
| • Spot market pricing plus premium dependent on retail value | CRP represents the market price to which a premium is added | Benchmark |
| • Product pricing classified by end-use | A range of CRP is generated for different end-uses and applied to transactions | Benchmark |
| • Pricing dependent upon specific quality attributes | CRP serves as the basis on which a bonus-malus is applied depending on pre-defined quality attributes | Benchmark |

**Table 7: List of CPM practices outlined by Mussel et al. (2003) with CRP as an influencing factor and CRP function. Source: Author**

The second stream of contributions stems from the CRP-related literature. While it explicitly does not treat the CRP as an important influencing factor, it shows how the emergence and existence of CRP shapes CPM practices and how CRP become fully integrated into some CPM practices. For example, the four-step process of the spot market evolution characterized by different types of CRP triggers different CPM practices. The first stage, called the “bilateral telephone market,” is characterized by the absence of a CRP, and the only conceivable CPM practice is direct negotiation between parties. The second stage is exemplified by the emergence of price reporting services that supply CRP, streamline the price discovery, and serve as a basis for subsequent price negotiation. As CRP gain credibility, the third stage is achieved when CRP appear in contracts and inform price escalator clauses. Finally, a regulated futures market is created, and the CRP becomes a tool for managing the price risk and enabling CPM practices like hedging and spot purchases (Roeber, 1996).

The same evolution was observed in the aluminium market, where the arrival of high-quality CRP emanating from liquid commodity exchanges opened ground for new CPM practices such as speculation or hedging and streamlined others like bilateral price negotiation, which became pegged to the CRP (Figuerola-Ferretti & Gilbert, 2005).

Similarly, the progress toward CRP issued by regulated commodity exchanges alters the nature of CPM practices: as CRP become more public and the price discovery transparent, they significantly streamline the CPM, broaden the range of available CPM practices, and become relatively more efficient (Radetzki, 2013).

The evolution of the lithium market provides additional empirical evidence of the CRP impact on CPM practices: for a long time, lithium trading leveraged CPM practices informed by transparent producer CRP. However, with the arrival of new entrants, the CRP became unavailable, and market participants had to turn to confidential bilateral negotiations. Later, the CRP resurfaced again in the form of

a benchmark published in the mineral industry press, and CPM returned to the CRP-based price discovery (Maxwell, 2015).

Finally, the oil market, with its several layers of co-existing CRP, represents the most complex evidence of the relationship between CPM practices and CRP. The oil market generates multiple CRP: published transaction prices, CRP assessed by the price reporting agencies, CRP issued by liquid commodity exchanges, and CRP for the quality differentials. These CRP subsequently shape the CPM practices: physical deliveries are agreed upon based on the spot CRP valid at the time of loading, long-term contracts are negotiated as formula prices linked to a prevailing spot CRP, the proliferation of oil grades is addressed through discount or premium to a CRP for a “standard” oil, and the CRP emanating from commodity exchanges are used for hedging (Fattouh, 2011). While the quality of this CRP complex gradually improves, the overregulation of the price discovery process may decrease the interpretive value of the CRP and thus hamper CPM (Stewart, 2013).

Rauterberg & Verstein (2013) implicitly develop the idea of different levels of CRP quality. Focusing primarily on financial indices, a close relative to CRP, they show that market participants use indices and benchmarks for three reasons: a blueprint for investments, a contract referent in long-term and derivative contracts, and an information source. Subsequently, they show that indices and benchmarks differ in quality, and market participants must carefully consider whether an index fits the intended purpose. For example, an index may be suitable as an information source but perform poorly as a contract referent because the index issuer may have made a trade-off between index accuracy and other legitimate objectives. Depending on the level of quality, the index may be particularly vulnerable to the three principal sources of risk: manipulation (deliberate intervention to change the index input, methodology, or output to suit the manipulator’s interest), underproduction (the index is not fully produced even though the social value exceeds the social cost), and malproduction (low-quality management of an index).

Similarly, Verstein (2015) explores benchmark manipulation and shows how relatively easy it is to manipulate the CRP and, subsequently, the whole market. The paper discusses the implications of index manipulation for the market participants and reviews measures authorities (should) take to prevent manipulation.

Relevant to this study, Verstein (2015) suggests the devastating impact of CRP manipulation (hence, poor CRP quality level) on CPM practices. Furthermore, the paper demonstrates that CRP play a fundamental role in helping market players understand the market dynamics and make good decisions; CRP are used in long-term contracts where they streamline risk management and improve the transaction efficiency; CRP are essential for all CPM practices based on derivatives, such as hedging or speculation.

At the same time, Verstein (2015) argues that market participants continue using CRP due to unaddressed historical legacies despite CRP's vulnerability to manipulation. An alternative explanation for using vulnerable CRP may be the indispensability of CRP for many CPM practices. Hence, if market participants want to hedge or include a price revision formula, they need a CRP.

Focusing on commodity market regulation, Cinquegrana (2008) highlights the risk of poor quality of CRP emanating from futures markets and their negative impact on CPM practices due to decreased informational efficiency, increased counterparty risk, and thus less efficient hedging and price discovery.

Finally, the CPM literature reveals several instances where the CRP impact on CPM practices can be inferred even though the relationship may have been mentioned only in passing and not have been recognized by the author, nor investigated in detail. Table 8 summarizes these contributions and interprets the relationship between CRP and CPM practices.

| Contribution | Inferred CRP – CPM practice relationship |
|---|---|
| CRP allow formula prices pegging to a benchmark and thus decrease the transaction costs, enable improved coordination of long-term business relationships, and reduce the need for market information gathering and negotiation skills.<br><br>The absence of generally accepted and sufficiently precise CRP hampers effective use of formula pricing (Hayenga and Schrader, 1980). | CRP enables CPM practice and makes it more efficient.<br><br>The absence of quality CRP makes the CPM practices based on CRP difficult to implement. |
| Hobbs (1997) concludes that price uncertainty, defined as not knowing what price the cattle will fetch before the auction, does not negatively impact farmers' intentions to sell cattle through auctions. The reason is that the CRP stemming from other auctions reduces the price uncertainty as it informs sellers about general market prices and thus significantly reduces the transaction costs related to auctions. | CRP makes auctions, a CPM practice, efficient. Should it not exist, other CPM practices may be more efficient. |
| The coffee CRP generated by the Chicago Board of Trade is the crucial benchmark for the whole supply chain (Newman, 2008). | CRP value informs the CPM practices and imposes CPM practices that are CRP based. |
| Objective, third-party CRP should be leveraged for managing commodity price increases<br><br>The absence of CRP suitable for hedging purposes forces companies to consider cross- | CRP streamline the CPM management.<br><br>CRP is fundamental for hedging as well as cross-hedging. |

| Contribution | Inferred CRP – CPM practice relationship |
|---|---|
| hedging as long as there is a strong correlation between the two commodities<br><br>(Zsidisin and Hartley, 2012). | |
| CRP is understood as raw material price indices, and commodity exchange prices are leveraged as benchmarks in negotiations to "beat the index" (Moosmayer, Schuppar and Siems, 2012). | CRP serves as a benchmark to compare the outcome of negotiations and thus shapes the CPM expectations, |
| Spot or forward contracts for wheat are designed around the benchmark price, which stems from futures contracts. The reference price is adapted along quality and local attributes.<br><br>Market participants use the rolling front month futures price as a proxy for physical markets in their CPM activities,<br><br>Differences among varieties are typically priced through a premium over a benchmark price; storability and storage cost trigger the differences between the spot and future prices and limit the scope of CPM practice relying on these two factors (Valiante and Egenhofer, 2013). | CRP is a fundamental influencing factor of the CPM practice feasibility and the subsequent price discovery process.<br><br>CRP impacts the CPM practices related to market price search, formula prices, and hedging/forward purchases. |
| CRP is used as a proxy for comparing commodity volatility; suppliers may follow geographically different CRP and thus leverage an opportunity for arbitrage through supplier switching (Pellegrino, Costantino and Tauro, 2019). | CRP is instrumental in operating the CRP differential-based arbitrage, a CPM practice. |

**Table 8: Contributions to CRP-CPM relationship**

In summary, this section provides mixed evidence. Numerous instances where the CRP relevance as an influencing factor in shaping CPM practices was identified or inferred by the Author may suggest a rich body of literature and knowledge. In contrast, the fact that none of the four holistic taxonomies of CPM influencing factors identified CRP as a relevant influencing factor, the fact that contributions remain scattered and there is no cross-referencing between the CPM and CRP-related contributions, the fact that CRP is often mentioned in passing, and the fact that no paper explicitly identifies CRP as an important CMP influencing factor worth operationalization and focused investigation, suggests that CRP remains unrecognized and under-researched.

### 2.5.3. Level of CRP contingency

The previous section documented that the CRP is a very important influencing factor and plays a key role in determining the CPM practice selection and efficiency. Building on the contingency theory assumption that different contingency levels of the influencing factor have different impacts on the phenomenon of interest (Donaldson, 2001), this section explores how scholars conceptualize different levels of CRP contingency.

**Table 9** summarizes the main contributions and documents that CRP contingency levels are often not considered (e.g., Hobbs, 1997; Moosmayer et al., 2012; Mussell et al., 2003; Newman, 2008; Pellegrino et al., 2019) because authors may investigate a topic where the CRP contingency level is not salient or was not identified as such. For example, Pellegrino et al. (2019) explore the main factors that impact the effectiveness and value of two CPM practices: switching suppliers and substituting commodities. The analysis focuses on the set-up, warehousing and validation costs, and CRP volatility. In contrast, the impact of CRP contingency was not considered even though one can imagine that substituting a commodity with a high quality CRP for a commodity with a low

quality CRP may increase uncertainty and generate additional transaction-related costs.

Several contributions were identified where the CRP contingency levels remain implicit and only inferable from illustrative examples (e.g., Rauterberg & Verstein, 2013; Verstein, 2015). Furthermore, scholars may focus exclusively on the polar cases (e.g., Gaudenzi et al., 2018; Hayenga & Schrader, 1980; Zsidisin & Hartley, 2012) without operationalizing them, providing intermediate levels, or justifying their absence. For example, Gaudenzi et al. (2018) differentiate between liquid and illiquid futures markets but do not say how to measure liquidity and its potential intermediate levels. Similarly, Zsidisin & Hartley (2012) recommend using objective, third-party indices without explaining how the objectivity attribute is defined and measured. Finally, Hayenga & Schrader (1980) conclude that the CRP should be well-accepted, accurate, and representative of actual transactions but do not show how to measure these attributes, how to aggregate them, how many levels of CRP contingency exist, nor provide examples of CRP falling into individual contingency levels. Hence, while informative, these contributions do not provide a full range of contingency levels nor guidance on how to establish them.

| Author | Presence of contingency levels | Key variable | Measures | Specific contingency levels |
|---|---|---|---|---|
| **1. Not considered** | | | | |
| Mussell et al., 2003 | Not considered | None | No | Not considered |
| Newman, 2008 | Not considered | None | No | Not considered |
| Pellegrino et al., 2019 | Not considered | None | No | Not considered |
| Moosmayer et al., 2012 | Not considered | None | No | Not considered |

| Author | Presence of contingency levels | Key variable | Measures | Specific contingency levels |
|---|---|---|---|---|
| Hobbs, 1997 | Not considered | None | No | Not considered |
| | | | | |
| **2. Illustrative examples** | | | | |
| Rauterberg & Verstein, 2013 | Explicit | Vulnerability to manipulation, underproduction, malproduction | No | Illustrative examples of contingency level |
| Verstein, 2015 | Explicit | Vulnerability to manipulation | No | Illustrative examples of contingency level |
| **3. Variables but not contingency levels** | | | | |
| Cinquegrana, 2008 | Inferred | Increased regulation, physical transactions included in price discovery | No | Does not specify |
| **4. Polar contingency levels only** | | | | |
| Gaudenzi et al., 2018 | Inferred | Market liquidity | No | Liquid vs. illiquid futures markets |
| Hayenga & Schrader, 1980 | Inferred | Existence of CRP,<br>well-accepted,<br>accurate,<br>representative of actual transactions | No | CRP value represents actual transactions,<br>CRP value reflects changes in important factors |
| Zsidisin & Hartley, 2012 | Inferred | Objectivity and origin,<br>CRP availability | No | Objective, third-party vs. non-objective and contract party issued, |

| Author | Presence of contingency levels | Key variable | Measures | Specific contingency levels |
|---|---|---|---|---|
| | | | | traded on commodity exchanges and thus available for hedging vs. others, |
| **5. Contingency levels provided** | | | | |
| Radetzki, 2013 | Inferred | Price discovery mechanism | No | Six discreet levels: (1) transfer prices, (2) posted prices, (3) bilateral negotiation, (4) producer dictated prices /user driven prices (5) auctions, (6) commodity exchanges |
| Maxwell, 2015 | Explicit | Public availability and transparency | No | Continuum ranging from private and opaque pricing to public and transparent pricing |
| Fattouh, 2011 | Inferred | Price discovery mechanism | No | List of price discovery mechanisms,<br>argues that neither mechanism is better- each fit based on purpose |
| Stewart, 2013 | Inferred | Horizontal and vertical market transparency | No | (1) Opaque market, (2) price reporting institutions, (3) futures markets, (4) increased regulation of market, |
| (Figuerola-Ferretti and Gilbert, 2005) | Explicit | Information content | Yes | Measure the noise-to-signal ratio: (1) producer posted list price, (2) price reporting journal, (3) less liquid commodity exchange, (4) liquid commodity exchange, |
| (Valiante and Egenhofer, 2013) | Inferred | Availability,<br>liquidity,<br>market sophistication, | No | Low vs. medium vs. high natural gas CRP price transparency |

| Author | Presence of contingency levels | Key variable | Measures | Specific contingency levels |
|---|---|---|---|---|
| | | regional relevance, and price transparency | | |

**Table 9: Contributions on CRP contingency levels**

In contrast, there is a small number of papers where scholars identified contingency variables and implicitly suggested that CRP contingency is a multidimensional construct. For example, Rauterberg & Verstein (2013) focus on the CRP quality and identify three sources of poor CRP indices: manipulation, underproduction, and malproduction (see Section 2.4.2. for definitions). Unfortunately, they do not operationalize these CRP-measured attributes and do not convert them into distinct CRP contingency levels. The multidimensional nature of CRP measured attributes seems a promising venue but the extant literature provides only limited insight into their nature and operationalization.

A continuum of CRP contingency levels based on the level of CRP regulation can be also inferred from Stewart (2013), who argues that recent attempts to increase the CRP regulation may hamper vertical transparency (the interpretation of market players' motivations and actions). Similarly, Valiante, & Egenhofer (2013) analyse the gas market and identify three levels of CRP transparency, understood as the quality of the price discovery process: low, medium, and high. Finally, Figuerola-Ferretti & Gilbert (2005) provide quantitative evidence that CRP generated by liquid commodity markets have superior information content compared to producer-posted list price, CRP issued by a price reporting journal, or less liquid commodity exchanges.

Scholars who attempted to operationalize the CRP contingency focused on the evolution of commodity markets toward higher regulation and price discovery

transparency. In particular, Maxwell (2015), building on Radetzki (2013) and Roeber (1996), conceptualizes a continuum based on commodity pricing transparency, which is a function of the market set-up. The continuum assumes that more competitive markets generate more public and transparent CRP; consequently, different CPM practices are warranted. Vertically integrated companies leverage transfer prices, a non-cooperative oligopoly relies on confidential bilateral negotiations between the buyer and the seller, cooperative oligopolies prefer publicly announced producer prices, often coupled with secret discounts during periods of low demand (Radetzki, 2013b), and an oligopoly leverages its market power and imposes the user-driven prices. Competitive mineral sectors rely on transparent auctions or champion negotiation (Li, 2010). Finally, some commodities become traded on regulated commodity exchanges, which generate a continuous stream of high-quality CRP, offer efficient price discovery towards equilibrium prices, constantly available facility to trade, information about the supply/demand balance through contango/backwardation, and facility for hedging (Radetzki, 2013b). In parallel, bilateral negotiation remains an option for companies who wish to decouple from the prevalent CPM practice (Maxwell, 2015).

These contributions provide both the CRP measured variables and numerous contingency levels. On the down side, the measured variables seem only vaguely defined and there is no guarantee that the CRP contingency levels are exhaustive and non-overlapping.

In summary, there is no consensus about the CRP contingency level operationalization and existing contributions provide only limited guidance concerning the suitable measured attributes and contingency levels. **Table 9** documents that numerous contributions do not consider it at all and some scholars only provide illustrative examples of contingency levels without further elaboration. There are also papers that provide CRP contingency variables with polar examples of the specific CRP contingency levels. Finally, operationalizations based on different measured variables with a range of CRP contingency levels can be found, however, it is unclear how the CRP measured

variables were selected nor whether the CRP contingency levels cover all possible configurations and are distinctive enough.

### 2.5.4. Fit between CRP contingency level and CPM practices

The previous section revealed some evidence of the relationship between the CRP contingency level and CPM practices, even though this link remains mostly unrecognized, was not subject to systematic empirical investigation, and remains mostly conceptual or anecdotic. This section reviews contributions that investigate the fit between the CRP contingency level and CPM practices.

The exploration of the CRP contingency level and CPM practices fit remains outside of scholarly research and none of the reviewed papers explicitly operationalizes it. However, a close reading of the literature suggests that scholars opt for the fit-as-matching approach (Venkatraman, 1989), where simple congruence between the contingency factor and the CPM practice is sought. For example, Jones et al. (2007) present compelling reasons why spot or forward buy should be preferred for a given contingency level, and Zsidisin & Hartley (2012) highlight the importance of selecting an objective, third-party index for formula clauses or emphasise the existence of futures exchanges as enabler for financial hedging. Similarly, Gaudenzi et al. (2018) document that buyers prefer cross-hedging for specialty raw materials with thin futures markets.

Maxwell (2015) offers valuable insight into the dynamic nature of fit-as-matching by documenting how CPM practices evolve along the CRP contingency level evolution. When the CRP was reliable and widely available, market players opted for producer pricing or price formulas, both CPM practices based on CRP. However, when it disappeared or became unreliable, bilateral negotiation was the only available CPM practice. Roeber (1996) shows a similar dynamics of CPM practice adjustment to the emergence of CRP in the gas market where the bilateral negotiation evolves into benchmark-based contracts and subsequently into a sophisticated financialized market with spot and futures contracts.

Despite these contributions into the fit between CRP contingency level and CPM practices, it should be noted, that scholars have not established performance

indicators to measure the CPM practice performance under different CPR contingency levels, which weakens the validity of the findings as CPM practices may have been used for legacy reasons or lack of skills rather than selected for their superior performance for a given CRP contingency level. Furthermore, the fit-as-matching approach stems from the observation of business practice on relatively small samples (e.g., Gaudenzi et al., 2020; Jones et al., 2007) or very specific contexts (e.g., Li, 2010; Maxwell, 2015) which may further bias the findings. Finally, existing CPM practices– CRP relationship research is not properly grounded in the contingency theory and therefore lacks empirical robustness, e.g., the CPM practices are not defined (e.g., Maxwell, 2015) nor contingency levels properly defined (e.g., Jones et al., 2007).

## 2.6. Research gap and Research question

The literature review has revealed multiple research gaps in the existing literature. This section, therefore, summarizes the key research gaps and subsequently formulates the research question.

### 2.6.1. Research opportunities in CPM practices research

The literature contains a wide range of CPM practices, and there is a broad consensus about CPM practices' meaning and underlying mechanisms, simplifying orientation and knowledge accumulation. On the downside, Fischl et al. (2014) note that CPM practices remain mostly conceptual and primarily based on literature reviews, conceptual approaches, and theoretical models. This review confirms that while even recent contributions remain predominantly conceptual (e.g., Finley & Pettit, 2011; Haksöz & Kadam, 2009; Hofmann, 2011; Pennings & Leuthold, 2000; Zsidisin & Hartley, 2012), empirical contributions are slowly emerging (e.g., Fischl et al., 2014; Maxwell, 2015; Gaudenzi et al., 2018).

In addition, the body of dominant CPM practices such as substitutes, forward buy, pass through, hedging, or absorption has gradually emerged and is subject to empirical investigation in numerous papers (e.g., Jackson, 1980; Finley & Pettit, 2011; Zsidisin & Hartley, 2012; Gaudenzi et al., 2018). In contrast, there is a plethora of less well-known CPM practices that remain under-researched and often only implicitly defined, e.g., the long list compiled by Fischl et al. (2014). To give an illustrative example of an "ignored" CPM practice, the avoidance of trading markets has appeared only twice in extant literature: Fischl et al. (2014) mention it without a definition or illustrative example, and Behar (2008) reports in passing that Chinese companies by-pass the open markets and sign contracts directly with the local producers of commodities.

*Research gaps:*

As CPM practices lack empirical foundations, further research should establish grounded definitions of a wide range of CPM practices, describe their generative mechanisms, and illustrate their application in practice. While the author attempted to provide working definitions and examples in the Section 2.1.1., more research is needed.

Furthermore, CPM research concentrates only on a limited number of "popular" CPM practices and ignores the rest, which creates blind spots and may orientate practitioners and researchers towards a narrow range of CPM practices and thus fail to capture the richness of the CPM field. Researchers should, therefore, revisit CPM and explore a wide range of CPM practices observed in the business environment. Scholars may also focus on more "exotic" CPM practices and shed light on the reasons for their (un)popularity with practitioners. Finally, they should expand the CPM practice toolkit anchored in practical examples and generalize them into actionable theoretical recommendations.

### 2.6.2. Research opportunities in CRP as a contingency variable

Contextual factors play a key role in selecting CPM practices and must be considered in the CPM research and development of any CPM frameworks. The

literature review reveals that the research on individual influencing factors is still in its infancy and lacks a focused and unified research agenda. For example, only a handful of influencing factors has been precisely defined and operationalized so far, e.g., ten commodity supply risk indicators and their measures in Achzet & Helbig (2013) or 15 agricultural commodity contingencies outlined in Jones et al. (2007). From a theoretical standpoint, Gaudenzi et al. (2018) provides an initial taxonomy of CPM influencing factors, and advances our understanding of the subject and encourages scholars to investigate the interplay and hierarchy of CPM influencing factors, a fundamental piece of knowledge in shaping the choice of a CPM practice when several and potentially contradictory influencing factors operate simultaneously.

Focusing on the CRP as a contingency variable, existing research has identified it but did not recognize it as a fundamental influencing factor. The CRP research remains scattered, with only a few CPM assessed in terms of their sensitivity to CRP. In addition, scholars show that different CRP influence the same CPM practices differently (e.g., Li, 2010; Maxwell, 2015). Hence, there must exist different levels of CRP. Unfortunately, little is known about what these levels are, what CRP properties constitute them, and how they can be measured.

In summary, the knowledge of CRP remains scattered, CRP as a stand-alone influencing factor remains implicit or only mentioned in passing, CRP conceptualization is not adapted to CPM practices, and limited attention is paid to exploring, defining, and operationalizing the CRP contingency levels. Consequently, the poor conceptualization of CRP contingency and its levels hamper a finer-grained interpretation of existing research as well as avenues for further research.

*Research gaps:*

The literature review reveals significant research gaps concerning our understanding of CRP as a CPM influencing factor. Firstly, the CRP should be isolated as a stand-alone variable, and its impact on CPM practices should be explored. Secondly, CRP should be investigated as one influencing factor among many, and the extant research should shed light on how CRP interacts with other

influencing factors and its relative importance when it triggers contradictory recommendations to co-existing influencing factors. Finally and most importantly, to advance our theoretical understanding of the CRP influence on CPM practices and provide actionable recommendations to practice, CRP must be properly conceptualized as a CPM influencing factor and its contingency levels defined and measured.

### 2.6.3. Research opportunities in CPM practices – CRP fit

The literature review substantiated the impact of CRP on CPM practices. However, some scepticism is warranted for recommendations that build on the fit-as-matching approach.

The literature review revealed that no performance variables were identified to measure CPM practice performance against different levels of CRP contingency nor assess the performance of different CPM practices against the same level of CRP contingency. Furthermore, very little research was undertaken to understand the "rules" of fit between the CRP and CPM practices. This research gap precludes researchers from advancing our understanding of the particularly relevant area to practitioners: when and why should we employ which CPM practice?

The importance of this research gap can be illustrated on a hierarchical model of six CPM practices outlined by Zsidisin & Hartley (2012), who recommend using CPM practices in the following order: use a substitute, contractual clause, pass through to the customer or supplier, forward buy, acquire futures or options, cross hedge, absorb risk and reduce demand. Yet, poor understanding of the CRP-CPM practices fit renders this hierarchy of CPM practices problematic: firstly, the existence of liquid commodity exchanges and the possibility of low-cost hedging based on CRP may require fewer resources than substitutes or forward buy. Therefore, hedging might be the first choice in some instances. Secondly, the same CPM practice may witness different performances depending on the CRP contingency level. For example, a highly liquid and respected CRP streamlines

the customer/supplier pass-through. In contrast, unreliable CRP may trigger endless haggling about the CRP value and render this CPM practice impractical. Hence, depending on the CRP contingency level, a different hierarchy of CPM practices may exist.

Furthermore, on a finer-grained level, CPM practices may have multiple variants whose performance is contingent upon the CRP contingency level. For example, formula prices may be based on the spot market, external benchmarks, estimation of production costs, or potential profits estimation (Mussell et al., 2003). Therefore, depending on the CRP contingency level, formula prices as a CPM practice may decouple from the spot market and draw on production costs instead.

Finally, a poor understanding of fit precludes any meaningful performance assessment of CPM practices against CRP as an influencing factor. Yet, such performance assessment is important theoretically and practically. Firstly, on the theoretical level, it would create testable hypotheses of the relationship between CPM practices and CRP contingency levels and might reveal any blind spots or misconceptions. It may also open ground for more sophisticated conceptualizations of fit and improve our understanding of the CRP contingency impact. Secondly, on the practical level, a performance-based framework of CPM practices would help practitioners select suitable CPM practices for a given CRP contingency level.

*Research gap:*

Considering the important research gaps summarized in the previous paragraphs, extant research is needed to uncover the underlying mechanisms of the CRP – CPM practices fit. This understanding would subsequently open ground for more sophisticated measures of fit conceptualized by Venkatraman (1989). The accumulation of knowledge would then enable comprehensive classification schemes, hierarchical CPM practice models, and actionable guidelines on using different CPM practices under different CRP contingency levels.

Furthermore, in order to measure the level of fit between CRP contingency and CPM practices, extant research must develop relevant performance variables and subsequently assess CPM practices´ performance under different scenarios: (a) a CPM practice performance under different CRP contingency levels, e.g., the effectivity of financial hedging when the commodity is not traded on commodity exchanges and an alternative CRP has to be used as contract reference (b) different CPM practices against the same CRP contingency level, e.g., evaluate the relative performance of substitutes, forward buy, hedging for a particular quality of the CRP.

Finally, current research relies on the fit-as-matching approach, which stems from the observation of current CPM practice but is not grounded in any theory. This lack of theoretical grounding does not give confidence in the robustness of existing recommendations. In addition, different conceptualizations of fit might reveal new insights into the CPM under the CRP as an influencing factor.

### 2.6.4. Research question

Structuring the literature review along the logic of contingency theory revealed multiple and fundamental research gaps. As it is impossible to address all these gaps simultaneously, this thesis will focus on the most critical research gap, which constitutes the biggest challenge when researchers apply the contingency theory (Sousa and Voss, 2008): the conceptualization of the CRP and theoretically grounded operationalization of the CRP contingency levels. To address this challenge, two research questions are formulated and the rest of the section relates these research questions to gaps identified in the previous sections.

*RQ1: What is the suitable commodity reference price conceptualization and measured attributes?*

The absence of carefully conceptualized and theoretically grounded CRP construct hampers the theoretical advancement of the CPM field. Indeed, previous sections suggest that it is impossible to study the impact of CRP on CPM practices, investigate the performance of CPM practices under different CRP

contingency level scenarios, or draw theoretical conclusions about the CPM practice – CRP contingency level fit without proper conceptualization of the CRP construct and understanding of its measured attributes as already emphasised in the section 2.5.2.

*RQ2: What are the relevant commodity reference price contingency levels?*

The second research question builds on the RQ1 and explores the relevant CRP contingency levels as this understanding is fundamental for measuring the CRP- CPM practices' fit, a major theoretical weakness of existing research.

Besides these important theoretical implications, understanding of the CRP and its contingency levels significantly contributes to practice: practitioners will be able to assess the CRP "quality" and decide whether the CRP is fit for purpose; they may also leverage theoretical recommendations and select the most suitable CPM practice for a given CRP contingency level; CRP issuers may redesign their CRP and achieve the intended contingency level; regulators may warn against "poor" CRP, put pressure on improving the CRP contingency level, and design differentiated regulatory requirements for different CRP contingency levels.

Figure 6 summarizes the thesis's focus and positioning within the CPM research. The basic CPM model demonstrates that companies leverage CPM practices to manage commodity prices and volatility. The selection of suitable CPM practices is then contingent on numerous contingency factors, one of which is the level of CRP contingency. The thesis will explore this relationship to document the CRP transparency intra-level homogeneity and cross-level heterogeneity and outline the CRP transparency impact on CRP functions and CPM practices. However, to do this, it is necessary to conceptualize the CRP construct (RQ1) and subsequently operationalize CRP construct into meaningful CRP contingency levels (RQ2).

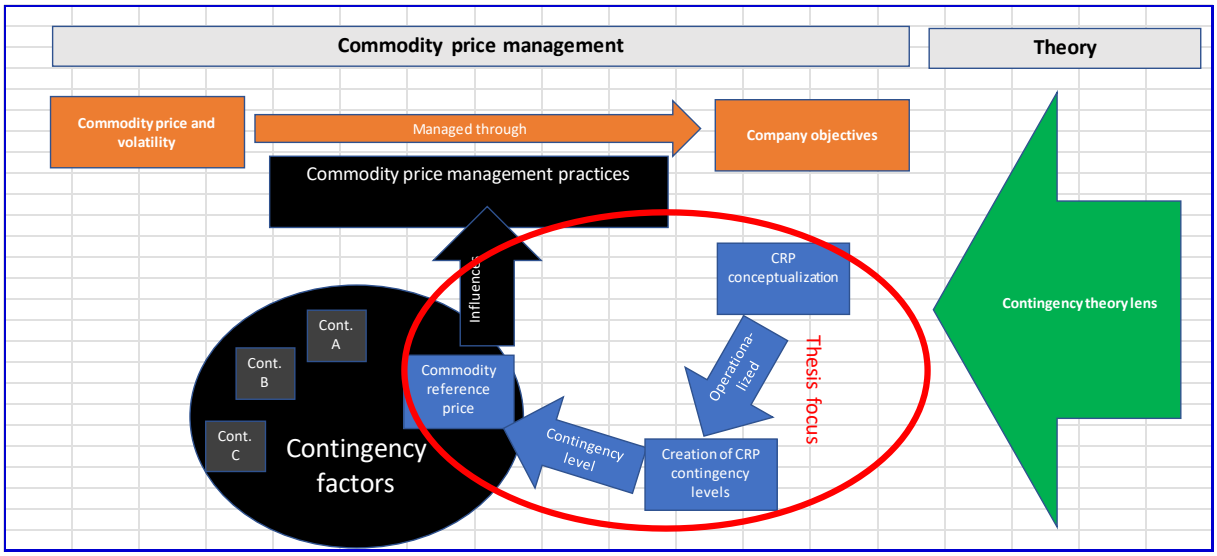



**Figure 6: thesis's focus and positioning within the CPM research. Source: Author.**

# 3. Methodology

## Introduction

This chapter outlines the methodological choices to answer the research questions. It starts with elaborating the research paradigm applied throughout the research process. Subsequently, the research method is divided into the developmental, exploratory, and confirmatory stages where different data collection and data analysis methods were leveraged.

## 3.1. Research design

The research “onion” designed by Saunders, Lewis, & Thornhill (2009) summarizes the key research design decisions adopted by this thesis (see Figure 7). Considering the theoretical anchoring and the research questions, this thesis adopts a positivist ontological stance. The research approach is inductive, realized through multiple exploratory case studies and in line with the state of the theory. The research choice is based on qualitative data collection methods realized through semi-structured interviews and documentary evidence gathering, and the data analysis leverages the triangulation of interviews and documentary evidence. Finally, the time horizon is cross-sectional.

The rest of the section focuses on all layers of the research ´onion´ in detail. Firstly, the positivist research paradigm is justified. Subsequently, the rationale for the inductive research strategy is explained. Next, the exploratory case study is put forward as the most suitable research strategy and the grounding for the qualitative data collection approach is justified. Finally, the reasons for a cross-sectional time horizon are briefly considered. As for the data collection and data analysis methods, these will be outlined in detail in *Section 3.2*.

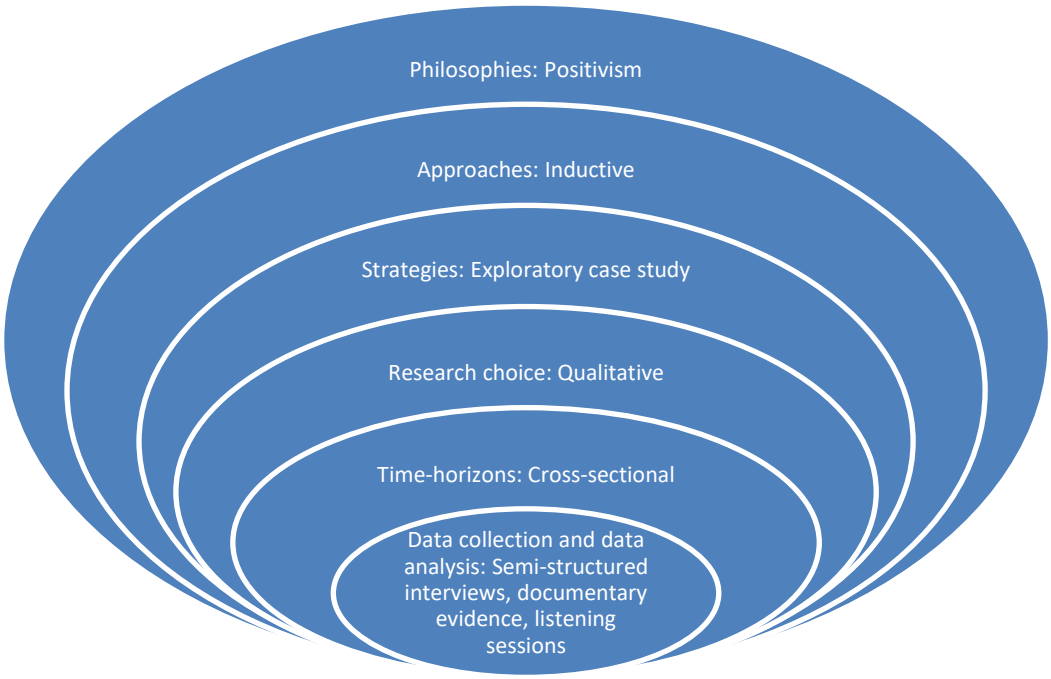



**Figure 7: Summary of key research design decisions. Adapted from Saunders, Lewis, & Thornhill (2009)**

### 3.1.1. Positivist research paradigm

There are three basic ontological/epistemological approaches: positivist, interpretive and critical (Willis et al., 2007). This section explains why positivism is the most suitable ontological approach considering the previous research, the research questions, and the research's theoretical anchoring.

This thesis seeks to establish an instrument to measure and compare the level of contingency of different CRP. As such, it is firmly grounded in the positivist research tradition due to (1) an ontological assumption about the objectives of the study, (2) epistemological assumption about the notion of knowledge, and (3) the relationship between the theory and practice (Chua, 1986):

1. A positivist ontology considers the object of study objective and existing independently of humans. The researcher then plays a passive role and discovers this objective reality. It also assumes that the phenomena under study can be easily identified and measured. Furthermore, a perfect correspondence between constructs and real-world phenomena is assumed. Additionally, positivists assume a unidirectional relationship between meaning and language with interviews, comments, and archival data articulating meaning and experience (Widdicombe and Wooffitt, 1995).

This research is grounded in contingency theory, a positivist theory, that considers the CRP and its attributes as objective entities that can be defined, measured, and the level of contingency improved (e.g., Donaldson, 1996). However, a perfect correspondence between constructs and real-world phenomena may be illusory and researchers should aim at moderate generalizations that represent the phenomena of the social world but are not sweeping (Berkovich, 2018).

Secondly, a predominantly positivist approach to CRP is apparent in the regulatory effort to establish an objective and universal instrument to evaluate the CRP price reporting quality (e.g., IEA, IEF, OPEC, & IOSCO, 2011), attempts to measure the CRP information content (Figuerola-Ferretti and Gilbert, 2005), or research into CRP vulnerability to manipulation (Verstein, 2015). Finally, the literature review revealed the relationship between the CRP contingency level and CPM practices (e.g., Maxwell, 2015; Zsidisin & Hartley, 2012) which assumes the existence of *a priori* fixed relationships among the CRP contingency level and CPM practices.

2. Positivist epistemology presupposes *a priori* fixed relationships between phenomena and seeks to find these knowable, constant, causal relationships. This understanding enables positivist researchers to predict and control, which leads to deterministic explanations. All positivist theories must allow empirical testing, and there is a stringent requirement concerning rigor and validity. It is, therefore, crucial that all concepts are defined precisely to assure homogeneity

among researchers (Johnson & Gill, 2010; Potter, 2006; Orlikowski & Baroudi, 1991).

Building on the evaluation criteria of Orlikowski & Baroudi (1991) and Lincoln & Guba (1985), both research questions are aligned with a positivist epistemological approach:

(1) Evidence of formal propositions (Orlikowski & Baroudi, 1991): different CRP contingency levels trigger different CPM practices, and there is an optimum fit between CPM practice and the CRP contingency level.
(2) Quantifiable measures and variables along with a single best description of a phenomenon (Orlikowski & Baroudi, 1991; Lincoln & Guba, 1985): the effort to operationalize the CRP measured attributes and CRP contingency levels.
(3) The researcher and object of inquiry are independent (Lincoln & Guba, 1985): the researcher acts as an independent, objective observer.
(4) Nomothetic statements/generalizations are independent of time or context (Lincoln & Guba, 1985): the link between CRP contingency level and CPM practices is assumed to be applicable to a large number of contexts, though universality can never be guaranteed.
(5) Identifiable, testable, and observable cause-effect relationship that draws on inferences about the phenomenon from a sample to a stated population (Orlikowski & Baroudi, 1991; Lincoln & Guba, 1985): this research establishes preliminary propositions depicting the cause-effect relationship between the different levels of CRP contingency and CPM practices which may be subsequently quantitatively tested.

3. Finally, there is a technical relationship between theory and practice where the researcher assumes value-neutrality as an impartial observer who does not make subjective judgments. Subsequently, the data collection and data analysis guidelines for the positivist case study research suggested by Dubé & Paré (2003) are suitable for exploring the research questions. At the same time, the author believes that it is impossible to achieve full independence between a

researcher and the phenomenon of interest because some discretion is necessary in the data coding and interpretation process.

The positivist ontology is not without criticism. For example, Sandberg & Tsoukas (2011) challenge the positivist approach, which they call “scientific rationality,” because it separates human reality into discrete entities with distinct properties and thus underestimates (1) the meaningful totality into which people are immersed, (2) ignores situational uniqueness, and (3) abstracts from time as experienced by people.

The author believes that these downsides can be partly addressed through a careful design of the case study which explores the problem of CRP in its rich context and attempts analytical generalization recommended by Yin (2014) grounded in important contextual factors.

### 3.1.2. Inductive research strategy

The literature review documented that CRP as a contingency factor is poorly understood and only vaguely defined. Yet, without the clear operationalization of a CRP construct and its contingency levels, it is impossible to explore the link between CRP transparency and CPM practices. This research, therefore, seeks to build a testable theory of CRP contingency levels by (a) conceptualizing CRP as a contingency factor, (b) proposing CRP measured attributes, (c) operationalizing the level of CRP contingency levels, and (d) confirming the practical applicability of the CRP contingency levels.

In light of the above, all research objectives clearly indicate an inductive research approach which builds theory from observations based on qualitative research, subjective inferences by the researcher, and several iterations during the data analysis typical for constructivist research (Park, Konge and Artino, 2020). However, careful anchoring of the research in the contingency theory and selecting research methods focused on developing constructs, operationalizing measures, and formulating testable hypotheses allows the researcher to reconcile inductive research with a positivist ontological stance.

### 3.1.3. Exploratory, multiple-case study approach

This section explains the selection of an exploratory, multiple-case study approach to answer the RQ and a qualitative mixed-data collection method, which combines semi-structured interviews with documentary evidence.

This research is exploratory because it seeks to identify CRP transparency attributes, operationalize them, and establish a CRP transparency index. While the literature review identified some CRP transparency attributes, there is uncertainty about their relevance, definition and measure attributes.

Social researchers choose between experiments, action research, phenomenology, ethnography, and case studies (Robson, 2002). This thesis opts for the exploratory, multiple case study approach because large and versatile primary data is needed to answer the research question and case studies are an excellent source of such data (McCutcheon and Meredith, 1993). Secondly, case studies are valuable when the constructs are poorly defined and understood (Mukherjee, Mitchell and Talbot, 2000), which is the case of this research. Thirdly, a case study approach allows the researcher to investigate complex and contemporary phenomena such as CRP transparency attributes within their real-life context (Yin, 1994). Finally, case studies are suitable for the *what* questions of an exploratory type where the objective is to develop pertinent hypotheses and propositions for further enquiry (Yin, 1994).

Compared to a single-case study approach, multiple-case studies are considered more valid and generalizable as conclusions arise independently from several cases. Eisenhardt (1989) argues that multiple-case design is compatible with the positivist qualitative research as it allows the juxtaposition of contradictory evidence, which generates novel and relevant theories and pushes researchers to take a new perspective and reframe existing theory. On the downside, the multiple case study research may lead to overly complex explanations and the resultant theory can be idiosyncratic and not generalizable (Eisenhardt, 1989).

The case study research is realized through a triangulation of documentary evidence and interviews. Documentary evidence draws primarily on CRP reports, CRP methodologies, and internal documents such as contracts, reports, or internal notes. The semi-structured interview design then allows the researcher to focus on particular phenomena while allowing respondents to spontaneously express their opinions. It also provides flexibility during the interview, and gives opportunities to complement the interview with direct observation (Kallio et al., 2016).

### 3.1.4. Positivist qualitative research choice

This section considers a suitable research approach considering the prior state of the theory and the research question. It concludes that a qualitative research approach is the most suitable one.

There are three states of prior theory: nascent, intermediate, and mature, and each of them requires a different research approach. Applying the Edmondson & McManus (2007) criteria, the theory can be considered as nascent (see Table 10 for summary) and provides new constructs and provisional theoretical relationships (Edmondson & McManus, 2007). At the same time, being anchored in contingency theory as well as in existing yet separate bodies of literature, the emerging theory can be integrated into existing research streams.

| **Attribute** | **Nascent theory research fit** |
|---|---|
| State of prior theory and research | *RQ1: CRP transparency construct is a new type contingency in contingency theory research.*<br>*RQ2: CRP transparency levels have not been researched.* |
| Research question | *RQ1: CRP transparency construct is newly conceptualized.*<br>*RQ2: CRP transparency levels have not been operationalized.* |

| | |
|---|---|
| Constructs and measures | *New constructs such as CRP transparency, CRP measured attributes, commodity reference price transparency index.* |
| Goal | *Definition of new constructs and their preliminary testing: establishment of CRP transparency, CRP transparency attributes, and CRP transparency index.* |
| Theoretical contribution | *Nascent theory that integrates separate research streams such as CRP, transparency, and contingency theory.* |

**Table 10: The nascent nature of research following Edmondson & McManus (2007)**

Hence, following the Edmondson & McManus (2007) recommendations for methodological fit, this thesis opts for a positivist qualitative research approach. While it may seem that the positivist paradigm is contradictory to qualitative research methods, the opposite is true, and qualitative research expands the scope of positivist research into emerging phenomena, new theories and concepts (Su, 2018).

Positivist qualitative research is well-established in supply chain management research, e.g. Pagell and Wu (2009), and while it was never codified, the research process has several common features that will be followed by this paper as well.

It typically starts with an extensive literature review of the phenomenon of interest prior to interviews to select suitable participants and design the interview protocol (Sobh and Perry, 2006). Subsequently, the interviews are collected and triangulated with other data sources in a way to maximize the detached relationship between the researcher and the respondent (Darby, Fugate and Murray, 2019), even though the total detachment required by the “purist” positivism cannot be achieved (Berkovich, 2018). Next, the data is coded in a way to eliminate researcher bias (Pagell and Wu, 2009), yet it is questionable whether the total elimination of bias is achievable and whether researchers should not accept that positivist qualitative research is always contaminated by a

certain degree of interpretivism (Sale, Lohfeld and Brazil, 2002). The data is typically coded into a priory codes based on conceptual frameworks and constructs (Sobh and Perry, 2006). Within and cross-case analysis is applied to identify key constructs and relationships and build theory and formulate propositions (Eisenhardt, 1989; Darby, Fugate and Murray, 2019).

It is apparent that positivist qualitative research differs from the “purist” positivism and the very nature of the positivist qualitative research process imposes a degree of interpretivism. Hence, this research should not be considered purely positivist, but rather situated along the positivist/interpretivist continuum where positivism is coloured by interpretivism (Sobh and Perry, 2006).

In summary, the author refuses being locked in a positivist-interpretivist dichotomy and takes a pragmatic view of research ontology outlined by Saunders, Lewis and Thornhill (2009) which argues that a single research may integrate both positivist and interpretivist ontology as long as such approach helps collect and interpret the data. In particular, the intuitive and interpretive literature review will adopt the interpretivist ontology and the expert-directed interviews will contain some degree of interpretivism (e.g., the participant briefs will be prepared by the author).

### 3.1.5. Cross-sectional time horizon

This research primarily explores a snap-shot of CRP transparency attributes and the level of these attributes taken at a particular moment. Hence, the time horizon should be considered cross-sectional. At the same time, if appropriate, the researcher may ask about the evolution of the CRP transparency attributes and the ensuing evolution of the CPM practices. This longitudinal perspective may raise to the surface the CRP transparency attributes and their relative importance.

### 3.1.6. Translation

Interviews were held in Czech, Slovak, French, German, and English. As the thesis is written in English, the question of the translation bias (to English) has to be considered and the three main challenges identified by Xian (2008) addressed:

A) Linguistic: the question of equivalents is simplified by the fact that all selected commodities are traded internationally and equivalent terms are easy to find in dictionaries or specialized articles.

B) Social-cultural: the term “volatile” in English means “fluctuating and unpredictable” while in Czech or German it denotes mostly “fluctuating heavily.” More neutral alternative terms such as “Schwankungen” in German or “Fluktuace” in Czech were selected when asking about commodity volatility.

C) Methodological: to guarantee that the translated data produce the same response as in the original language, this paper took a domestication approach considering that a successful qualitative data translation confers the original data meaning. As long as this requirement is met, the actual form of conveying the meaning is irrelevant. The translator therefore plays an active role in constructing and interpreting the meaning. As recommended by Czarniawska (2004), the data analysis was performed in the original language and only the results were translated to minimise any meaning loss or shift during the analysis and interpretation phase.

To enhance the procedure validity, a sample of quotations was translated by an experienced translator and compared to the author´s translation without any significant differences.

## 3.2. Research method

Building on the fundamental research choices outlined in the previous sections, this section outlines the exact plan for answering the RQs (See Figure 8 for outline).

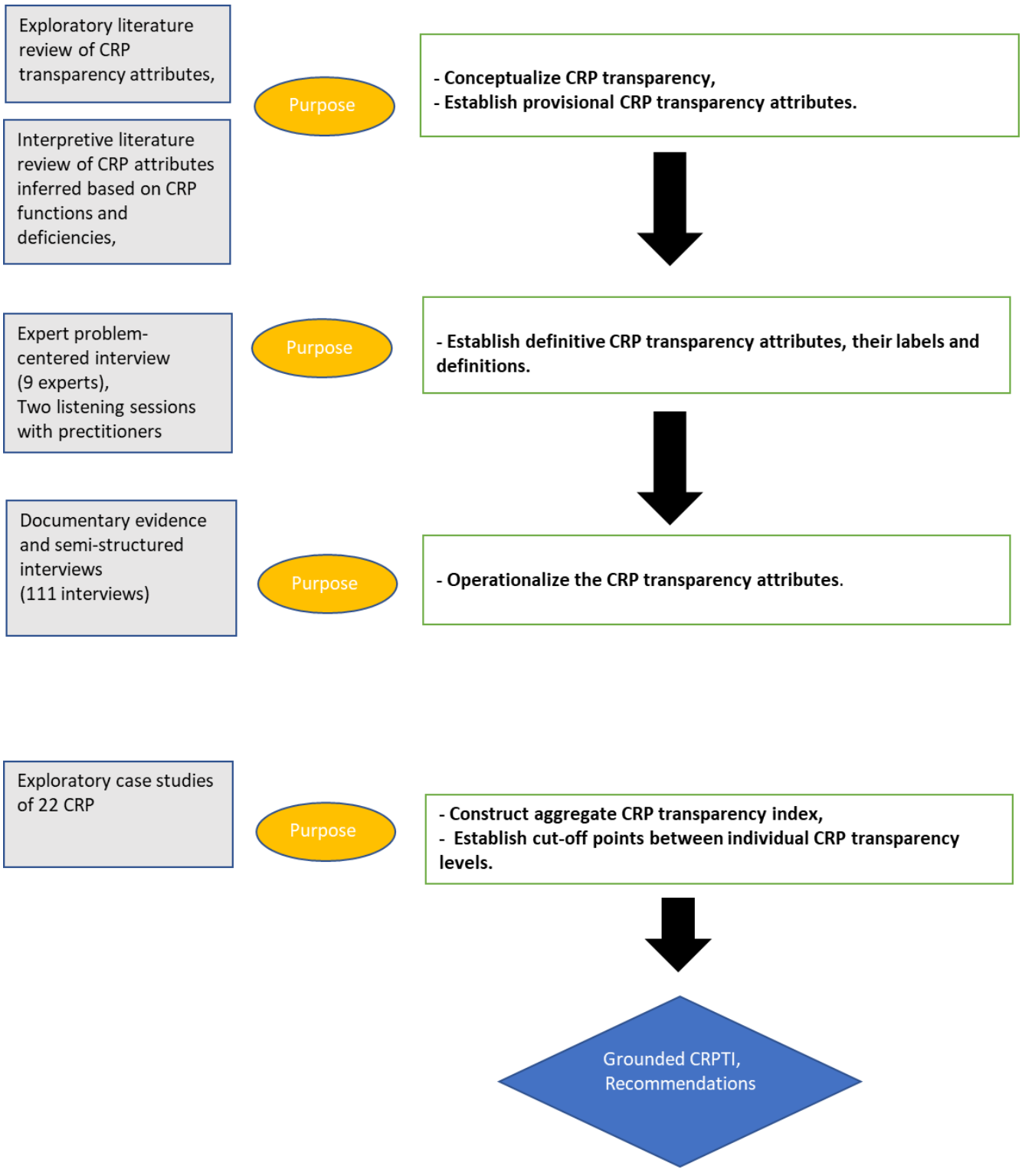



**Figure 8: Research method outline. Source: Author.**

## 3.3. Developmental phase: construct definition and measured attributes

In the developmental phase, a literature review was performed to gain understanding of the CRP construct and its functions. Subsequently, the CRP level of contingency is conceptualized as CRP transparency, which is coherent with the extant literature which already operationalizes market and price constructs as "transparency."

Next, an exploratory literature review is performed to unravel the CRP measured attributes from both extant and practitioner literatures. The following procedure was adopted:

(a) CRP measured attributes were extracted and provisionally labelled. In total, 69 different labels were identified (See Appendix 5 for the full list).

(b) A taxonomy by Wang & Strong (1996) derived from the information quality literature was selected to provisionally organize and reduce these CPR transparency attributes into four distinct groups (Accessibility, Representational, Intrinsic, Contextual)..

Table 11 provides examples how the literature was reviewed for potential measured attributes, labelled and classified. Whenever possible, labels stemmed from Wang & Strong (1996) and Lee et al. (2002).

| Quote | Label | Classification |
|---|---|---|
| "…in general complete and reliable information about demand, supply and inventory is hard to come by. This creates uncertainty, and market confidence in pricing mechanisms is generally low, especially in the electricity and gas markets." (Cinquegrana, 2008: 4) | Completeness<br>Reliability | Contextual<br>Intrinsic |
| "…adopt a transparent methodology that ensures the benchmark's reliability and accuracy. Such transparency does not mean the publication of the formula applied for | Robust methodology | Intrinsic |

| Quote | Label | Classification |
|---|---|---|
| the determination of a given benchmark, but rather the disclosure of elements sufficient to allow stakeholders to understand how the benchmark is derived and to assess its representativeness, relevance and appropriateness for its intended use." (EU, 2016:3) | | |
| "First, obtaining regular and accurate information on key markets depends largely on the willingness of PRAs to release or share information." (Fattouh, 2011:77) | Timeliness, Disclosure | Intrinsic, Accessibility |
| "Centralized exchange trading should increase market transparency, because all actual and potential transactors will have equal access to exchange prices." (Figuerola-Ferretti & Gilbert, 2005:968) | Accessibility | Accessibility |
| "There is no evidence to suggest that there is a consistent upward or downward bias of any one PRA's reported data compared with another." (IEA et al., 2011:9) | Reliability | Intrinsic |
| "Price information is rarely transparent and comparable. Thus, consultants have to process it. Raw data received are adjusted for discounts, agent commission, quality/product mix, transport cost, taxes/duties, exchange rate and inflation, if applicable. Product prices are not directly comparable because prices for different species or same species may vary from different sources, different qualities and dimensions, and product measurement problems (different units, conversion factor, and real price vs. index)." (Favada & Pepke, 2014:9) | Standardized, Comparable | Representational |

**Table 11: Illustrative examples of the labelling and classification process**

Thirdly, an interpretive literature review anchored in the CRP deficiencies analysis is performed. This approach, successfully used in the data quality literature to unravel the data quality attributes (e.g., Wand & Wang, 1996; Stvilia et al., 2007; Ge & Helfert, 2006), first derives CRP deficiencies and the types of

activities affected by these problems from the literature, and subsequently infers the relevant CRP measured attributes which resolve these deficiencies (Stvilia et al., 2007). Compared to a standard literature review, a CRP deficiency-focused interpretation of the literature may unravel novel “theoretical” (Wand & Wang, 1996) CRP attributes that may have been missed by previous research.

The provisional findings from the developmental phase were leveraged in the exploratory phase to determine the definitive CRP measured attributes.

## 3.4. Exploratory phase

Having conceptualized the CRP contingency and drawn provisional CRP measured attributes from the literature, the exploratory phase leverages semi-structured interviews to explore CRP measured attributes as well as their labels and definitions with a panel of nine experts. Subsequently, the CRP attributes are operationalized through a combination of semi-structured interviews with purchasing managers and documentary evidence. Finally, the CRP measured attributes are aggregated into a new construct called “CRP transparency index.”

### 3.4.1. Data collection

#### 3.4.1.1. Definitive CRP transparency attributes, labels and definitions

While the literature review provided valuable insights into the CRP measured attributes, they have to be considered provisional as the voice of the CRP users may have been missed (Ge and Helfert, 2006). To the best of Author´s knowledge, there is no study that would explore the CRP measured attributes from the CRP user perspective. To address this weakness, the literature review must be complemented with an empirical examination of CRP users. Hence, this section describes the data collection approach selected to investigate CRP

transparency attributes relevant to practitioners, their suitable labels, and definitions.

**Expert problem-centered interview**

To avoid a single researcher bias, the author intended to leverage the Delphi method, an integrative and interactive process through which a panel of experts discusses and reaches a consensus on the investigated subject (Linstone and Turoff, 1975). Unfortunately, most experts refused to engage in this time-consuming method. Furthermore, preliminary conversations with experts showed that the CRP transparency topic was novel to them and that more direct and interactive data collection methods may elicit more valuable insight. Finally, the Delphi method might bias experts in the subsequent discussion about the CRP measured attribute labels and definitions.

Thus, the author opted for a problem-centered expert interview (Witzel and Reiter, 2012), which is characterized as an egalitarian dialogue in which the research problem is refined jointly by the researcher and the respondent (Murray, 2016) and where a researcher´s expertise in the phenomenon of interest is assumed. There are several compelling reasons to use the problem-centered expert interview: access to experts´ experience and subject-matter knowledge, in-depth understanding thanks to expert informed insights and opinions that might not be available to non-experts, contextualization and assessment of multiple factors impacting the phenomenon of interest, real-world applicability and ability to formulate recommendations for practice, iterativity which allows the researcher to refine and revisit the questions and confirm the correct understanding (Witzel and Reiter, 2012; Döringer, 2021; Bogner and Menz, 2009; Littig, 2009).

At the same time, scholars also mention several limitations related to expert interviews: inherent expert barriers and potential bias, small sample size, risk of heterogenous barriers, expert non-representativity of their field, expert selection bias, limited expert availability and commitment, and resource and time intensive

(Witzel, 2000; Bogner and Menz, 2009; Witzel and Reiter, 2012; Von Soest, 2023)

**Semi-structured interview template and briefs**

To elicit relevant information, a problem-centered expert interview requires a careful interview design. It usually starts with open-ended questions, where the interviewer acts as an engaged listener. Subsequently, the interviewer asks precise follow-up questions which focus on the critical thematic aspects (Mey, 2000; Döringer, 2021). These recommendations are reflected in the problem-centered interview template (see Table 12: Problem-centered interview template), which was tested for clarity and output on two experienced procurement managers. Based on the pre-test feedback, no changes were necessary.

The problem-centered interview template was developed to encourage open discussion but also keep the discussion focused on CRP and its measured attributes. The rationale for each question is outlined in the “Annotated comments” column. To facilitate the discussion, all informants received a detailed brief (see Figure 9) before the interview in which the CRP construct was defined, a few illustrative examples provided, and two specific questions asked: “What makes a good quality CRP?” and “What are the critical CRP quality attributes?” Each interview started with a generic discussion about CRP quality. The respondents were encouraged to develop their view of CRP transparency and were only interrupted with clarification and probing questions when suitable.

| Topic / support document | Questions | Annotated comments |
|---|---|---|
| **Spontaneous CRP transparency attributes:**<br><br>**Participant Brief I** | What makes a good quality CRP? | This question explores the respondent´s understanding of CRP features. |
| | Could you give an example of a good/bad quality CRP? Why? | A probing question which encourages the respondents to reflect on the CRP transparency level and articulate the relevant attributes. |
| | What would be the features that characterize a good/bad quality CRP?<br><br>Are there qualitative differences between CRP as far as this particular attribute is concerned? | This question logically develops the previous questions and prompts the respondent to reflect on adjectives that characterize a good/poor CRP.<br><br>A probing question then encourages the respondent to articulate a CRP transparency attribute level of contingency. |
| | You named several CRP transparency attributes. Are they equally important?<br><br>Why did you emphasize this CRP transparency attribute in particular? | These probing questions explore the relative importance of CRP transparency attributes and prompts the respondent to reflect on the most important CRP transparency attributes. |

| Topic / support document | Questions | Annotated comments |
|---|---|---|
| **Provisional CRP transparency attributes:**<br><br>**Participant Brief II** | How do you assess the relevance of individual CRP measured attributes?<br><br>In the previous discussion, you mentioned the attribute X. Does it fall into a category, or should we add it as a new category? | The question relates to Brief II. where the respondents should consider the relevance of CRP measured attributes identified in the literature. As they may be similar or different from the spontaneous respondent assessment, the list may be complemented with additional attributes. |
| | Why would you drop the CRP measured attribute? | If the respondent considers dropping a CRP measured attribute and has not developed the reason why, the probing question seeks to shed light on the motives. |
| | Would you split the CRP measured attribute into more categories?<br><br>Would you merge some CRP measured attributes? | Besides dropping CRP measured attributes, respondents might want to split or merge attributes into more categories. As this procedure may not be intuitive, respondents will be prompted to consider this option. |
| | What is the reason for merging/splitting these categories? | A probing question seeking to understand the logic behind the respondents proposal. |
| | What do you think about the CRP measured attribute definition?<br><br>What (other) aspects should be emphasized in the definition? | This question relates directly to definitions provided in Brief II. Participants are asked to evaluate the definition based on intuitive criteria. |
| | What do you think about the CRP measured attribute label? | This question relates directly to potential labels provided in Brief |

| Topic / support document | Questions | Annotated comments |
|---|---|---|
| | Would you relabel the attribute? | II. Participants are asked to choose the label that best describes the CRP measured attribute. |
| | Why do you think that this label is more suitable? | A probing question to understand the logic behind the proposed label. |

**Table 12: Problem-centered interview template**

## Commodity reference price attributes - informant brief I.

### Introduction

This research focuses on commodity reference price transparency. Please, read the document and consider the following questions:

**(1) How can you tell a good/bad quality Commodity reference price?**
**(2) From your perspective, what are the critical Commodity reference price quality attributes?**

This research is interested in your subjective assessment and suggestions. Hence, there is no right or wrong answer. All responses will be anonymized and only used for this research.

The commodity reference price is defined as an externally created, collectively accepted, dynamic anchor for a standard product that market participants employ to make sense of the market environment and agree on a specific transaction price.

**Table 1** outlines a few illustrative examples of commodity reference prices.

| Commodity reference price (CRP) | CRP issuer |
|---|---|
| *Aluminum 3-month buyer settlement price* | *London metal exchange* |
| *PhelixDE Baseload Year Future Cal-18 (best bid)* | *Energy exchange Leipzig* |
| *White-top kraftliner, 140 g (Germany)* | *Euwid* |
| *International Coal, Europe, 6.000 Kcal, NAR, 2 Mnths, CIF ARA* | *Argus* |
| *Diesel 10ppm NWE ABWHP00 (FOB NWE)* | *Platts* |
| *Acetone (Asia Pacific) China main port* | *ICIS* |
| *Average fuel price in Slovakia (Diesel)* | *Slovak Statistical Office* |
| *Hot Rolled Coil Negotiated Domestic Basis Prices – Germany* | *MEPS European steel review* |
| *Concrete C 16/20 CX1* | *Cemex price list* |
| *Scrap surcharge (NWE)- peeled and drawn steel* | *Internal company report* |

**Figure 9: Participant brief: CRP definition with illustrative examples. Source: Author.**

After the open-ended discussion, the respondents were presented with the second brief (see Figure 10), which summarized the preliminary CRP measured attributes, provisional definitions, and possible labels. Subsequently, the relevance of the CRP attributes was discussed and the CRP measured attributes mentioned during the open-ended interview were revisited. The same pre-test procedure was applied to participant briefs and no changes were necessary.

It can be argued that the second brief clashes with the positivist approach which requires a complete researcher's detachment. However, the Author presented the second brief as informed by the extant literature and only asked probing questions without offering his opinions. Despite this effort, some degree of interpretation cannot be excluded.

**Appendix 2** summarizes the coding scheme for expert interviews.

## Commodity reference price attributes - informant brief II.

This research conceptualizes the commodity reference price quality as **transparency**. I am interested in your assessment of various Commodity reference transparency attributes, some of which may have already been discussed. Please, study the table, and then let us discuss your thoughts.

| | | | Your Thoughts? | | | |
|---|---|---|---|---|---|---|
| **Transparency category label** | **Provisional definition** | **Alternative labels** | **Relevance?** | **Split /Merge transp. attributes?** | **Narrow/ broaden the definition?** | **Relabel?** |
| Accuracy | provide information about the CRP accuracy compared to the market. | Intrinsic, Free from error, Reliable, Objective, Unbiased, | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Credible Source of information, Fair, | | | | |
| Contextual transparency | bring additional information about the CRP context, such as timeliness or completeness of information, | Complete price and background information, Level of disclosure, Informativeness of price movements, Provide granular data, Make information available, Mediate market information, | | | | |
| Representational transparency | relate to form, clarity and representation consistency, | Standardized format, Easy to use format, In duly aggregated form, | | | | |
| Accessibility | suggest the ease of access to CRP | Accessible, Public/Open access, Free access, | | | | |
| Timeliness | suggest that the information occurs at a useful moment | Timely, Publication frequency, Regularly published, | | | | |
| Methodology | denotes the overall quality of the CRP price discovery process | Robust, Disclosure of reference price purpose, | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Transparency of methodology, Reliability of assessment, Price discovery mechanism quality, Regulated, | | | | |

**Figure 10: Participant brief: CRP attribute labels. Source: Author.**

All interviews were recorded, lasted 50 minutes on average, and were transcribed the same day. There were three follow up phone interviews with experts to clarify their opinions.

### Expert sampling

An expert interview is a qualitative research method aiming at exploring a specific field of interest through the specialized knowledge of an expert (Meuser and Nagel, 2009). To make the most of the expert interviews, this thesis opted for the purposeful sampling approach and targeted procurement directors who dealt with multiple CRPs over their careers, worked preferably in the automotive, manufacturing, or construction sectors, represented organizations with sophisticated procurement processes, and were frequently invited to practitioner conferences as leading procurement experts (see Table 13 for expert details).

The Author knew personally all experts and contacted them per email with a standard invitation. 15 experts were contacted and nine agreed to participate.

| Expert title | Sector | Relevant experience | Extensive experience with the following commodities |
|---|---|---|---|
| Central procurement director | Metal processing | 14 years | Technical gases, steel, aluminium, electricity/gas, chemicals |
| Senior procurement director | Telecommunication | 27 years | Non-ferrous metals, electricity/gas, oil, paper |
| Procurement director | Food industry | 32 years | Chemicals, paper, oil, aluminium, resins, technical gases |
| CEO | Services | 36 years | Paper, oil, electricity |
| Procurement director | Public transport | 12 years | Concrete, oil, electricity, steel, non-ferrous metals |
| Procurement director | Banking | 18 years | Paper, electricity/gas, construction commodities |
| Central procurement director | Banking | 21 years | electricity/gas, chemicals, concrete, steel |
| Purchasing and Supply chain director | Services | 16 years | Electricity/gas, steel, non-ferrous metals, chemicals, resins |
| Procurement group leader | Consumer goods | 12 years | Technical gases, energy, oil, non-ferrous metal |

**Table 13: Respondent characteristics**

### Presentation and listening sessions

To gain confidence and additional insight, once a final list of CRP transparency attributes, labels, and definitions was established, the author engaged with

practitioners in two presentation and listening sessions. The nature of the research was explained to practitioners and CRP transparency attributes were outlined in a power-point presentation where the CRP transparency concept was presented, followed by a presentation of the definitive CRP transparency attributes, the reasoning behind selecting the final list of CRP, and definitions and labels of each CRP attribute.

The first group was composed of 11 construction sector purchasing managers with extensive experience in dealing with various CRP. The second group of 18 procurement managers entailed the participants of a workshop dedicated to commodity price management. It was composed of specialist-level buyers (average 8 years of commodity procurement experience) from a varied group of sectors (automotive, manufacturing, processing, banking and services). The suggestions from these sessions complemented the expert opinions.

#### 3.4.1.2. Commodity reference price transparency index

Having established the commodity reference price transparency index (CRPTI) attributes, it is necessary to collect data for CRPTI construction: refine the measurement scale, determine the cut-off points between the CRP transparency levels, and populate the CRPTI with actual CRP.

**Case study approach**

The CRPTI is a tool for comparing CRP transparency levels, hence the unit of analysis is a CRP and more specifically its transparency level. To gather data for CRPTI construction the author opted for an exploratory multiple case study approach with embedded case studies (see Section 3.1.3. for a short introduction).

(a) The multiple case study approach is required because a number of CRP is needed to construct the CRPTI. Each CRP thus constitutes a specific case whose CRP measured attributes will be measured.

(b) Each CRP will then contain several embedded case studies representing the same CRP leveraged by a different purchasing buyer. The Author hopes that the cross-case analysis offers a richer insight into how buyers use the CRP, assess the CRP quality and measured attributes, and how instrumental the CRP is in CPM practices used. At the same time, the triangulation of embedded case studies should reveal any outliers likely to skew the CRP measured attributes assessment. While any outliers remain relevant for the subsequent analysis of the CRP/CPM practices link, they should be eliminated from the CRP aggregate assessment for the CRPTI construction.

The triangulation of documentary evidence and interviews informed the case study elaboration. The case study format and contents have been standardized (1) to summarize the information about the individual CRP transparency attributes which are fundamental for the CRP transparency assessment, (2) to review how respondents use the CRP in their business activities, which is important for the establishment of the cut-off points between the CRP transparency levels, and (3) to outline the CPM practices leveraged by the respondents to manage the commodity price risk, which is fundamental for exploring the within group homogeneity and between group heterogeneity where “group” is understood as a particular CRP transparency level.

In addition, a separate section was reserved to outlier respondents who assessed the CRP transparency differently from the rest, used the CRP differently from the rest, or used different CPM practices. An effort was made to understand the reasons for the deviation and determine whether it should be included into the overall CRP transparency assessment, or whether is it a case of erroneous CRP use.

Appendix 1 provides an illustrative example of the case study template filled with all relevant information.

The case study design followed the recommendations for positivist case studies formulated by Dubé & Paré (2003)

- The unit of analysis was clearly defined.
- The constructs were a priori specified and shaped the internal design but were also considered preliminary in line with the theory building approach.
- Multiple case design was adopted for all CPR to yield more generalizable research results.
- Particular care was paid to comparable research context (same period, business context, knowledgeable interviewees).
- Detailed description was provided about how data was collected and analysed.
- Case study protocol and case study database was established.
- Case analyses included to identify outliers and to understand the reason.
- Quotes presented to support claims.

**CRP selection**

The CRP serve two research objectives. Firstly, the researcher wants to explore the different levels of CRP measured attributes and gain insight how to classify these attributes into five levels following a geological metaphor. At the same time, each CRP will constitute a distinct case study which will be used to populate the CRPTI and to explore the CRP quality level internal homogeneity and external heterogeneity compared to other CRP quality levels. Hence, a varied sample of CRP likely to represent different CRP quality levels is necessary. Therefore, a purposeful sampling approach was selected and the following procedure applied:

(a) The author reviewed extant literature for any suggestions of widely used CRP (e.g., Bastianin, Galeotti, & Polo, 2019; Valiante, & Egenhofer, 2013; European Commission, 2010; Figuerola-Ferretti & Gilbert, 2005; IEA et al., 2011; Radetzki, 2013). Subsequently, the author recontacted the expert panel leveraged in the previous research phase (see Section 3.4.1.1.) and sought their

suggestions of CRP that represent different quality levels. This gave an initial list of 54 CRP covering non-ferrous metals, construction materials, steel, fuel, energy, and chemicals. Technical gases were added to this list to represent the ‘nonexistent’ CRP category.

(b) Subsequently, the author selected 27 CRP likely to represent distinct CRP quality levels and thus highlight the commonalities and differences in the phenomena of interest (McCutcheon and Meredith, 1993).

(c) Finally, the number and ease of access to potential respondents was considered as the triangulation of several sources eliminates the respondent bias. Thus, the final list of 22 commodities was established (see Table 14 for summary).

| Commodity | Commodity reference price | Reason for selection | No. of respondents |
|---|---|---|---|
| Non-ferrous metals | *(1)* LME Aluminium (official price)<br><br>*(2)* Czech and Slovak cable industry copper notation | Frequently mentioned as high-quality CRP (e.g., Figuerola-Ferretti & Gilbert, 2005)<br><br>Recommended as regional CRP coexisting with LME | 14 |
| Banana | *(3)* Sopisco News Outlook on the banana market | CRP quality was subject to arbitrage where CRP quality was challenged | 4 |
| Industrial gases | *(4)* Supplier dictated price formula | Added following expert suggestions as an example of nonexistent CRP | 11 |
| Concrete | *(5)* Cemex.cz (2016 price list) | Example of supplier issued CRP | 8 |
| Diesel | *(6)* Platts: European Marketscan: ULSD 10 PPM: Euro-denominated | Suggested as price reporting agency issuing a high-quality CRP (e.g., IEA et al., 2011) | 6 |

| Commodity | Commodity reference price | Reason for selection | No. of respondents |
|---|---|---|---|
| | *(7)* Slovak Statistical Office: average fuel prices in the Slovak Republic (weekly) | Recommended as regional, widely used CRP with specific data collection method | |
| Electric power | *(8)* EEX: Phelix Base Year Future: best bid<br><br>*(9)* EEX: Phelix Base Year Future: settlement price | Suggested by Experts as “non-negotiable” authoritative CRP,<br><br>Commodity exchange generated CRP established through a different procedure | 21 |
| Commodity chemicals | *(10)* Fertecon: Sulphuric Acid Weekly market Report<br>*(11)* ICIS Pricing: ICIS Pricing Chloride Acid (Europe)<br>*(12)* ICIS Pricing: Melamine (Europe) | CRP issued by a price reporting agency<br>CRP issued by a price reporting agency<br>Spot and contract CRP discovered through different mechanisms | 9 |

| Commodity | Commodity reference price | Reason for selection | No. of respondents |
|---|---|---|---|
| Paper | *(13)* Euwid: Euwid Packaging Markets | CRP issued by a price reporting agency | 4 |
| Round wood | *(14)* Czech statistical office: average purchase prices of round-wood in the Czech Republic (CZK per cubic meter) | Recommended as CRP with specific data collection method | 4 |
| Rubber | *(15)* World bank: rubber, TRS20.<br>*(16)* Shanghai futures exchange: Natural Rubber: Contract RU1710 (futures month October) | CRP issued by a public institution<br><br>Recommended as CRP which is structurally different to (15) | 4 |
| Steam Coal | *(17)* Argus Coal daily international | Suggested as price reporting agency issuing a high-quality CRP (e.g., IEA et al., 2011) | 4 |
| Steel | *(18)* MEPS: European Steel Review | CRP for a heterogeneous commodity | 22 |

| Commodity | Commodity reference price | Reason for selection | No. of respondents |
|---|---|---|---|
| | *(19)* Moravia Steel: alloy surcharge | Suggested by experts as an example of producer issued CRP | |
| | *(20)* Internal monthly steel report | Suggested by an expert as structurally interesting CRP | |
| | *(21)* Platts: World steel review | Suggested as price reporting agency issuing a high-quality CRP (e.g., IEA et al., 2011) | |
| | *(22)* Steel benchmarker: Western Europe | Suggested by experts as structurally different alternative to MEPS and Platts | |

**Table 14: Commodity reference prices overview**

**Sampling adequacy test**

As the CRP sample size is fundamental for the CRP transparency index construction and gaining insight into a CRP business use, it was subjected to three sampling design adequacy and appropriateness tests suggested by Boyatzis (1998). Table 15 suggests that the sample met the required criteria.

| | **Comment** | **Evaluation** |
|---|---|---|
| **Sampling efficacy test** | | |
| Sufficient variety of units of analysis to allow cross-analysis and generalization? | 22 CRP selected following the theoretical sampling procedure provide sufficient variety for cross-case analysis. | ✓ |
| Sufficient variety of units of coding to understand the unit of analysis? | Eisenhardt (1989) recommends 4 to 10 cases. Due to the number of CRP to explore, exploratory nature of the research, and practical difficulties to get access to some CRP informants, the author settled for a minimum of four embedded case studies, which combined with documentary data analysis allow for sufficient within-case analysis. | ✓ |
| **Sampling efficiency test** | | |
| Is the sampling designed to optimize the resource requirements (time, effort)? | A limited number of commodities reduces effort for the author to become knowledgeable about the commodity.<br><br>A theoretical sampling of respondents likely to provide relevant insight into CRP transparency attributes and CRP impact on CPM reduces the number of embedded cases to four. | ✓ |
| **Ethics test** | | |

| | Comment | Evaluation |
|---|---|---|
| Respondent informed consent, data, and company anonymization? | Informed consent was obtained from all respondents, all data was anonymized. | ✓ |

**Table 15: sampling design adequacy and appropriateness tests following Boyatzis (1998)**

### Interviewee selection

Previous extant research focused on procurement managers (PM) responsible for CPM as the best information source about the CPM practices (e.g., Fischl et al., 2014; Gaudenzi et al., 2018; Jones et al., 2007) and CRP transparency attribute levels. Considering the specific phenomenon of interest, the author paid particular attention to selecting respondents likely to have significant experience in commodity procurement. Therefore, uniquely purchasing managers were targeted (1) who worked in medium and large manufacturing companies for whom the commodity represents a non-trivial spend, (2) worked as procurement specialists for the target commodity, and (3) were buying more than one commodity to allow for CRP transparency attribute levels comparison between CRP.

Table 16 gives an overview of interviewee profiles where senior procurement managers with extensive work experience were sought. Unfortunately, criterion no. (3) proved impossible for CRP covering banana, diesel, rubber, and steam coal, as most respondents specialized on a single commodity from the list. Hence, criterion no. (3) was not applied to these respondents.

| Respondent no. | Job Title | Industry | Professional experience in commodity procurement | CRP interviewed |
|---|---|---|---|---|
| **1** | Purchasing director | Metals processing | 18 | Aluminium<br>Industrial gas<br>Commodity chemicals<br>Steel |
| **2** | Purchasing director | Aerospace industry | 14 | Steel<br>Aluminium<br>Electricity |
| **3** | Purchasing director | Oil and Gas utilities | 16 | Electricity<br>Steel<br>Diesel |
| **4** | Group purchasing director | Food processing | 20 | Electricity<br>Paper |
| **5** | Group purchasing director | Automotive components | 22 | Electricity<br>Aluminium<br>Steel |
| **6** | Purchasing director | Metals processing | 24 | Steel<br>Electricity<br>Aluminium |
| **7** | Purchasing director | Metals processing | 14 | Steel<br>Industrial gas<br>Electricity |
| **8** | Purchasing group director | Home furnishings | 28 | Paper<br>Commodity chemicals<br>Diesel |
| **9** | Site purchasing director | Packaging production | 17 | Paper<br>Commodity chemicals |
| **10** | Senior strategic buyer | Electric utilities | 11 | Diesel<br>Commodity chemicals<br>Industrial gas |
| **11** | Purchasing manager | Construction material | 8 | Aluminium |
| **12** | Group purchasing manager | Beverage | 14 | Aluminium<br>electricity<br>resins |

| Respondent no. | Job Title | Industry | Professional experience in commodity procurement | CRP interviewed |
|---|---|---|---|---|
| **13** | Supply chain director | Automotive components | 34 | Aluminium |
| **14** | Site purchasing director | Electric utilities | 18 | Aluminium steel |
| **15** | Purchasing group leader | Developer | 25 | Aluminium concrete steel |
| **16** | Purchasing manager | Industrial goods manufacturer | 30 | Aluminium electricity industrial gas |
| **17** | Purchasing specialist | Automotive components | 6 | Aluminium steel |
| **18** | Purchasing director | Large diversified holding | 29 | Electricity steel wood bananas |
| **19** | Supply chain manager | Packaging production | 34 | Wood |
| **20** | Purchasing executive | Industrial goods manufacturer | 9 | Aluminium |
| **21** | Group purchasing director | Construction material | 12 | Concrete steel |
| **22** | CEO | Construction material | 14 | Concrete |
| **23** | Purchasing specialist | Developer | 21 | Concrete steel |
| **24** | Purchasing specialist | Developer | 16 | Concrete steel |
| **25** | Senior buyer | Utilities | 32 | Concrete |
| **26** | Central procurement officer | Retailer | 5 | Bananas |
| **27** | Family buyer | Retailer | 23 | Bananas |
| **28** | Central procurement director | Insurance | 27 | Diesel |

| Respondent no. | Job Title | Industry | Professional experience in commodity procurement | CRP interviewed |
|---|---|---|---|---|
| **29** | Procurement Director | Oil and Gas utilities | 15 | Electricity Industrial gas Steel |
| **30** | Senior buyer | Automotive components | 4 | Diesel |
| **31** | Procurement Director | Mining | 27 | Diesel |
| **32** | Buyer | Household goods manufacturer | 17 | Electricity Coal Industrial gas |
| **33** | Supply chain specialist | Aerospace industry | 8 | Commodity chemicals |
| **34** | Purchasing manager | Banking | 12 | Electricity |
| **35** | Group supply chain director | Aerospace industry | 21 | Steel electricity aluminium |
| **36** | Site purchasing director | Chemical | 14 | Commodity chemicals Industrial gas coal |
| **37** | Commodity buyer | Metals processing | 32 | Steel electricity |
| **38** | Site procurement manager | Oil and Gas utilities | 20 | Steel electricity Industrial gas |
| **39** | Procurement executive | Electric utilities | 10 | Electricity |
| **40** | Senior specialist | Car manufacturer | 6 | Aluminium steel Industrial gas |
| **41** | Electricity buyer | Oil and Gas utilities | 13 | Electricity |
| **42** | Procurement consultant | Household goods manufacturer | 7 | Electricitity |
| **43** | Procurement manager | Mining | 18 | Wood |
| **44** | Purchasing manager | Construction material | 11 | Concrete |

| Respondent no. | Job Title | Industry | Professional experience in commodity procurement | CRP interviewed |
|---|---|---|---|---|
| **45** | Integrated supply chain manager | Electric utilities | 33 | Coal |
| **46** | Purchasing group manager | consumer goods | 26 | Wood |
| **47** | Procurement scout | Automotive components | 23 | Commodity chemicals |
| **48** | Buyer | Automotive components | 5 | Rubber |
| **49** | Senior buyer | Agricultural products | 22 | Rubber |
| **50** | Buyer and seller | processing industry | 10 | Rubber |
| **51** | Procurement executive | Household goods manufacturer | 8 | Rubber |
| **52** | Central procurement manager | Automotive components | 19 | Electricity |
| **53** | Site procurement manager | Household goods manufacturer | 17 | Commodity chemicals Paper |
| **54** | Operations director | Chemical indutry | 22 | Commodity chemicals |
| **55** | commodity buyer | Household goods manufacturer | 3 | Electricity |
| **56** | strategic buyer | banking | 24 | Electricity |
| **57** | CEO | Metals processing | 30 | Industrial gas Steel |
| **58** | Buyer | Beverage | 13 | Industrial gas |
| **59** | Design-to-cost manager | Electric utilities | 20 | Coal |
| **60** | buyer | Oil and Gas utilities | 9 | Steel |
| **61** | director | Developer | 35 | Concrete steel |
| **62** | Purchasing specialist | steel processing company | 14 | Steel |

| Respondent no. | Job Title | Industry | Professional experience in commodity procurement | CRP interviewed |
|---|---|---|---|---|
| **63** | procurement consultant | retailer | 21 | Bananas |

**Table 16: Interviewee profiles**

To minimize the impact of national peculiarities, the respondent panel was restricted to procurement managers (PM) operating in the Czech Republic, Slovakia, Poland, Germany, and Austria, all highly industrialized OECD countries entertaining intensive mutual trading relations and cross-ownership of companies and sharing some commodity markets. Finally, both direct and indirect commodity buy was included because they may surface interesting differences in CPM management and CRP impact. Table 17 summarizes the environmental case study selection criteria.

| Factor | Requirement | Comment |
|---|---|---|
| Size | Medium and large companies | The PM working in mall companies may not buy the commodity in sufficient volumes or have a dedicated buyer to manage them. |
| Business | Manufacturing or retail companies | The PM working in companies faces both input and output commodity price uncertainty. |
| Commodity spend | Non-trivial/ important | The buyer must manage at least 250,000 Euro/year commodity spend. |

| Factor | Requirement | Comment |
|---|---|---|
| Location | Austria, Czech Republic, Germany, Poland, Slovakia | The PM must work in a developed and industrialized country context. |
| Procurement organization | Dedicated procurement manager | The PM must be knowledgeable about the commodity. |
| Number of commodities procured | At least one commodity | If possible, the PM should manage at least two commodities to allow for a comparison of CRP transparency attribute levels between commodities. |
| Type of buy | Direct/indirect | The PM is responsible for both direct buy (company buys the commodity directly) and<br>indirect buy (company buys the commodity as a part of a procured product). |

**Table 17: Environmental case study selection criteria**

In total, 63 procurement managers were interviewed. If a procurement manager covered more than one CRP, a separate interview was organized to avoid fatigue and contamination from other CRP. Hence, a total of 111 interviews were realized. To avoid a single respondent bias, at least three interviews per CRP were performed (see Table 14 for more details).

**Documentary evidence**

Documentary evidence is fundamental in exploring different levels of CRP contingency; especially information about different publication frequencies, completeness of information provided, or the details of CRP methodology. The Author, therefore, collected compiled data (Kervin, 1999) in the form of CRP reports, and multiple-source documentary secondary data (Saunders, Lewis and Thornhill, 2009) in the form of CRP methodologies, reports, and practitioner articles likely to support the operationalization of the CRP transparency attributes. Saunders et al., (2009) warn against risks related specifically to documentary secondary data: difficult or costly access, no control over the data quality, and biased data presentation by the initial purpose. Considering these risks, Table 18summarizes the key decisions concerning the documentary secondary data usage.

| **Documentary evidence source** | **Suitability** | **Reliability** | **Costs and Benefits** | **Decision** |
|---|---|---|---|---|
| CRP Reports | ✓ | ✓ | ✓ | Generic description, no sensitive data disclosure |
| CRP Methodology (published) | ✓ | ✓ | ✓ | Full use |
| Practitioner articles/ reports | ✓ | ☒ | ✓ | Use as a low-reliability information source |
| Documents shared by the informants | ✓ | ☒ | ✓ | Use in anonymized form,<br>no sensitive data disclosure |

**Table 18: Documentary secondary data usage**

The CRP reports and methodologies proved particularly helpful in answering the Research Questions. However, they were mostly compiled for commercial purposes, protected by a paywall, or banned for disclosure. Consequently, the following procedure was applied to collect these important pieces of evidence:

whenever access to the data was public, the document was downloaded. As for the subscription-based reports, the author visited the issuer web page and downloaded a sample copy if available. Where no documentary evidence was available from public sources, the author asked the respondents to share a copy of the report. This was the case for the internal steel reports issued by the central procurement departments.

Respecting the extremely sensitive nature of the CRP data and reports, many of which are subscription-based, and the explicit ban on data sharing, the author decided not to quote them directly but only describe their contents in generic terms. These descriptions were subsequently used in operationalizing the CRP transparency attributes and quoted in the results chapter.

For example, the MEPS European steel review would be described as follows to capture the essence of the report relevant to the CRP transparency attribute operationalization but not betray any confidential information:

> The report is published once a month. It provides detailed descriptive information about the market evolution regarding prices, market sentiment and expectations, available capacity, and stocks. Trade information is shared on an aggregated level, such as ‘French buyers agreed…’ or ‘Service centres delayed….’
>
> The basis price and product definition are explained in detail. High and low prices are quoted for different types of steel products, grades, and regions. A six-month price history is provided. Steel purchasing indices covering different grades, regions, and sectors are provided, including monthly or quarterly evolution. Medium-term price forecasts are quoted as well. Reference prices are quoted in euro, pounds, and dollars for some grades.
>
> The issuer provides only scant information about the data collection and interpretation methodology: it is based on in-depth research and extensive discussion with market players. No information about the data evaluation process. The issuer says that the index is widely used in price revision formulas.

Most CRP issuers published their data collection and analysis methods on their web-pages. However, the data collection phase also confirmed that some CRP issuers were reluctant to share detailed methodological information because they considered it important to their competitive advantage (Saunders, Lewis and Thornhill, 2009). The author, therefore, decided to base the CRP assessment uniquely on the publicly available data and informant assessments and not disclose *in the form of citations* any methodology-related data collected through private conversations and correspondence with CRP issuers.

Practitioner articles, reports, and blogs provided an interesting insight into the phenomena of interest. However, it proved impossible to establish their quality. In line with Saunders et al. (2009) recommendations, these documents were, therefore, not considered an objective account of reality but a source of the writer's perceptions, which may have been deliberately biased or distorted.

**Semi-structured interviews**

Several data collection methods recommended by Saunders et al., (2009) were considered to explore the CRP transparency attributes and gain insight on how to classify these attributes into five levels following a geological metaphor. An observation of respondents during situations when the CRP is used might bring relevant insights; however, it is impractical due to the difficulty to secure organizational access, to the difficulty to coordinate researcher´s and respondents´ agendas, the time required to perform the research, the inability to ask probing questions, and the risk of significant observer bias (Saunders et al., 2009).

A questionnaire would ensure that all respondents answered the same questions and would allow the researcher to solicit a very large respondent sample (Saunders et al., 2009). On the other hand, anonymous questionnaires preclude going back to respondents and collect additional data. Furthermore, the phenomenon of interest requires many open questions, and the researcher could not be sure that respondents understand the CRP-related terms in the intended

way and hence runs the risk of biased answers. Finally, considering the number of issues explored, the questionnaire would be long and complex, which might result in a low number of returned questionnaires. For these reasons, a questionnaire cannot be recommended for the intended exploratory research.

In contrast, semi-structured interviews allow the researcher to ask direct questions about the phenomenon of interest and ask probing questions to get additional insight into the answers (Rubin and Rubin, 2011). Compared to structured interviews, semi-structured interviews potentially generate more knowledge through the exploration of venues that are considered important by the informant and interviewer´s active inclusion in the knowledge-producing process (Leavy, 2014). Furthermore, a semi-structured interview format allows the exploration of novel topics or perspectives raised by the respondent, making it particularly suitable for exploratory research (Saunders, Lewis and Thornhill, 2009).

In the light of the previous considerations, a semi-structured interview was selected as the most appropriate data collection method.

**Interview structure and template**

Semi-structured interviews are the most popular form of interview approach (Leavy, 2014). However, they require careful preparation and planning (Saunders, Lewis and Thornhill, 2009). This research methodologically follows the five step semi-structured interview guide recommended by Kallio et al. (2016).

*Step1: Identifying the prerequisites for using semi-structured intervie*ws. This research perfectly fits the prerequisites formulated by Kallio et al. (2016): it is exploratory, studies people´s opinions, the researcher can acquire some knowledge of the phenomenon of interest prior to the interview, and it is expected that respondents are not fully aware of the subject.

Besides the CRP transparency attribute exploration, the semi-structured interviews will be also leveraged during the exploratory phase where the CRP transparency index will be constructed and its relevance for CPM investigated.

*Step 2: Retrieving and using previous knowledge.* Conducting semi-structured interviews requires some knowledge of the research topic (Kelly, Bourgeault and Dingwall, 2010). Hence, the researcher retrieved previous knowledge and research gaps identified in the Literature review chapter and combined them with his own empirical experience.

*Step 3: Formulate the preliminary semi-structured interview guide.* The interview guide is understood as a list of questions which orientate the dialogue toward the research topic. It must be sufficiently loose to allow the change of order of questions and achieve rich data (Kallio *et al.*, 2016).

The interview therefore starts with generic questions about CPM and commodity price management practices. It is important to understand why a practitioner chooses a particular CPM practice and whether and how it is impacted by CRP. Subsequently, the initial CPM discussion is immediately followed by the inquiry about the CRP function in the CPM process, the CRP existence, and CRP utility. The CRP role in the CPM process is then investigated in detail. The discussion is structured along the main sources of transaction costs (Coase, 1937; Williamson, 1979; Oliver E Williamson, 1985).

Next, the interview turns specifically to CRP transparency attributes. The respondents are prompted to reflect on CRP quality and definitive CRP transparency attributes, their artifacts, and their assessment. The researcher was mindful of any CPR transparency attributes that were not in the definitive list.

**Appendix 3** outlines the coding scheme for these semi-structured interviews.

*Step 4: Pilot testing of the interview guide*.

The pilot case is important for refining data collection instruments and procedures. It also serves for determining the unit of analysis and familiarizing

the researcher with the phenomenon under study (Yin, 2013). The semi-structured interview guide was presented to a senior researcher familiar with CPM and two senior procurement directors. Their comments and suggestions were reflected in the provisional interview guide. Subsequently, the interview guide was field-tested with four companies procuring standard steel products such as rods, tubes or steel sheets. The access to these companies was facilitated by prior personal contacts and respondents were supportive of the early research stage and agreed to repeat the research process should this be necessary.

Steel products were selected because the researcher has good knowledge of the commodity and does not have to familiarize himself with the commodity procurement specificities such as terminology, material grades or the supply market.

The pilot study followed the normal field procedure and confirmed that the semi-structured interview and probing questions brought rich data about the phenomena of interest. The pilot study indicated that the interview design was understandable, relevant and easy to follow: firstly, respondents were conversant with the CRP concept and actively used CRP to inform their business decisions. Secondly, when prompted they willingly commented on different CRP transparency features and raised numerous concerns for their business practice. Some were even able to compare the transparency levels of different CRP. Thirdly, they were able to describe the CPM practices and even commented on how CRP impact these practices.

While the interviews yielded rich and relevant information, some adjustments to the provisional interview template were necessary: the template was complemented with probing questions, the term “transparency” was replaced by “quality” in the last section where the overall CRP transparency was discussed, the provisional CRP attributes, which were not mentioned by the respondent, were raised by the researcher as “mentioned in other interviews”, and the participant comments were sought. The final template was tested with two respondents representing steel CRP. As the interviews rendered rich and

relevant information concerning the phenomenon of study and the probing questions helped respondents to articulate their thoughts, the template was used for the remainder of interviews.

*Step 5: Presenting the definitive semi-structured interview guide*.

Table 19 summarizes the semi-structured interview template.

| Topic | Main question | Annotated explanations |
|---|---|---|
| **Commodity price management practices** | How do you usually manage the commodity price for the product category that you are in charge of? | Researcher wants to gain insight into the CPM process and CPM practices whether and how the CRP impacts the CPM process and practices. |
| | Probing questions | |
| | How exactly does this CPM practice work?<br><br>Has the choice of CPM practice evolved over time?<br><br>What are the reasons for choosing this CPM practice?<br><br>Why is it the most suitable CPM practice?<br><br>Did you use alternative CPM practices? How do they compare?<br><br>Would *xxx* method be an option? | Researcher wants to understand the details of the CPM practices and their evolution over time.<br><br>Researcher also raised an alternative CMP practice to get additional insight into any hidden reasons. |

| Topic | Main question | Annotated explanations |
|---|---|---|
| **CRP function** | (How) do you leverage the CRP in managing the price of this commodity? | If the respondent did not mention the CRP and its attributes in the first part of the interview, this section prompts him/her to reflect on the CRP. |
| **CRP existence** | Is there a commodity reference price for the commodity?<br><br>Are there more CRP? Do you use any of them? Why this one(s)?<br><br>Is there a difference among them? | Researcher wants to understand if there is a CRP for this commodity and if there are more than one, why the respondent uses this particular one. |
| **CRP utility** | Is CRP useful for the CPM?<br><br>How exactly?<br><br>Why ?<br><br>Do you see any weaknesses? | Researcher wants to understand the respondent´s assessment of the CRP utility for his/her CPM activities.<br><br>This questions may serve as springboard for the probing questions of Part I. However, the question is not used in Part I. if the respondent does not mention a CRP—in order not to bias the respondent. |

| Topic | Main question | Annotated explanations |
|---|---|---|
| **CRP role in CPM** | | |
| **Search**<br><br>**Price discovery** | What sources of information do you follow to manage the commodity price?<br><br>Is the CRP leveraged during the search process?<br><br>How much time/resources do you spend on these activities?<br><br>If applicable, relate to CRP transparency questions in section two. | All questions from this section are based on the assumption that there are different levels of CRP contingency and that respondents will leverage CRP differently.<br><br>Furthermore, the discussion about the specific CRP usage may help unravel the CRP transparency attributes and their level.<br><br>Researcher inquires specifically about the CRP role in the price search phase.<br><br>If the respondent uses a CRP in this phase, researcher probes with questions in section two. |
| **Negotiation / contracting** | How do you negotiate the commodity price with the supplier?<br><br>Is CRP leveraged during the negotiation? | Researcher wants to inquire specifically about the CRP role in the price negotiation and contracting.<br><br>If the respondent uses a CRP in this phase, we probe with questions in section two. |

| Topic | Main question | Annotated explanations |
|---|---|---|
| | How much time/resources do you spend on these activities?<br><br>If applicable, relate to CRP transparency questions in section two. | |
| **Contract execution/**<br><br>**monitoring** | How do you monitor that the agreed commodity price is respected and that it is in line with the market evolution?<br><br>Does CRP play any role in monitoring activities?<br><br>How much time/how many resources do you spend on these activities?<br><br>If applicable, relate to CRP transparency questions in section two. | Researcher seeks to inquire specifically about the CRP role in the contract execution and monitoring phase.<br><br>If the respondent uses a CRP in this phase, we probe with questions in section two. |

| Topic | Main question | Annotated explanations |
|---|---|---|
| **Enforcement** | Are there any conflicts related to commodity price? How do you manage them?<br><br>Is CRP leveraged during the enforcement phase?<br><br>How much time/how many resources do you spend on these activities?<br><br>If applicable, relate to CRP transparency questions in section two. | We want to inquire specifically about the CRP role in the conflict resolution phase.<br><br>If the respondent uses a CRP in this phase, we probe with questions in section two. |
| **Adaptation** | Are there instances when you need to review the commodity price?<br><br>Does CRP play any role in the review process?<br><br>What does the whole process look like? How do you agree on new prices? | Researcher seeks to inquire specifically about the CRP role in the adaptation phase.<br><br>If the respondent uses a CRP in this phase, we probe with questions in section two. |

| Topic | Main question | Annotated explanations |
|---|---|---|
| | How much time/how many resources do you spend on these activities?<br><br>If applicable, relate to CRP transparency questions in section two. | |
| **Evolution of transaction costs** | Has the intensity or importance of these activities evolved significantly recently?<br><br>Why?<br><br>If applicable, relate to CRP transparency questions in section two. | This question is anchored in transaction cost theory. The change of CRP transparency level and its attributes may trigger a change of transaction costs. This critical incident may prompt respondents to think about the evolution of CRP transparency and reveal relevant insights. |
| **CRP quality** | What makes a good quality CRP? | Researcher wants to explore the CRP consumer´s view of CRP transparency. However, the pre-test showed that the term *CRP quality* is more understandable to practitioners and gives insightful answers. |
| **CRP methodology** | How is the RP constructed? By whom?<br><br>Is it possible to check and replicate RP construction? | |

| Topic | Main question | Annotated explanations |
|---|---|---|
| | Who influences the CRP construction?<br><br>Is there a qualitative difference in CRP methodologies? | |
| **CRP accuracy** | How accurately does the RP reflect your actual realization prices?<br><br>What causes the difference?<br><br>Is the difference stable over time or evolves?<br><br>Does CRP accuracy differ between the CRP you use? | These questions address the definitive CRP transparency attributes and explore respondents´ assessment of CRP transparency attribute levels. |
| **CRP completeness** | What market information does the RP reveal?<br><br>What information do you use? | |

| Topic | Main question | Annotated explanations |
|---|---|---|
| | Is it adequate in terms of the information provided?<br><br>Is the CRP easy to understand/work with? | |
| **CRP frequency** | How often is the CRP published?<br><br>Is it adequate?<br><br>Would you prefer a different publication frequency? Why? | |
| **New CRP transparency attribute** | Could you tell me why you consider this CRP transparency attribute relevant? | Should the respondent mention a new CRP transparency attribute during the interview, it is explored in detail as it may challenge the definitive CRP transparency attributes. |

**Table 19: Semi-structured interview template**

**Semi-structured interview outline**

Every interview started with a short introduction of the research project. Respondents were informed about the data collection and the analysis method. Measures to guarantee data confidentiality and respondent anonymity were explained, and the data retrieving procedure was outlined. Finally, the express agreement from respondents was sought.

Interviews took between 45 to 75 minutes (between 5,000-9,000 words of transcript) and were recorded. Each interview was transcribed and coded within five working days using the NVIVO11 software. Any unclear or missing points were addressed through a phone follow-up interview, lasting on average 20 minutes.

Before and after the interview, the researcher collected relevant artifacts (contracts, strategy documents, company presentations, organigrams). Furthermore, the researcher took field notes and used them in subsequent data analysis (Yin, 2009). Rich information was also collected through casual conversations and recorded as field notes in line with Van Maanen´s (2011) recommendation. However, any information that was explicitly labelled as off-record was excluded as well as any information that could not be reliably anonymized.

### 3.4.2. Data analysis

This section outlines the data analysis process. It starts with a directed thematic analysis approach which was applied to all collected data. Subsequently, it outlines the expert problem-centered interview analysis. Next, the procedure for operationalizing the CRP transparency attributes is outlined followed by the construction of the CRP transparency index. This is followed by a semi-structured interview analysis and the establishment of a case study for

each CRP. Finally, the exact procedure for establishing the Commodity reference price transparency index is outlined.

#### 3.4.2.1. Directed Thematic analysis

A thematic analysis is used across different methods (Boyatzis, 1998) or as a stand-alone qualitative method (Braun and Clarke, 2006). It identifies, reports, and interprets themes within data (Braun & Clarke, 2006; Boyatzis, 1998). It is perfectly compatible with a positivist ontology and seeks to achieve “objective” and “unbiased” coding through a codebook and multiple coders (Braun and Clarke, 2021).

In line with a positivist ontology, this thesis adopts a directed qualitative analysis, also called a theoretical thematic analysis (Braun & Clarke, 2006), which starts with a theory, unlike a conventional content analysis or a summative content analysis. The main advantage of this approach is that it focuses on a particular research question or theme within the data and that it allows a more detailed analysis of a particular phenomenon (Braun & Clarke, 2006).

Codes are derived from theory and defined before and during data analysis (Hsieh & Shannon, 2005). The researcher then leverages this codebook to identify and report the themes in the data rather than actively create them from the data (Braun and Clarke, 2021). Codes relevant to the research question, which cannot be directly categorized with the initial coding scheme, are first coded as “miscellaneous” and later attributed either to existing categories or given a specific code (Braun & Clarke, 2006).

However, the directed qualitative analysis approach is not without criticism: firstly, it induces an informed yet strong bias in the data analysis, and the researcher may overlook critical contextual factors that are not important for the theory or ignore disconfirming evidence (Hsieh & Shannon, 2005; Yin, 2009). Secondly, it implies that the themes passively emerge from the data, thus obfuscating the researche’'s active role in identifying, selecting, and reporting the themes (Braun and Clarke, 2006).

Despite this criticism, a directed thematic analysis approach is suitable for exploring and expanding the CRP transparency attributes and CPM practices already identified from the literature. Any emerging topics can be provisionally coded as “Miscellaneous CRP transparency attributes” or “Miscellaneous CPM practices” and subsequently fine-tuned.

This thesis adopts the six-step data analysis process recommended by Fereday & Muir-Cochrane (2006) (See Table 20). The rest of the section outlines the process and illustrates how these recommendations were applied throughout the data analysis process.

| Thematic data analysis process |
| --- |
| 1. Develop code manual |
| 2. Test the code reliability |
| 3. Summarize the data and identify initial themes |
| 4. Apply the code template and additional codes |
| 5. Connect the codes and identify themes |
| 6. Corroborate and legitimate the coded themes |

**Table 20: Six-step data analysis process following Fereday & Muir-Cochrane (2006)**

### 1. Develop code manual

A coding scheme is a tool for organizing raw data into categories (Poole & Folger, 1981 in Hsieh & Shannon, 2005). Good codes are conceptually meaningful, clear and concise, and close to the data (Boyatzis, 1998). There are multiple ways to define themes (Braun & Clarke, 2006). This research opted for theory-driven codes that reflect the elements of the theory and are filled with particular meanings or jargon (Boyatzis, 1998). Keeping in mind that theory-driven codes suffer from lower interrater reliability because they are developed out of context and may be challenging to apply to the raw data gathered (Boyatzis, 1998), the author paid special attention to creating a comprehensive

coding scheme, which builds on the Intuitive and Interpretive CRP transparency attributes analysis.

Furthermore, to assure a code´s theoretical relevance, a procedure recommended by Boyatzis (1998) was followed: a code should be parsimonious, clear, contain only one theme, facilitate coding of raw data, maximize differentiation of sub-samples, and minimize exclusions. The same procedure was applied to all the coding scheme codes. Table 21 illustrates the code definition of “CRP Accuracy” and Table 22 “Miscellaneous CRP transparency attribute.”

| **Label (name)** | **CRP Accuracy** |
|---|---|
| Definition of what the theme concerns (theme characteristics) | How accurately/reliably CRP reflects the market price/transaction price |
| Description of how to know when the theme occurs (indicators of existence) | The respondent speaks about CRP accuracy/ reliability.<br><br>Respondents compare the CRP to the actual market/transaction price. |
| Definition of qualification or exclusion of the theme | Even implicit assessments of CRP accuracy are taken into account, e.g., “LME price is not even discussed because everyone considers it to be THE reference.” |
| Positive and negative examples to eliminate confusion when looking at the theme. | Positive example: “We argue that this price does not reflect the real market.”<br><br>Negative example: “The benchmark is not objective.” (referring to the price discovery method). |

**Table 21: “CRP Accuracy” code definition**

| **Label (name)** | **Miscellaneous CRP transparency attribute** |
|---|---|
| Definition of what the theme concerns (theme characteristics) | Any CRP transparency attribute not captured through the *a priori* coding scheme |
| Description of how to know when the theme occurs (indicators of existence) | The respondent speaks about a CRP transparency attribute. |
| Definition of qualification or exclusion of the theme | The respondent calls/considers an attribute as a CRP transparency attribute. |
| Positive and negative examples to eliminate confusion when looking at the theme. | Positive example: The attribute cannot be coded under a priori codes, e.g., "ergonomic."<br><br>Negative example: The attribute can be coded under a priori codes, e.g., "aesthetic." → Representation. |

**Table 22: "Miscellaneous CRP transparency attribute" code definition**

### 2. Test reliability of the codes

There are many possible ways of testing code reliability in the initial stage. The following measures were taken:

A) Take sample interviews and explore if the codes can be meaningfully applied to the raw data (Boyatzis, 1998): two pilot interviews were coded, and the coding process was relatively straightforward.

B) Test whether the codes allow organizing data into meaningful groups (Fereday & Muir-Cochrane, 2006): a priori codes facilitated the organization of codes into meaningful themes such as "Accuracy," "Methodology," etc.

C) Display the coded excerpts and investigate whether the *a priori* codes show internal homogeneity and external heterogeneity (Patton, 1990): coded extracts were reasonably homogenous and could be analyzed as a group.

D) Check the consistency of judgment over time and events (Boyatzis, 1998): the researcher performed the test with three interviews at two months distance between the coding events. An almost perfect consistency of judgment was achieved.

### 3. Summarizing data and identifying initial themes

The research procedures should be documented, and the process should be repeatable by another researcher (Dubé & Paré, 2003).

In the first step, the author transcribed the interviews to familiarize himself with the data and complemented them with notes or impressions the researcher gained during the interview. Secondly, the author heavily relied on *a priori* codes to summarize the data. However, the author also explored emerging codes that might enhance his understanding of CRP transparency attributes. Thirdly, the author created sub-codes for some CRP transparency attributes to capture the divergent respondent understanding of the main code.

### 4. Applying template of codes and additional coding

Subsequently, the author returned to the interviews and re-coded the data along with the new coding template. Additionally, being aware that using a priori codes and a narrowly defined research question necessarily creates bias, the author searched for inductive codes related to emerging and potentially relevant themes. Subsequently, the author created several new codes but later discarded them as not relevant to the research question.

The coding was done using Nvivo 11 software which allowed the researcher to see all extracts for each code immediately and review the quote in context if necessary.

**5. Connecting the codes and identifying themes**

To allow for cross-comparison, extracts are organized into coherent and consistent patterns (Braun & Clarke, 2006). At this stage, the author looked for themes and patterns in the data, consensus and conflicting evidence, similarities and differences within and across groups. The author was particularly wary of semantically overlapping codes or utterances that could be classified into more than one code. A definitive theme map was drafted.

6. **Corroborating and legitimating coded themes**

The final phase consists of creating a report (Braun & Clarke, 2006) and interpreting the results (Boyatzis, 1998). The researcher tells the story drawn from and backed by the data and answers the research question (Braun & Clarke, 2006). Multiple extracts illustrate the central claims. However, the researcher must also highlight alternative readings or contradictory evidence (Boyatzis, 1998).

Based on a thematic analysis, a provisional list of CRP transparency attributes was drafted that complemented the literature review and the expert interviews.

### 3.4.2.2. Establishment of definitive CRP measured attributes

This section outlines the exact procedure adopted for the final CRP transparency attribute selection, the determination of CRP transparency attribute labels, and the formulation of CRP transparency attribute definitions leveraging the problem-centered expert interviews.

### CRP measured attribute labels

From the outset, the CRP transparency labels derived from the literature were considered provisional. The triangulation of expert recommendations, the feedback from the listening sessions and the literature review suggested suitable CRP transparency attribute labels. In particular, the expert input was fundamental in identifying easily comprehensible and univocal labels.

The suggested labels were subsequently assessed against the recommendations of the terminological literature which provides guidance on evaluating the term suitability: terms are labels that relate to concepts and must be short, unambiguous, linguistically correct, and appropriate for their purpose, otherwise the intended users will not understand and accept them (Isohella and Nissilä, 2015). As the users of CRP transparency attributes will be novices, experienced buyers, and subject-matter experts, well-established words from users' everyday language should be preferred whenever possible and complex designations, jargon, or potentially confusing metaphors avoided (Shneiderman *et al.*, 2016). Furthermore, the researcher should prefer transparent, univocal, consistent, and semantically neutral terms (Sager, 1990). Term transparency means that the term signals the contents of the concept it represents. Univocity implies that the term refers to only one concept. Consistency considers the relation to other fields and systems where the term may be used. Finally, semantic neutrality requires that the term is free from connotations (Isohella and Nissilä, 2015). Table 23 summarizes the term suitability criteria according to which all suggested labels have been assessed.

| Term suitability criteria |
| --- |
| Short |
| Unambiguous |
| Linguistically Correct |
| Fit for purpose |
| Transparent |
| Univocal |
| Consistent |
| Semantically neutral |

**Table 23: Term suitability criteria following Sager, (1990), Schneider et al. (2013), Isohella and Nissilä (2015).**

### Final CRP transparency attribute selection

To achieve these objectives and to minimize the researcher bias risk when establishing the final list of CRP measured attributes, the author followed criteria drawn from Lee et al. (2002), Wang & Strong (1996), and Wand & Wang (1996) leveraged for establishing the information quality attributes, and complemented them with Donaldson´s (2001) implicit call for variables with a distinct contingency level. Hence, to be considered a CRP measured attribute has to meet the following criteria: (1) *triangulation*: the CRP transparency attribute was highlighted in the literature, was considered relevant by the experts, and addresses an important CRP deficiency. (2) *Distinctiveness*: CRP attributes considered relevant but not distinctive enough to differentiate CRP transparency levels were dropped. (3) *Contingency level*: CRP transparency attribute has to contain several meaningful contingency levels, and (4) *overlap*: there is no semantic overlap between any two CRP transparency attributes.

### CRP transparency attribute definitions

This thesis understands the term “definition” as an explanation of the meaning of a term that form part of a domain-specific vocabulary used by a group of experts to communicate about phenomena to which the term refers (Seppälä, Ruttenberg and Smith, 2017). To establish good quality definitions of CRP transparency attributes, the extant literature and expert interviews were triangulated and the key guidelines for writing good quality definitions recommended by Seppälä, Ruttenberg, & Smith (2017) were followed (see Table 24).

Furthermore, the definitions were presented to practitioners during the presentation and listening sessions and their input considered.

| Criterion | Operationalization |
|---|---|
| **Conform to conventions** | - Not include the term being defined<br>- Avoid punctuation other than commas<br>- Written in a natural language<br>- The definition of count nouns should start with an article<br>- Follow the same typographical and editorial guidelines |
| **Respect genus-differencia form** | - Anchor the entity defined in a higher level of generality<br>- Pick the cases that fall under the term defined<br>- Use exactly one higher level entity<br>- Avoid plurals<br>- Avoid categorizers |
| **Non-defining information** | - Avoid encyclopaedic information<br>- Avoid negative terms<br>- Avoid definition by extension |
| **Definition scope** | - Neither too broad nor to narrow |
| **Good practice** | - Unique definitions<br>- Avoid circularity<br>- Avoid generalizing expressions<br>- Avoid examples and lists<br>- Avoid subjective statements<br>- Define abbreviations<br>- Check spelling<br>- Cite sources |

**Table 24: Attributes of good quality definitions following Seppälä, Ruttenberg, & Smith (2017)**

#### 3.4.2.3. Operationalization of CRP measured attributes levels

Once the CRP measured attributes were established, it is necessary to operationalize them through measurement scales in order to construct the

aggregate commodity reference price transparency index. This thesis operationalizes CRP measured attributes as different levels of transparency (see the Chapter 4 for a justification of this decision).

This subsection, therefore, first considers various tools through which the transparency has been operationalized and selects a geological metaphor of five transparency levels conceptualized by Lamming et al. (2001) as the most suitable one. Subsequently, the exact procedure for operationalizing individual CRP transparency attributes is outlined.

**Measurement scales development**

The empirical measurement of transparency is lagging in the advancements in transparency dimensionality, and there is significant uncertainty whether existing scales capture the central theoretical content of transparency (Schnackenberg, Tomlinson, & Coen, 2021). Furthermore, no attempt has been made to measure the CRP transparency attributes. Hence, this thesis must pay particular care in developing relevant CRP transparency attribute scales.

Drawing on the CRP literature, the CRP transparency attribute could be measured through the transparency of the price-setting mechanisms (Radetzki, 2013). However, this classification scheme is impractical as it potentially leads to the multiplication of levels and significant intra-level variance, violating the parsimony and distinctiveness requirement of clear constructs (Suddaby, 2010). For example, the organized exchanges differ in the degree of pre-trade (depth of markets, actual quotes) and post-trade transparency, degree and speed of dissemination, degree of anonymity, and off-exchange trading permission (Madhavan, 2000). Yet, despite these fundamental structural differences, they would occupy the same transparency level.

Turning for inspiration to transparency literature (reviewed in the Chapter 4), Schnackenberg, Tomlinson, & Coen (2021) conceptualize transparency as the perceived quality of information, a three-dimensional construct composed of perceived information disclosure, clarity, and accuracy. To measure transparency they leveraged previous research and measured twelve different transparency

attributes on five-point Likert scales ranging from *strongly agree* to *strongly disagree*, from *small extent* to *a large extent*, or from *not at all* to *frequently*. Unfortunately, such a straightforward approach to measuring CRP transparency attributes using established Likert-scales is unsuitable, because scales like “never, seldom, sometimes, often, always” (e.g., Allen & Seaman, 2007) are meaningless without detailed description what each attribute means. For example, without a clear definition of what “seldom” means in terms of CRP transparency as publication frequency, one respondent may tick “seldom” for weekly CRP publications and another one quarterly.

In contrast, the metaphor drawn from the online trading research (Granados et al. 2010) is much more promising. It defines four discreet transparency levels: (1) transparent (product and price information about all sellers is available and accessible to all buyers), (2) distorted (product and price information is distorted for all buyers: for example, outdated or incorrect information), (3) biased (information is available only about some sellers: for example, search engines highlighting paying websites) and (4) opaque (some information about the price or product is concealed). These transparency levels could be potentially adapted to individual CRP transparency attributes and turned into measurable scales. Unfortunately, the measurement tool does not account for complete CRP absence.

Therefore, to account for the CRP absence, this thesis selects and adapts a geological metaphor of five discreet transparency levels ranging from *Blackhole* to *Dazzle* (Lamming et al., 2001) because it meets the parsimony and distinctiveness requirements and accounts for all conceivable CRP transparency attribute levels including the CRP absence. In addition, the five geological levels comply with Weijters, Cabooter, & Schillewaert, 2010) recommendation to use fully labelled five-level Likert scales for the general population. Furthermore, the geological metaphor does not require equal distance between consecutive transparency points which is important for the conceptualization of individual CRP transparency attribute levels. Finally, the geological metaphor also does not imply

that the translucent CRP transparency level is mid-point, but a response option in its full right.

Hence, each CRP transparency attribute will be measured through a five-level geological metaphor. Table 25 outlines the basic meaning of the five discreet transparency levels, which will be adapted for each CRP transparency attribute.

| |
|---|
| **Dazzle:**<br>- full disclosure of impressive quality |
| **Transparent:**<br>- clear and open to scrutiny, but not disclosing all detail |
| **Translucent:**<br>- important features absent or distorted |
| **Opaque:**<br>- prevents from seeing through, difficult to evaluate |
| **Black-hole:**<br>- nothing or very little emanates |

**Table 25: CRP Transparency levels**

### CRP measured attribute operationalization

The operationalization procedure leveraged CRP measured attribute definition, and the author established a comprehensive code where all the data stemming from the documentary evidence and the semi-structured interviews with PM related to this code were gathered.

Next, the data was triangulated and split into five transparency levels following the geological metaphor logic. This process was iterative as maximum intragroup homogeneity and extra-group heterogeneity was sought.

For example, to establish CRP transparency as publication frequency, all observed publication frequencies were aligned on a continuum. Subsequently, these publication frequencies were triangulated with interviewee assessments and provisionally grouped into the five contingency levels. Next, maximum intra-group homogeneity and extra-group heterogeneity was sought, the cut-off points established, and each CRP transparency level exactly defined.

Finally, to normalize the measured variables, the CRP transparency attribute contingency levels were scored from 0 to 4, where the Blackhole transparency level corresponds to 0 and Dazzle to 4. This scoring is essential for the subsequent construction of the aggregate CRP transparency index.

**CRP transparency assessment**

Four CRP transparency attributes emerged from the previous analysis: accuracy, completeness, publication frequency and methodology. Now they have to be assessed for each CRP individually. While the assessment of CRP transparency as completeness, publication frequency, or methodology for a given CRP can be done directly by the author based on the pre-defined scales, the CRP transparency as accuracy must stem from the interviews and may witness significantly different assessments by respondents. To resolve this challenge, the following procedure was adopted to determine CRP accuracy: (a) each interview and any documentary evidence were individually assessed for accuracy. If all data set the accuracy at the same transparency level, the level was retained. (b) If answers differed by only one transparency level, the more frequent assessment was kept. (c) Finally, if assessments varied by more than two transparency levels, the average was calculated and retained. Table 26 illustrates the CRP accuracy assessment process for the packaging paper CRP.

| Respondent | Relevant quotation or description of activities that suggest the level of accuracy | Assessment (comment) |
|---|---|---|
| 1 | Does not know about the CRP existence: “I admit that I do not even know what reference price to use as the supplier did not offer it and we did not look it up.” | Not applicable |
| 2 | Does not acknowledge the CRP relevance and procures paper packaging through annual e-auction with a fixed price contract. | Opaque (1) |
| 3 | Is aware of CRP existence but leverages competition between suppliers to discover the price. | Opaque (1) |
| 4 | Uses CRP as one argument among many for the price discovery:“"… so EUWID is only used as an argument in price negotiations, but not the most important one. ... Our prices do not follow EUWID”" | Translucent (2) |
| 5 | Incorporates the CRP into the long-term contract and adjusts the price on a quarterly basis if the CRP moves by more than X %. The formula is very complicated and reflects four paper grades. At the same time, the respondent regularly benchmarks the market. The CRP is just a tool to avoid haggling during the contractual period. | Translucent (2) |
| 6 | Considers the CRP lagged but informing the price discovery. With some business partners, a base price is negotiated and adjustments follow the CRP evolution. | Translucent (2) |

| Respondent | Relevant quotation or description of activities that suggest the level of accuracy | Assessment (comment) |
|---|---|---|
| 7 | Uses the CRP in automatic price escalators. Uses the “low” CRP quote. Has the same formula on the customer side. | Transparent (3) |
| Accuracy | Overall assessment | **Translucent (2)** |

**Table 26: Packaging paper CRP “Accuracy” assessment**

#### 3.4.2.4. Construction of CRP Transparency Index

Once the CRP transparency attributes were operationalized, they had to be meaningfully aggregated to represent the relevant CRP contingency levels. This section describes the process adopted for designing the aggregate CRP transparency index, a tool for evaluating and comparing CRP transparency.

**Composite indicator construction**

To develop the CRP transparency index (CRPTI) and explore CRP transparency level implications for business practice, this paper adopts the composite indicator development approach recommended by Saisana & Tarantola (2002), summarized in Table 27. The composite indicator perspective is suitable for building CRPTI because it allows an aggregation of a set of sub-indicators that have no common meaningful unit of measurement nor obvious way of weighing them (Saisana and Tarantola, 2002) and thus provide an overall view and a summary figure to compare CRP contingency levels (Nardo et al., 2005).

In line with the contingency theory insistence on clearly operationalized contingency levels (e.g., Donaldson, 2008), the original model was

complemented with one additional step where the individual contingency levels were defined and the cut-off points established.

| Recommendation | Comment |
|---|---|
| Decide on the phenomenon to be measured | The CRP level of transparency is the phenomenon of interest to be measured.<br><br>Previous chapters documented that CRP transparency measurement would significantly enhance our understanding of CRP and their usage in business practice.<br><br>The CRPTI evaluates CRP transparency level, allows the comparison of the degree of transparency of different CRP, and subsequently highlights potential CRP strengths and weaknesses, and suggests appropriate CRP use in business activities. |
| Selection of sub-indicators | Previous sections already identified the relevant CRP transparency attributes: accuracy, completeness, publication frequency, and methodology. |
| Assess the quality of the data | A combination of documentary data and semi-structured interviews informs individual CRP transparency attributes. The input data can be considered reliable as it was gathered through a triangulation of documentary evidence and interviews with knowledgeable respondents. |
| Assess the relationship between sub-indicators | The individual CRP transparency attributes are formative. Equal weighting and a simple addition of the four individual scores were applied as the default option because there was no empirical or statistical ground for opting for a different scheme (Nardo et al., 2005) because no CRP transparency attribute was deemed more important than the others.<br><br>The composite index was then based on assumptions that the higher the aggregate CRP transparency score, the better. |

| Recommendation | Comment |
|---|---|
| Normalize and weigh the indicators | Even though precisely defined codes should facilitate data treatment and improve inter-rater reliability, a "certain amount of 'expert judgment' is always needed when qualitative data is turned into quantitative indicators" (Nicoletti, Scarpetta, & Boylaud, 2000:17).<br><br>The four CRP transparency attributes are qualitatively assessed through *a priori* coding scheme and classified into the five levels of the Geological transparency metaphor (Lamming *et al.*, 2001). The qualitative assessment is subsequently normalized on a scale from zero to four, where zero corresponds to *Blackhole* and *Dazzle* to four. |
| Define the discreet contingency levels and establish the cut-off points | Similar to individual CRP transparency attributes, the aggregate CRP transparency level is divided into five discreet contingency levels following a geological metaphor.<br><br>The uneven cut-off points were established through an iterative process of determining the appropriate cut-off points and validating their relevance based on the within-group homogeneity and cross-group heterogeneity.<br><br>Subsequently, cut-off points between individual CRP transparency levels were set at 0 for the *Blackhole* CRP transparency level, 1 to 6.5 for *Opaque*, 6 to 10.5 for *Translucent*, 11 to 15 for *Transparent*, and 16 for *Dazzle*. |
| Index presentation | Each CRP is presented as a bar stretching into one of the five transparency levels. In line with the geographical metaphor, individual CRP transparency levels are colored with different shades of black. 'Dazzling' transparency is colored in yellow to highlight the potentially dazzling impact. |
| Test for robustness and sensitivity | In the confirmatory phase of the research, the robustness of the CRP transparency level assessment was checked, the relevance of the cut-off |

| Recommendation | Comment |
|---|---|
| | points was supported by additional evidence, and the practical utility of the CRPTI was confirmed. |

**Table 27: General scheme for building composite indicators following Saisana & Tarantola (2002)**

### CRP aggregate transparency level

The CRP transparency attributes have no common meaningful unit of measurement nor an obvious way of weighing them, which is typical of composite indicators (Saisana and Tarantola, 2002). Thanks to the uniform operationalization following the geological metaphor, the individual CRP transparency attributes were qualitatively assessed and normalized on a scale from zero to four, where zero represented 'Black hole' transparency and four 'Dazzling' transparency. Of course, the categorical scales forgo much information about the variance between units, yet they enable efficient and meaningful aggregation (Nardo *et al.*, 2005). It is important to note that CRP transparency attributes are formative, implying that the increase of one indicator results in the aggregate index increase without necessarily being accompanied by an increase in the remaining indicators (Diamantopoulos and Winklhofer, 2001).

As for the weighting of individual CRP transparency attributes, the author turned to literature for guidance about the potential CRP transparency attributes weighting in the aggregate index: Lamming et al. (2001) argue that transparency is not beneficial unless the data is also accurate. Hence, the accuracy attribute should dominate the aggregate index. However, the relative importance of accuracy may be context-dependent, and CRP issuers may trade it off for other legitimate goals (Rauterberg and Verstein, 2013) such as completeness, frequency, or methodology. Hence, there is no empirical or statistical ground for deviating from the default option of equal weighting (Nardo *et al.*, 2005). The (un)equal weighting deserves further elaboration and testing. However, it is out of the scope of this work and is highlighted as a limitation of this research.

As the literature does not provide a clear guidance and the interview analysis did not reveal any empirical reason for unequal weighting, the aggregate CRPTI score is a simple aggregation of individual scores of the four CRP transparency attributes. The minimum aggregate CRPTI score is 0 and the maximum 16.

Having defined normalized indicators and established equal weights, the aggregate score for the 22 sample CRP can be calculated: Table 28 provides an illustrative example for the Paper CRP.

| | | |
|---|---|---|
| Accuracy | **Overall assessment** | **Translucent (2)** |
| Completeness | The report shows a price range for the quarter, price history and monthly price changes, limited number of products, and only vague transaction information. | **Translucent (2)** |
| Timeliness | Published 2x month | **Translucent (2)** |
| Methodological robustness | The methodology remains proprietary with only generic guidelines:“"Objectively sourced current market prices for particular paper grades and intermediates. Relevant market data is compiled at regular intervals”" (Euwid, 2016). | **Opaque (1)** |
| **FINAL INDEX SCORE** | The final score aggregates individual scores of the four CRP transparency attributes. | **7** |
| **CRPTI transparency level** | The CRPTI transparency level follows the pre-determined cut-off points. | **Translucent** |

**Table 28: Overall CRP transparency score assessment**

**Establishing the cut-off points**

The cut-off points were established based on the intra-group homogeneity and extra-group heterogeneity of CRP, in particular the commonalities and differences in how practitioners leveraged these CRP to inform their business decisions. Consequently, the uneven cut-off points were established at: 0 for *Blackhole*, 1 to 6.5 for *Opaque*, 7 to 10.5 for *Translucent*, 11 to 15 for *Transparent*, and 16 for *Dazzling*. Hence, the Blackhole and Dazzling CRP transparency levels form the extremities of the continuum and are operationalized as single points. In contrast, the Opaque, Translucent and Transparent CRP transparency levels are operationalized as ranges with maximum intragroup homogeneity and extra-group heterogeneity concerning the way practitioners leverage the CRP in their business activities.

Their validity was then evaluated against the four validity criteria suggested by Trochim (2000): convergent, concurrent, discriminant, and predictive validity (see Table 29). The evaluation suggests good support for the uneven cut-off points; however, the cut-off points should be considered as preliminary and tested on a larger sample of CRP.

| **Validity criterion** | **Supporting evidence** | **Evaluation** |
|---|---|---|
| Convergent validity means that operationalization is similar to other operationalizations it should be theoretically similar to. | Th182arriergical metaphor conceptualization by Lamming et al. (2011) suggests uneven cut-off points as Blackhole and Dazzling transparency are viewed as extreme points of a continuum.<br><br>The transaction cost theory conceptualizes governance | Uneven cut-off points are coherent with other contingency operationalizations. |

| Validity criterion | Supporting evidence | Evaluation |
|---|---|---|
| | set-ups as a continuum with uneven cut-off points with the market governance and hierarchy forming the extremities and a range of hybrid governances forming the swollen middle (e.g., Peterson, Wysocki, & Harsh, 2001). | |
| Concurrent validity means that operationalization distinguishes between groups it should theoretically distinguish between. | The following measures were taken to assure maximum intragroup homogeneity and extra-group heterogeneity:<br>- No overlaps are possible<br>- The assessment of individual CRP transparency levels show significant homogeneity in terms of usage in business practice and are distinct from neighbouring transparency levels.<br>- borderline cases, such as 1-2-1-2, are systematically ranged into the lower transparency level, which corresponds to empirical observation of how practitioners use these CRP<br>- a single lower score does not downgrade the CRP into a lower CRP transparency level, e.g., Hydrochloric acid CRP scoring 1-2-2-2 remains in the Translucent transparency category | Uneven cut-off points show significant intra-group homogeneity and extra-group heterogeneity. |

| Validity criterion | Supporting evidence | Evaluation |
|---|---|---|
| | | |
| Discriminant validity means that operationalization is dissimilar to operationalizations it should theoretically be dissimilar to | The operationalization is theoretically different from Maxwell (2015), who focuses on the market structure from which the CRP stems.<br><br>The operationalization is theoretically different from Rauterberg & Verstein (2013), who classify CRP by the index provider's intention. | Good discriminant validity compared to existing alternative operationalizations. |
| Predictive validity means that operationalization predicts something it should theoretically predict | Uneven cut-off points predict how practitioners use the CRP in business practice. | While the sample of CRP shows good predictive validity, a larger sample is needed to gain confidence in the predictive validity of the uneven cut-off points. |

**Table 29: Justification of uneven cut-off points**

## Reliability and Validity

Table 30 summarizes the measures the author took to enhance the construct validity, the reliability, and the external and internal validity. Firstly, *construct validity* was strengthened through a theoretical anchoring in information quality, CRP literature, and contingency theory. Construct operationalisation and the relationship with other constructs were anchored in contingency theory and followed the established geological metaphor. The cut-off points for individual CRP transparency attributes were not selected randomly but emerged from a combination of the theory and data. Furthermore, particular care was paid to

selecting a sample of CRPs likely to represent different transparency levels, identification of experts, and triangulation of multiple sources of evidence. Unclear points were revisited during the follow-up interviews.

Secondly, multiple measures were taken to increase *external validity*. In particular, the cross-case and within-case analysis provided rich data for the exploration of the CRP transparency index's cut-off points, CRP functions, and specific CPM practices used. Rereading the data transcripts was instrumental in identifying commonalities and differences among CRP transparency levels and their impact on CPM practices. Finally, two or more CRP were explored within the same company to identify hidden contextual factors that may influence the evaluation and use of the CRP.

Thirdly, in addition to the clear research framework anchored in contingency theory, *internal validity* was enhanced through a clear chain of evidence where the key results were presented in a detailed, structured form, tabulated, and complemented with quotations. In addition, emerging results were discussed with practitioners during face-to-face discussions and listening sessions. Finally, emerging findings were compared to existing CRP research and considered through the lens of rival theories.

Fourth, a number of measures were taken to assure *research reliability*: all practitioner interviews followed the same semi-structured interview template, and all experts received the same support documents, which served as the basis for the selection and labelling of CRP transparency attributes. The data analysis followed all steps of the directed thematic analysis process, and the transcripts were re-examined for emerging codes.

| **Construct validity** | **Measures taken** |
|---|---|
| Theoretical grounding and consistency (McCutcheon and Meredith, 1993) | Grounded in information quality and CRP literature,<br>Geological metaphor,<br>Anchored in contingency theory. |
| Data collection procedure leading to accurate observations of reality (Denzin and Lincoln, 1994) | Reliance on multiple sources of evidence,<br>A purposeful sampling of CRP likely to represent different transparency levels, knowledgeable experts,<br>Multiple interviews for each CRP. |
| Data triangulation (Gibbert et al. 2008; Yin, 2014) | Interviews complemented with documentary analysis, extant and practitioner's literature. |
| Draft review with key informants (Taylor et al., 2010) | Unclear points were clarified with informants in a follow-up interview,<br>case study brief was revisited with informants if appropriate,<br>CRP transparency attributes were discussed with experts and practitioners. |
| **External validity** | **Measures taken** |
| Cross-case and within-case analysis (Eisenhardt, 1989) | Case studies were compared to those covering the same CRP or transparency level and different CRP or transparency levels. |
| The nested approach of conducting case studies | If possible, two or more CRP were explored within the same company. |

| | |
|---|---|
| within an organization (Yin, 2014) | |
| The rationale for the case study selection and details for case study context (Cook and Campbell, 1979) | The rationale for CRP and informant choice outlined.<br>Followed guidelines for the positivist case study by Dubé & Paré, (2003). |
| Compare evidence with extant literature (Riege, 2003) | Compared to existing commodity reference price research. |
| **Internal validity** | **Measures taken** |
| Clear research framework showing that variable X leads to outcome Y (Gibbert et al., 2008) | Clear methodology to define measured variables, assess the CRP transparency, and construct CRPTI. |
| Pattern matching (compare empirical pattern with predicted one) (Eisenhardt, 1989; Yin, 2014) | A sample of 22 CRP suggests that individual CRP transparency levels have different implications for business practice (cross-case heterogeneity) and that CRP occupying the same CRP transparency level are leveraged in a similar way by practitioners (within-case similarity). |
| Debriefing the findings with uninvolved academics and practitioners (Ellram and Tate, 2015) | Results reviewed in face-to-face discussions with procurement professionals and in listening sessions. |
| Establish clear chain of evidence (Eisenhardt, 1989) | Exploratory case study drafted in standardized format, |

| | |
|---|---|
| | Results are tabulated and complemented with quotations. |
| **Reliability** | **Measures taken** |
| Research protocol including semi-structured interview questions (Yin, 2014) | All interviews followed the same semi-structured interview template.<br>All experts received the same briefs and the structure of the interview followed the same pattern. |
| Development of case study database (Yin, 2014) | Case study database established. |
| Coding scheme (Boyatzis, 1998) | Detailed coding scheme established. |
| Structured thematic analysis process (Braun and Clarke, 2006) | The directed thematic analysis process followed. |

**Table 30: Construct validity, external and internal validity, and reliability measures**

# 4. Developmental phase

This chapter seeks to answer RQ1: considering CRP as a CPM influencing factor, what are the suitable commodity reference price conceptualization and measured attributes? In order to ensure that the concept of CRP is theoretically and empirically grounded, the CRP construct is first defined, its functions and potential weaknesses inferred, and subsequently conceptualized as CRP transparency. Next, the CRP transparency attributes are explored from three complementary perspectives drawn from information quality literature (Wand and Wang, 1996; Wang and Strong, 1996; Lee *et al.*, 2002): firstly, explicit and implicit CRP transparency attributes are extracted from the CRP-related literature and reduced into provisional categories (the intuitive approach); secondly, the CRP transparency attributes are derived from the analysis of CRP weaknesses (the interpretive approach); thirdly, CRP transparency attributes are explored empirically through directed expert interviews (the empirical approach). Finally, the three approaches are triangulated, and the final list of CRP transparency attributes is established,189arriersd, and defined.

## 4.1. CRP definition

Building on the literature review, this section proposes a grounded CRP definition that integrates all important features inferred from the extant literature (Bukenya & Labys, 2005; Caliskan, 2007, 2009; Moosmayer, Schuppar, & Siems, 2012; Radetzki, 2013b; Rauch, 1999; Figuerola-Ferretti & Gilbert, 2005; Mazighi, 2005; Maxwell, 2015):

*The commodity reference price is an externally created dynamic anchor for a standard product that market participants employ to make sense of the market environment and inform their business decisions.*

***Externally created.*** Reference prices (RP) result from human interactions (Poitras, 2013) and may be internal or external depending on the information-

gathering stage (Lowengart, 2002). Internal RP is in the buyer's mind and may be based on the memory of past prices (Mazumdar, Raj and Sinha, 2005) or experience and judgment based on external cues or context (Lowengart, 2002).

In contrast, external RP assume that the buyer's idea of what they should pay for a product is formed by information from the external environment (Mazumdar and Papatla, 2000). There is a consensus (e.g., Maxwell, 2015; Radetzki, 2013; Rauch, 1999) that CRP are created externally by institutions outside of the market participant's mind and influence, e.g.,"examples of commodity reference prices include price indexes compiled and published by market data providers, and prices used to settle exchange-traded or cleared futures or other contracts related to an Underlie"" (ISDA, 2019:1).

***Dynamic anchor.*** CRP value changes over time. CRPs discovered through the double auction mechanism, published continuously, and reacting immediately to new information are the most dynamic ones. Weekly or monthly CRP published by price reporting agencies and trade journals form the middle ground. Finally, quarterly or annual producer catalogue prices incorporate new information with a significant lag and are the most stable CRP (Radetzki, 2013; Figuerola-Ferretti & Gilbert, 2005).

***Standard product.*** Unlike generic RP definitions, CRP relates to a particular sub-group of RF that differentiate homogeneous commodities from differentiated products. Indeed, it is impossible to create a meaningful CRP for a differentiated category like shoes due to the number of variants, local idiosyncrasies, and product branding. In contrast, a single CRP is possible for homogenous polymers thanks to standardized specification and anonymity because the manufacturer's name is not necessary to quote the price and compare quotes (Rauch, 1999). Consequently, the CRP applies to completely standardized products whose physical or chemical properties, grade, unit, packaging, and delivery terms are precisely specified, e.g., OIL-BRENT-ICE or ZINC LME CASH (Roncoroni, Fusai and Cummins, 2015). Whenever there are multiple commodity grades, one may progressively assume the CRP role, e.g., the Henry Hub in Louisiana for the natural gas futures (Mazighi, 2005). Rice, with more than ten co-existing

benchmarks, is a notable exception due to regional grade differences (Jamora and von Cramon-Taubadel, 2017).

***Making sense of the market environment*** **and informing business decisions.** CRP reflect the market supply and demand conditions (Ward and Choi, 1998) and mediate prevailing market prices, defined as what market participants typically pay for immediate or future delivery at the transaction time (Roeber, 1996). In this sense**,** CRP is a useful institution that helps market participants make sense of the actual market price and sentiment (Caliskan, 2007 & 2009) and constitutes a benchmark in price negotiations (Moosmayer et al., 2012).

### 4.1.1. CRP functions

An in-depth understanding of CRP functions is fundamental for conceptualizing the CRP contingency and exploring its measured attributes. The review of the RP and CRP contributions revealed that practitioners leverage CRP in five different yet interrelated ways: *anchor, price discovery, information source, valuing holdings, and contract reference* (see Table 31 for definitions and summary of the main ideas).

**Appendix 4** provides an in-depth review of each CRP function.

| CRP function | Definition | Main idea |
|---|---|---|
| Anchor | The basis for comparing and evaluating the outcomes of business activities (Kahneman, 1992). | There are three types of anchors: Expectational, Normative and Aspirational (Mazumdar, Raj & Sinha, 2005).<br><br>Expectational anchors involve buyers expecting to pay a reference price (CRP), shaping price discovery and standardization. But they can lead to manipulation and biases.<br><br>Aspirational anchors involve comparing prices paid by others, influencing organizational goals. But they can encourage haggling and unequal discounts.<br><br>Normative anchors are considered "fair" prices, based on past levels, competition, or costs. But they may lead to focus on peaks, risky behaviour, and abuse. |
| Price discovery | The process of arriving at a specific realization price for a given commodity (Ethridge et al., 1981). | Price determination involves establishing equilibrium prices through various mechanisms. CRP differ in the price determination process quality ranging from efficient commodity exchanges to more arbitrary methods. Hence, CRP differ in quality.<br><br>Price discovery is informed by CRP, e.g. prevailing prices, negotiation benchmark, and contribute to pricing heterogeneous commodities.<br><br>There is a complex interplay and mutual cross-pollination between CRP and realization prices. |

| | | |
|---|---|---|
| Information source | A platform for gathering, sharing, and trading private information (Rauterberg and Verstein, 2013). | CRP are a valuable information source for market participants.<br><br>CRP convey information about the market sentiment, future resource availability, insights into market fundamentals, etc.<br><br>CRP users leverage them for budgeting, price forecasting, trading, decision making, and sharing private market information. |
| Valuing holdings | A valuation tool for different holdings and obligations (Rauterberg and Verstein, 2013). | CRPs are used for valuing financial holdings, trade inventories, calculating taxes, marking-to-market physical trades, and settling financial contracts.<br><br>CRP are vital for pricing mutual funds, secondary equity offerings, mergers, and insurance replacements. |
| Contract reference | An ex-ante contract term to manage price adaptation (Kang, 2005). | CRP are used differently in contracts:<br>- negotiation basis in fixed price contracts,<br><br>- reference points for fixed price forward contracts and escalator clauses,<br>- flexible contracts with price formulas incorporating CRPs are preferred.<br>Formula pricing reduces transaction costs, aids coordination, and benefits smaller players, but have been criticised for limited contribution to price determination and reduced market liquidity (Schroeder & Ward, 2000). |

**Table 31: Overview of CRP functions**

## 4.2. Conceptualizing CRP contingency as transparency

Having defined the CRP, outlined its functions, it is now possible to conceptualize CRP as a measurable, influencing factor with several discriminating contingency levels. The rest of the section provides the rationale for conceptualizing the CRP contingency as *CRP transparency*.

### 4.2.1. Rival CRP conceptualizations

Previous research conceptualized CRP contingency as the degree of market liquidity (Gaudenzi et al., 2018), level of acceptance, accuracy, degree of representativeness of actual transactions (Hayenga and Schrader, 1980), the quality of the price discovery mechanism (Roeber, 1996; Radetzki, 2013b; Maxwell, 2015), CRP information content understood as the noise-to-signal ratio (Figuerola-Ferretti and Gilbert, 2005), or regional relevance (Valiante and Egenhofer, 2013).

While insightful, these CRP conceptualizations lack theoretical grounding and provide only a partial, one-dimensional view of the CRP contingency. Yet, the number and variety of CRP features suggest that CRP contingency may be a multidimensional construct.

### 4.2.2. Transparency label in CRP literature

CRP literature already widely uses the term “transparency” to denote various CRP contingency levels and measured attributes. For example, scholars labelled as “transparency” the degree of disclosure of the CRP assessment process (IEA et al., 2011; Valiante, & Egenhofer, 2013), the disclosure of CRP transaction prices, (Valiante, & Egenhofer, 2013; Humphries, 2010), information content of transaction prices (Figuerola-Ferretti and Gilbert, 2005), the quantity of input data

for establishing the CRP (Azzam, 2003; Koontz and Ward, 2011), CRP price disclosure and the breadth of available CRP (Roeber, 1996), the quality of the price discovery mechanism (Maxwell, 2015; Radetzki, 2013b; Li, 2010; Aspris et al., 2017), the availability of trading information (pre-trade and post-trade) in financial and physical markets (Cinquegrana, 2008), the availability of market information (Veerman et al., 2016), information about prevailing prices (Duffie, Dworczak and Zhu, 2017), and information about CRP purpose and methodology (EU, 2016a). Hence, the new label follows an implicit scholarly terminological consensus.

### 4.2.3. Transparency features relevant to the CRP conceptualization

A cross-disciplinary review of transparency in business research revealed diverse applications and conceptualizations of the term (Schnackenberg and Tomlinson, 2014). Yet, the primary meaning of transparency can be broken down into two necessary and partly overlapping constituents: visibility and inferability of information (Michener and Bersch, 2013).

*Visibility* is understood as the ability to see through something, share information that is not usually shared (Hultman and Axelsson, 2007), disclose information that is reasonably complete and relatively easy to find (Michener and Bersch, 2013), the opposite of secrecy (Rawlins, 2008) or openness (Karlsson, 2010). In addition, scholars differentiate between “active” transparency, disclosed voluntarily or obligatorily, and “passive” transparency, which is only revealed upon request (e.g., Michener & Bersch, 2013). Transparency as visibility is particularly salient in supply chain research, where it is conceptualized as disclosing supplier names, product traceability, supplier sustainability conditions, and buyer purchasing practices (Egels-Zandén, Hulthén and Wulff, 2015).

Reverting to CRP functions, the visibility constituent is fundamental for all five CRP functions: the very existence and publication of the CRP constitute a “visible” benchmark for valuing holdings; “visible” CRP share information that is usually not shared and become an anchor, an information source, and a contract

reference that inform business transactions. Finally, the “visibility” of the price discovery process then greatly enhances user confidence in the CRP.

However, transparency as mere disclosure is insufficient and may result in non-user-friendly data formats or even degenerate into (purposefully) unintelligible communication (Vujnovic and Kruckeberg, 2016). Therefore, it has to be complemented with transparency as *Inferability* conceptualized as a quality that makes things easy to understand, unbiased, trustworthy, and value-adding to the receiver (Forssbæck and Oxelheim, 2014). Furthermore, data presentation should allow easy processing and extraction of information relevant to the business goals of receivers (Granados, Gupta, & Kauffman, 2010b).

Inferability is enhanced by three mechanisms: disaggregation, verifiability, and simplification (Michener and Bersch, 2013). First, *disaggregated* data is ideally raw, untampered with, and as close to the source as possible. Additionally, data should not be changed, aggregated, or furnished in closed formats that cannot be processed. Secondly, confidence in data increases if a credible third party has validated the *verifiability* of it. Finally, *simplification* leverages heuristics to render information easier to understand and adapt to the receiver´s capabilities.

While visibility makes CRP functions possible, inferability determines the CRP quality and, subsequently, the effectivity with which a CRP function is fulfilled. For example, a biased price discovery process makes the CRP anchoring worthless; an unsuitable CRP format may disqualify CRP from the reference price or valuing holdings functions. Finally, the difficulty in understanding CRP significantly reduces its value as an information source.

Schnackenberg & Tomlinson (2014) expand Michener & Bersch's (2013) two-component model and propose *accuracy* understood as validity, precision, non-distortion, and correctness as the third fundamental transparency constituent. Considering CRP functions, CRP transparency as accuracy is particularly important for the anchoring, contract referencing, and valuation functions.

Furthermore, by breaking down inferability into *clarity* and *accuracy*, Schnackenberg & Tomlinson (2014) highlight the possible trade-offs between

accuracy, clarity, and disclosure faced by CRP issuers (Rauterberg & Verstein, 2013). For example, a CRP composed of a raw, long list of all transactions (representing *accuracy*) may be of little value to market participants who only look for a reliable aggregate CRP value that spatially situates the market price (Caliskan, 2007) to value their holdings (representing *clarity*). Similarly, market participants may willingly forgo detailed information about the price discovery process (representing *disclosure*) as long as it has been validated by a respected third party (representing *clarity*). Finally, some market participants may prefer more timely (representing *dislosure*) but less accurate (representing *accuracy*) CRP, while others may prefer the contrary.

#### 4.2.3.1. Summary of arguments for CRP transparency conceptualization

Previous sections highlighted compelling arguments for conceptualizing the CRP contingency and CRP transparency.

| Topic | Argument for CRP transparency conceptualization |
|---|---|
| Rival CRP conceptualizations | In contrast to rival conceptualizations which lack theoretical grounding and are unidimensional, CRP transparency is theoretically grounded and may be multidimensional. |
| Transparency label in CRP literature | The term transparency has been used in the extant literature to denote different CRP contingency levels and measured attributes. |
| CRP anchored in Supply chain transparency literature (See Chapter 2) | CRP contingency constitutes a specific sub-group of price transparency, which in turn is a sub-group of market transparency which then belongs into the Supply chain transparency for Knowledge integration cluster. |

| | |
|---|---|
| CRP as enabler of business transparency | The CRP contingency level is shaped by visibility and inferability of the price information, two fundamental transparency features identified by Michener and Bersch (2013). |

### 4.2.4. CRP transparency definition

Having reviewed the CRP transparency construct from different perspectives and positioned it as a sub-group of market and price transparency, it is now possible to define the construct as *the quality of information for the intended use that the commodity reference price issuer intentionally shares with market participants*.

This definition synthesises key CRP transparency features: the CRP transparency definition reflects the basic meaning of market and price transparency constructs and accounts for different levels of transparency. It emphasises that CRP transparency is a multidimensional construct, which is directly and intimately linked to information, its disclosure, inferability, and accuracy. It also builds on the review of extant CRP literature, which reveals that CRP transparency is implicitly defined as "seeing through" (Veerman et al., 2016), "high quality" (Maxwell, 2015), or "disclosure" (Valiante, & Egenhofer, 2013). Finally, it emphasises the active role of CRP issuers, and it reflects the contingent nature of the required level of CRP transparency.

## 4.3. Exploring the CRP transparency attributes

Having anchored CRP transparency in existing transparency research and conceptualized it as a multi-dimensional construct, the this section will explore CRP transparency attributes from three complementary angles: a critical review of the CRP literature, an interpretive analysis of CRP weaknesses from which the

CRP transparency attributes are derived, and an empirical investigation of a panel of CRP experts.

The combination of the three complementary approaches to extract and triangulate contingency measured attributes has been frequently used in the information quality literature (e.g. Wand & Wang, 1996; Wang & Strong, 1996; Ge & Helfert, 2006; Stvilia et al., 2007).

The intuitive approach draws the CRP transparency attributes from a specific application context (Ge & Helfert, 2006) and relies primarily on the literature review and the researcher´s experience (Wang & Strong, 1996). The advantage of the intuitive approach is the possibility to select directly the most important attributes for the phenomenon of study. The disadvantage is that some attributes may have been missed (Ge & Helfert, 2006).

**Appendix 5, Section A2 reports the findings from the intuitive approach to CRP transparency attribute identification.**

The interpretive, or theoretical, approach is driven by the real-world perspective (Ge & Helfert, 2006). Building on Stvilia et al. (2007) and Wand & Wang (1996), it first explores CRP deficiencies and the types of activities affected by these problems and subsequently derives the relevant CRP attributes which resolve these deficiencies from the literature. The advantage of this approach is a comprehensive list of attributes relating to the phenomenon of interest. On the downside, the voice of the CRP may have been missed (Ge & Helfert, 2006).

**Appendix 5, Section A3 reports the findings from the CRP deficiency analysis and the subsequent interpretive approach to CRP transparency attribute identification.**

Finally, the empirical approach moves away from the researcher-centred methods. Building on Ge & Helfert (2006) and Lee, Strong, Kahn & Wang (2002), it seeks to derive the transparency attributes directly from CRP users by studying the factors they consider when determining whether the CRP is fit for their particular business decisions.

Next Section reports the findings from the empirical approach to CRP transparency attribute identification.

## 4.4. Empirical approach to CRP transparency attributes

This section complements the intuitive and interpretive approaches with the empirical exploration of the voice of the CRP users. Based on interviews with nine procurement managers, spontaneous CRP attributes are identified first and complemented with an expert assessment of CRP transparency attributes drawn from the intuitive and interpretive approaches. Finally, a provisional empirical taxonomy of CRP transparency attributes is established.

### 4.4.1. Spontaneous CRP attributes

The open-ended discussion over the CRP transparency attributes highlighted the novelty and complexity of the topic, and experts admitted that they never reflected on the CRP quality attributes. Yet, they spontaneously mentioned at least three CRP transparency attributes (see Table 32 for a summary), providing additional evidence that CRP is a multi-dimensional construct. For example, Expert 2 mentioned following CRP attributes:

> "It should be easily accessible, widely known, objective. … accepted by our final customer to avoid any misalignment with our sales price calculation… relevant for our region … reflect the market … objectively reflecting the market."

| | Methodology | Accuracy | Contextual | Timeliness | Accessibility | Representation | Acceptability |
|---|---|---|---|---|---|---|---|
| **Exp. 1.** | respected source | | futures curve, comments | frequency | | | |
| **Exp. 2.** | not manipulated | | regional relevance | | accessible | | widely used, accepted |
| **Exp. 3.** | | market price | background information, futures | current, frequency | | | |
| **Exp. 4.** | trustworthy issuer | market price | locally relevant | | accessible | | accepted |
| **Exp. 5.** | | | futures chain | current | | | widely used |
| **Exp. 6.** | quality of method | accurate | locally relevant | frequency | | stable format | accepted by parties |
| **Exp. 7.** | defensible internally, quality of method | | background information | | accessible | | |
| **Exp. 8.** | not manipulated | reflecting market reality | locally relevant | | accessible | | widely accepted |
| **Exp. 9.** | issuer reputation | market average | relevant for industry | | | | |

**Table 32: Spontaneous CRP transparency attributes**

### 4.4.2. Guided interview on CRP transparency attributes

When asked about the CRP transparency attribute relevance for the CRP transparency construct, experts had three options: they could approve it, they could refuse it as irrelevant, or they could merge it with another CRP transparency attribute (see Table 33 for summary). Subsequently, they were prompted to develop their assessment in detail.

The relevance of some CRP transparency attributes became salient through the analysis of differences between CRP. For example, if the respondent speaks about a subscription-based CRP, accessibility stands out compared to others, and the respondent is likely to highlight this CRP transparency attribute. Sometimes experts struggled with describing the CRP transparency attribute and were evidently missing terminology to articulate it. For example, Expert 8 described CRP transparency as methodology in the following way:

> “LME is the best, being a respected institution. … BDSV for the secondary steel prices is an objective reflection of market reality … [But the oil CRP, issued by] OPEC stems from a shady meeting where they decide what the oil price will be. I do not like it because it does not reflect economic fundamentals.”

| | Methodology | Accuracy | Contextual | Timeliness | Accessibility | Representation | Acceptability |
|---|---|---|---|---|---|---|---|
| **Exp. 1.** | ✓ | ✓ | Merge w/ Accuracy | ✓ | ☒ | ✓ | ☒ |
| **Exp. 2.** | ✓ | ✓ | ✓ | ✓ | ☒ | ☒ | ✓ |
| **Exp. 3.** | ✓ | ✓ | ✓ | ✓ | ✓ | ☒ | ☒ |
| **Exp. 4.** | ✓ | ✓ | ✓ | ✓ | ☒ | ☒ | Merge w/ Accuracy |
| **Exp. 5.** | ✓ | ✓ | Merge w/ Accuracy | Merge w/ Methodology | ☒ | ☒ | Merge w/ Methodology |
| **Exp. 6.** | ✓ | ✓ | ✓ | ✓ | ☒ | ☒ | ☒ |
| **Exp. 7.** | Merge w/ Accuracy | ✓ | ✓ | ✓ | ☒ | ☒ | ☒ |
| **Exp. 8.** | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | Merge w/ Methodology |
| **Exp. 9.** | ✓ | ✓ | ✓ | ✓ | ☒ | ✓ | ☒ |

**Table 33: Expert assessment of CRP attribute relevance**

Expert suggestions will be revisited in detail in the next section where provisional CRP transparency attributes will be labelled, conceptualized, and retained or excluded as the definitive CRP transparency attributes.

Merging spontaneous and guided data collection approaches resulted in seven CRP transparency attributes: acceptance, methodology, accuracy, completeness, timeliness, accessibility, and representational transparency. CRP *acceptance* emerged as a new CRP transparency construct. Experts overwhelmingly agreed that accuracy, methodology, contextual transparency, and timeliness were fundamental to CRP transparency. In contrast, representativeness, accessibility, and acceptance were considered relevant but not sufficiently distinctive. The expert interview analysis also revealed a broad agreement on what individual CRP transparency attributes meant. Finally, finer-grained analysis uncovered new facets of the CRP transparency attributes, such as *structural* or *useful accuracy*. However, these differences do not warrant splitting the main CRP transparency attribute into two or more distinct attributes.

## 4.5. Towards definitive CRP transparency attributes

### 4.5.1. Aggregation of the three approaches to CRP transparency attributes

Each of the three approaches selected to explore CRP transparency attributes has some limitations. While an interpretive approach provides valuable insight into the CRP transparency attributes, there is no guarantee that the voice of the customer has not been missed. In contrast, an intuitive approach draws CRP transparency attributes from the experience and intuition of practitioners and researchers but remains vulnerable to omissions. Finally, an empirical approach may fall victim to saliency bias and omissions. Hence, the triangulation

of the three approaches should compensate for their respective weaknesses and lead to a robust taxonomy of CRP transparency attributes.

Table 34 aggregates provisional CRP transparency attributes and suggests that the three approaches render a semantically overlapping list of CRP transparency attributes, except for acceptability, which only surfaced in the empirical approach.

| **Intuitive approach** | **Interpretive approach** | **Empirical approach** |
|---|---|---|
| **-** | **-** | Acceptance |
| Intrinsic as Methodology | Methodology | Methodology |
| Intrinsic as Accuracy | Accuracy | Accuracy |
| Contextual | Information content | Completeness |
| Accessibility as Timeliness | Timeliness | Timeliness |
| Accessibility as Accessibility | Accessibility | Accessibility |
| Representational | Understandability | Representational |

**Table 34: Aggregation of provisional CRP transparency attributes**

Next, each provisional CRP transparency attribute is anchored in the CRP literature, its critical properties highlighted, its weaknesses and potential corrective measures considered and the practitioner view of the CRP transparency attribute relevance for the CRP transparency construct summarized (see Appendix 7 for an in-depth discussion).

### 4.5.2. Expert assessment of CRP Transparency attribute labels

So far, the CRP transparency attribute labels have to be considered provisional and there is no guarantee that the provisional CRP transparency attribute labels are fit-for purpose. Therefore, the labels will be first explored through a panel of experts and a short-list established which will be subsequently assessed against the terminological literature recommendations.

Table 35 provides an aggregate view of expert opinion on the most suitable CRP transparency attribute labels. It indicates a relatively limited number of suitable labels whose number could be further reduced after the careful analysis of what these labels actually mean for the respondent.

**Appendix 6 provides additional insights and into the expert assessment of suitable CRP transparency attributes labels.**

In summary, 15 provisional CRP transparency attribute labels were shortlisted for the in-depth analysis following the terminological literature recommendations:

- *Accessibility / Ease of Access*
- *Acceptability*
- *Representational transparency / Standardized format*
- *Accuracy*
- *Contextual transparency/ Completeness/ Availability of information/ Information content*
- *Timeliness/ Frequency/ Publication frequency*
- *Methodology/ Price discovery quality*

| | Methodology | Accuracy | Contextual | Timeliness | Accessibility | Representation | Acceptability |
|---|---|---|---|---|---|---|---|
| **Exp. 1.** | Quality | Accuracy | Availability of information | Timeliness | N/A | Standardized format | N/A |
| **Exp. 2.** | Index methodology | Accuracy | Completeness | Timeliness | Accessibility | N/A | Acceptability |
| **Exp. 3.** | Robust methodology | Accuracy/ Objectivity | Completeness | Timeliness | Accessibility | N/A | N/A |
| **Exp. 4.** | Governance/ Compliance | Precision | Contextual | Frequency of publication | The ease of access | N/A | N/A |
| **Exp. 5.** | Regulation | Accuracy / Objectivity | Contextual | Frequency | N/A | N/A | Acceptability |
| **Exp. 6.** | Price discovery quality | Objectivity | Contextual | Frequency | Accessibility | N/A | N/A |
| **Exp. 7.** | Good methodology | Accuracy / Quality of forecast | Price drivers | Timeliness | N/A | N/A | Acceptability |
| **Exp. 8.** | Relevance | Precision / Simplicity | Complex | Regularity | Transparent access | Appropriate format | N/A |
| **Exp. 9.** | Source transparency | Reliability / Accuracy | Completeness | Publication frequency | Accessibility | Representational | Acceptability |

**Table 35: Expert opinion on the most suitable CRP transparency attribute label**

### 4.5.3. Terminological literature assessment

The previous section established a short list of relevant CRP transparency attribute labels. This section evaluates each term against the criteria recommended by the terminological literature.

| | Short | Unambiguous. | Linguistically. Correct | Fit for purpose | Transparent. | Univocal | Consistent. | Semantically. neutral |
|---|---|---|---|---|---|---|---|---|
| Accessibility | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Ease of Access | ☒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Acceptability | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Representa-tional transp. | ☒ | ☒ | ✓ | ✓ | ☒ | ☒ | ✓ | ✓ |
| Standardized format | ☒ | ✓ | ✓ | ✓ | ☒ | ✓ | ✓ | ✓ |
| Accuracy | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Contextual T. | ☒ | ☒ | ✓ | ✓ | ☒ | ✓ | ✓ | ✓ |
| Completeness | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

| | Short | Unambiguous. | Linguistically. Correct | Fit for purpose | Transparent. | Univocal | Consistent. | Semantically. neutral |
|---|---|---|---|---|---|---|---|---|
| Availability of information | ☒ | ☒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Information content | ☒ | ☒ | ✓ | ☒ | ✓ | ✓ | ☒ | ✓ |
| Timeliness | ✓ | ✓ | ✓ | ☒ | ✓ | ✓ | ✓ | ✓ |
| Frequency | ✓ | ☒ | ✓ | ✓ | ☒ | ✓ | ✓ | ✓ |
| Publication frequency | ☒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Methodology | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Price discovery quality | ☒ | ☒ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |

**Table 36: CRP transparency label evaluation against against the terminological literature**

Table 36 suggests that some provisional CRP transparency attribute labels are terminologically sound and should be maintained: “acceptability” and “accuracy” are perfectly suitable for the purpose. Similarly, “accessibility” is maintained because it complies with all terminological requirements and is shorter than its synonym, “ease of access.” Finally, “methodology” is terminologically sound, shorter, and less ambiguous than “price discovery quality” and should be preferred.

In contrast, other provisional CRP transparency attribute labels proved less suitable and were replaced by the labels that emerged during the expert assessment: “representational transparency” proved unsuitable on several grounds—it is not short, and its meaning might appear ambiguous and unclear to some users. Therefore, the label will be replaced by “standardized format,” even though it does not cover all the subtleties of CRP representation.

The term “contextual transparency” is too long, potentially ambiguous, and mediates the concept it represents poorly. Similarly, “availability of information” and “information content” may be too generic because all CRP transparency attributes convey important information. Hence, the term “completeness” will be retained as it fulfils all terminological criteria and suggests that CRP conveys all necessary or appropriate details.

Finally, neither “timeliness” nor “frequency” seem suitable. In contrast, the term “publication frequency” seems adequate despite being wordy.

In summary, the following CRP transparency attribute labels were retained: **accessibility, acceptability, standardized format, accuracy, completeness, publication frequency,** and **methodology**. These labels will be used in the next section, which establishes the definitive list of CRP transparency attributes based on expert assessment.

### 4.5.4. Definitive CRP transparency attributes

Previous sections explored the CRP transparency attributes, suitable labels, and their exact meaning and relevance in the CRP context. Table 37 summarizes the analytical framework for the inclusion of a CRP transparency attribute into the final list of CRP transparency attributes (the assessment criteria were outlined in the Methods section 3.4.2.2.).

| Attribute | Literature | Practitioner relevance | Deficiency | Distinctiveness | Contingency levels | Non-overlapping | **Decision to include** |
|---|---|---|---|---|---|---|---|
| **Accuracy** | ● | ● | ● | ● | ● | ● | ● |
| **Methodology** | ● | ● | ● | ● | ● | ● | ● |
| **Completeness** | ● | ● | ● | ● | ● | ● | ● |
| **Accessibility** | ● | | ● | | ● | | |
| **Publication frequency** | ● | ● | ● | ● | ● | ● | ● |
| **Representational** | ● | | | | | | |
| **Acceptability** | | ● | | | | | |

**Table 37: CRP transparency attribute inclusion criteria**

Based on this assessment, four CRP transparency attributes were retained: accuracy, methodology, completeness, and publication frequency. In contrast, CRP accessibility, acceptance, and representational transparency attributes were dropped because they were considered either unimportant, non-distinctive, or a dependent variable of other CRP transparency attribute.

The selected CRP transparency attributes provide a holistic, complementary, and non-overlapping view of the CRP transparency: CRP accuracy informs how well a CRP mediates the actual or potential transaction prices. It is complemented with CRP completeness, which highlights the breadth and depth of market information shared and disclosed to market participants. Hence, CRP accuracy is situated, or not, in grade, regional, or transaction size details. CRP publication frequency indicates how often the CRP is published and therefore indicates how potentially lagged the CRP price and information it conveys is. Finally, CRP methodology informs how reliable the information conveyed by the CRP is. Figure 11 emphasizes the complementarity of the selected CRP transparency attributes.

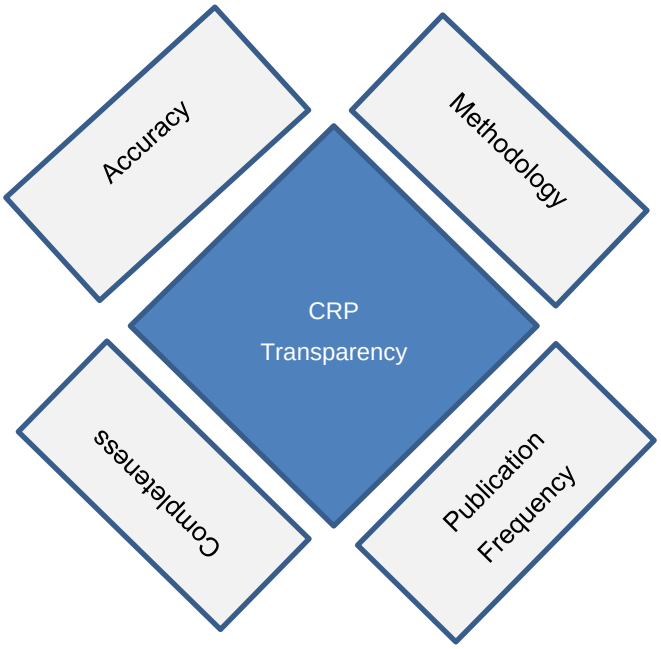



**Figure 11: Definitive CRP transparency criteria.**
**Source: Author.**

# 5. CRP transparency index

In this chapter, the CRP transparency index is constructed and leveraged to compare the CRP transparency level and to determine a suitable approach to commodity price management. To achieve this objective, the CRP transparency attributes are first defined and operationalised using a geological metaphor outlined in the Methods Section 3.4.1. Subsequently, CRP are assessed for each CRP transparency attribute. Next, the CRP transparency attributes are aggregated into the CRP transparency index, populated with a sample of CRP. Finally, the impact of CRP transparency levels on CRP functions is explored.

## 5.1. CRP Transparency attribute operationalisation

This section focuses on operationalizing the four attributes of the CRP transparency construct: accuracy, completeness, publication frequency, and methodology. Each CRP transparency attribute is first defined, then operationalised following a geological metaphor of five distinct transparency levels, and finally, assessed against a sample of CRP.

### 5.1.1. CRP transparency attributes definition

Based on the extant literature reviewed in the previous chapter and the data gathered from the experts and case-study respondents, each CRP transparency attribute was defined (see Table 38). A detailed justification of each definition can be found in Appendix 8.

| CRP transparency attribute | Definition | Key references |
|---|---|---|
| Accuracy | *conformity to the actual or potential transaction prices* | Wand and Wang, 1996; Lee *et al.*, 2002; Figuerola-Ferretti & Gilbert, 2005; Cinquegrana, 2008; Koontz & Ward, 2011; Radetzki, 2013 |
| Completeness | *breadth and depth of market information disclosed to market participants*. | Wang and Strong, 1996; Madhavan, 2000; Lee *et al.*, 2002; Ahlers et al., 2013 |
| Publication Frequency | *commodity reference price publication frequency*. | Bloomfield & O'Hara, 1999; Azzam, 2003; Fattouh, 2011; Koontz & Ward, 2011; Valiante, & Egenhofer, 2013; Radetzki, 2013b; Veerman et al., 2016 |

| CRP transparency attribute | Definition | Key references |
|---|---|---|
| Methodology | *a set of methods and principles used to determine the CRP* | Strauss, 1992<br>IEA et al., 2011;<br>Rauterberg and Verstein, 2013;<br>Verstein, 2015;<br>Stewart, 2013 |

**Table 38: CRP transparency attribute definition**

### 5.1.2. CRP transparency attribute operationalisation

CRP transparency attributes were operationalised into five levels following the geological metaphor based on the thematic analysis of the interviews and documentary evidence. In parallel, they were standardised on a 0 to 4 scale (see Table 39). A detailed overview of the operationalisation, including illustrative quotations, an assessment of the sample of 22 CRP, and relevant findings concerning each CRP transparency attribute transparency level can be found in **Appendix 8**.

| CRP Transparency attribute | Accuracy | Completeness | Publication Frequency | Methodology |
|---|---|---|---|---|
| **CRP transparency level** | **Operationalisation / Standardisation on a 0 to 4 scale** | **Operationalisation / Standardisation on a 0 to 4 scale** | **Operationalisation / Standardisation on a 0 to 4 scale** | **Operationalisation / Standardisation on a 0 to 4 scale** |
| **Black Hole** | The CRP does not exist.<br>0 points | The CRP does not exist.<br>0 points | Not published at all, published irregularly, or annually.<br>0 points | Not published, discretionary price setting, intentionally heavily biased.<br>0 points |
| **Opaque** | The CRP is perceived as arbitrary and does not reflect the actual market level or transaction prices. | Single CRP price with limited background information regarding CRP specification, market structure, grade, | Published regularly but less frequently (quarterly, monthly). | Price discovery follows an existing, internal, not published procedure. Non-replicable. |

| CRP Transparency attribute | Accuracy | Completeness | Publication Frequency | Methodology |
|---|---|---|---|---|
| | It may be biased or irrelevant to the buyer's region or grade.<br>1 point | region, or commercial terms, no transaction information, and no market and price interpretation.<br>1 point | 1 point | 1 point |
| **Translucent** | The CRP provides a high-level and aggregated view of the market price or trend, yet significant adjustments are needed to discover the transaction price.<br>2 points | Price range (low-high, spot/contract price), grades, regional prices, limited transaction information, and some market and price interpretation.<br>2 points | Published regularly and frequently (bi-weekly, weekly).<br>2 points | Price discovery follows a formal published procedure based primarily on judgment and is difficult to replicate. Explicit measures against manipulation.<br>2 points |

| CRP Transparency attribute | Accuracy | Completeness | Publication Frequency | Methodology |
|---|---|---|---|---|
| **Transparent** | The CRP mediates prevailing market prices, and actual transactions happen around the reference price with standardised and justified adjustments for the grade, quantity, distance, etc.<br><br>3 points | Wide range of prices (spot, forward, regional, grades), selected transaction information: bid/ask, transaction price, volume, transaction parties, extensive market, and price interpretation.<br><br>3 points | Published very frequently (daily).<br><br>3 points | Price discovery follows a formal published procedure based on replicable or even mechanistic methodology. Robust measures against manipulation.<br><br>3 points |
| **Dazzle** | CRP is the transaction price or quote and is used at face value in transactions. | CRP reveals the full range of prices: spot, forward/futures, options, and different grades. Extensive transaction information: bid-ask, volumes, transaction parties. Availability of market and price interpretation. | Published continuously.<br><br>4 points | A particular transaction or quote stands for the reference price.<br><br>4 points |

| CRP Transparency attribute | Accuracy | Completeness | Publication Frequency | Methodology |
|---|---|---|---|---|
| | 4 points | 4 points | | |

**Table 39: CRP transparency attributes operationalization**

### 5.1.3. Summary of findings from the practical application

This section focused on defining and operationalising four CRP transparency attributes. The practical application sections which can be found in the Appendix 8 assessed the sample of 22 CRP and investigated the relevance and distinctiveness of the individual CRP transparency attribute levels through documentary analysis and practitioner interviews.

The data showed significant differences among CRP in individual CRP transparency attributes. The contingency increase dynamics varied among CRP transparency attributes. The transitions among CRP accuracy or completeness levels were smooth and each transparency level incrementally added on the previous one. In contrast, CRP publication frequency and CRP methodology exhibit qualitative chasms. In the case of CRP publication frequency, the lower transparency levels represent lagging indicators of past trading, while the Transparent and Dazzle CRP attribute transparency levels mediate the forward-looking trading information and quotes. Similarly, CRP methodology transparency contain a qualitative break between the discretionary Black Hole CRP methodology and Opaque CRP methodology where some aspects of the methodology are shared and may be audited by a third person. Another qualitative break is then reserved for the Dazzle CRP methodology transparency level when the issuer stops intervening directly into the CRP creation and contends with setting the trading process, rules and degree and form of information disclosed.

The CRP transparency attribute assessments will be aggregated in the next section to determine the CRP transparency level of individual CRP, and subsequently construct and populate the commodity reference price transparency index.

## 5.2. Commodity Reference Price Transparency Index

Commodity reference price transparency index (CRPTI) is a tool for assessing the CRP transparency level based on the aggregation of the four CRP transparency attributes. Depending on the CRP transparency level and the (mis)alignment of CRP transparency attributes, the CRPTI then suggests a suitable CRP use in business practice and suitable CPM practices. Furthermore, CRPTI can be used as an analytical tool by CRP issuers and regulators for determining the CRP transparency attribute(s) to modify so as to create a more transparent CRP, and thus increase CRP utility for the market participants.

This section is organized as follows: first, it aggregates the four CRP transparency attributes into a single number following the procedure outlined in Section 3.4.2.5 and constructs the CRPTI. Next, three different types of CRP transparency attribute alignment are outlined: “ideal” CRP transparency configurations that achieve the same level across all four CRP transparency attributes, marginally misaligned where CRP transparency attributes do not differ by more than 1 level, and misaligned CRP where CRP transparency attributes differ by more than two levels. Finally, the impact of individual CRP transparency levels on CRP functions and CPM practices outlined.

### 5.2.1. CRP transparency attribute aggregation

Previous section assessed individual CRP transparency attributes and normalised their contingency level on a scale from zero to four. This section aggregates these individual assessments and classifies CRP following the procedure and cut-off points outlined in section 3.4.2.5. The results are summarised in Table 40 and document that the Black Hole CRP transparency level was not identified in the CRP sample, seven CRP occupy the Opaque CRP transparency level, nine CRP were attributed to the Translucent CRP transparency level, five CRP populate the Transparent CRP transparency level, and one CRP meets the criteria set for the Dazzle CRP transparency level.

| CRP | CRP transp. as accuracy | CRP transp. as completeness | CRP transp. as pub. frequency | CRP transp. as methodology | CRPTI score |
|---|---|---|---|---|---|
| Not observed | | | | | |
| Technical gas | 0 | 1 | 0 | 0 | 1 |
| Concrete: Cemex | 1 | 1 | 0 | 0 | 2 |
| Steel alloy surcharge: Moravia Steel | 1 | 1 | 1 | 0 | 3 |
| Natural rubber: World bank, TSR20 | 1 | 1 | 1 | 1 | 4 |
| Steel: Internal report | 1 | 1 | 1 | 1 | 4 |
| Copper: Czech/Slovak cable industry | 2 | 1 | 2 | 1 | 6 |
| Wood: Czech Stat. Office | 1 | 1 | 1 | 3 | 6 |
| Banana: Sopisco | 2 | 2 | 2 | 1 | 7 |
| Carton paper: Euwid | 2 | 2 | 2 | 1 | 7 |
| Hydrochloric acid: ICIS | 1 | 2 | 2 | 2 | 7 |
| Steel: MEPS | 2 | 3 | 1 | 2 | 8 |
| Steel: SteelBenchmarker | 2 | 2 | 2 | 2 | 8 |
| Diesel: Slovak Stat. Office. | 3 | 1 | 2 | 3 | 9 |
| Methanol: ICIS | 3 | 2 | 2 | 2 | 9 |

| CRP | CRP transp. as accuracy | CRP transp. as completeness | CRP transp. as pub. frequency | CRP transp. as methodology | CRPTI score |
|---|---|---|---|---|---|
| Steel: Platts | 2 | 3 | 2 | 2 | 9 |
| Sulphuric Acid: Fertecon | 2 | 3 | 2 | 2 | 9 |
| Diesel: Platts | 3 | 3 | 3 | 3 | 12 |
| Electric power: EEX Settlement price | 4 | 3 | 3 | 3 | 13 |
| Aluminium: the LME Official Price | 4 | 3 | 3 | 4 | 14 |
| Steam Coal: Argus | 4 | 4 | 3 | 3 | 14 |
| Natural Rubber: Shanghai futures exchange | 3 | 4 | 4 | 4 | 15 |
| Electric power: EEX best bid | 4 | 4 | 4 | 4 | 16 |

**Table 40: CRP transparency attribute aggregation**

### 5.2.2. Populating the CRP transparency index

Having aggregated the CRP transparency attributes and having determined the overall CRP transparency level for all the selected CRP, it is now possible to construct the CRP transparency index (CRPTI) and populate it with a sample of 22 CRP following the procedure outlined in Section 3.4.1.2.

Figure 12 represents CRPTI as a graph where individual CRP transparency levels are highlighted with different shades of grey, except for the Dazzle CRP transparency level, highlighted in yellow to signify its exceptional level of transparency.

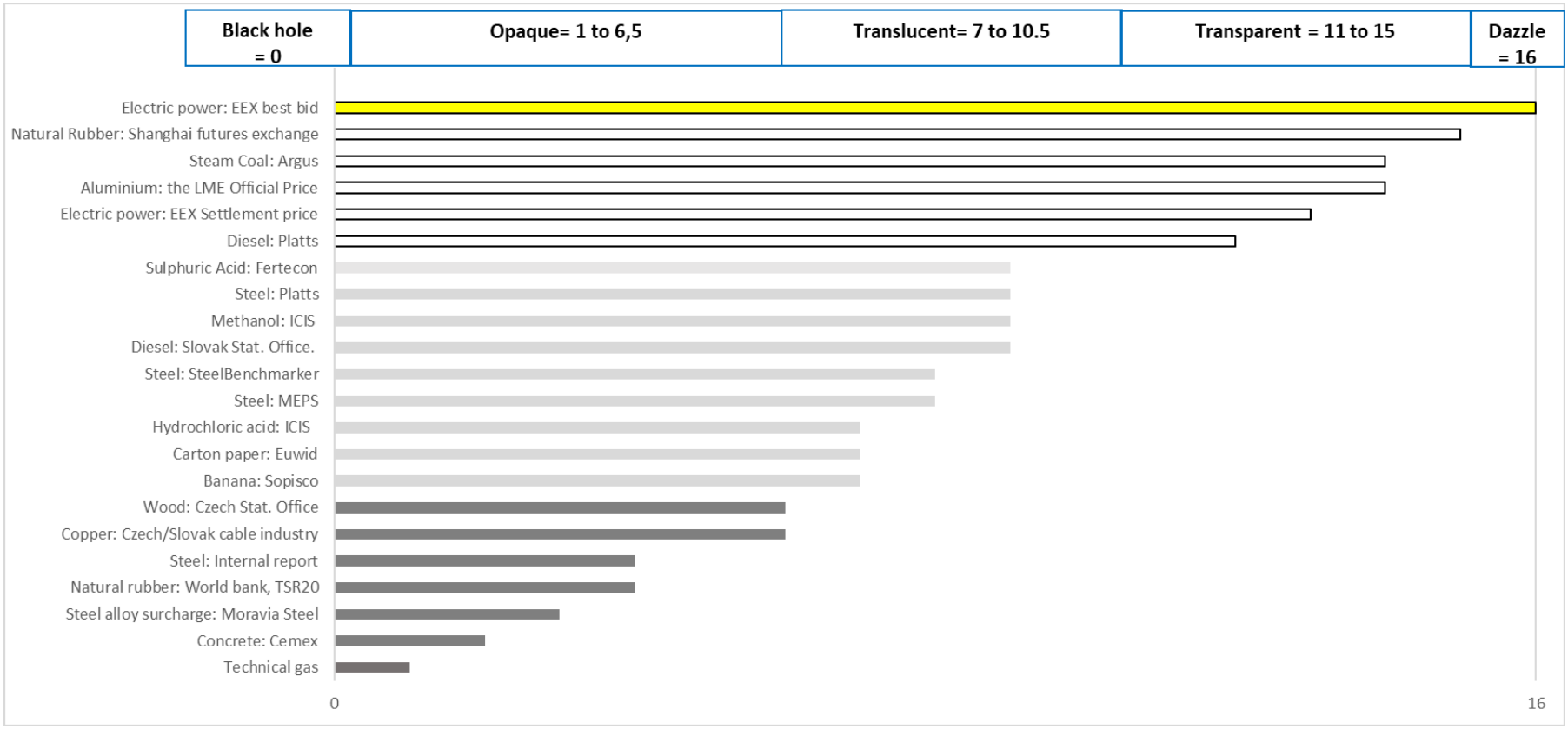



**Figure 12: Commodity reference price transparency index. Source: Author.**

**The Black Hole CRP transparency level** was not observed in the sample. However, there is strong evidence of its existence, e.g., “We are in the niche business and need very specific, custom-made steel grades that are not covered by any index.” “[It is not] in the producers’ interest to standardize the [specific rubber grade]. [Instead] they keep the composition secret and impossible to compare.”

**The Opaque CRP transparency level** is populated by several CRP, typically lesser known, regional, and less frequently published CRP. The issuer objectives range from simple information sharing (Wood CRP or CRP stemming from the internal report) through anchoring (Cemex CRP, Moravia steel CRP) to creating a regional reference price (Copper CRP).

**The Translucent CRP transparency level** is filled with CRP issued primarily by the price reporting agencies. It functions as an information source that provides comprehensive market and price information for a commodity and its derivatives, which market participants leverage during the CPM activities.

**The Transparent CRP transparency level** contains well-known international benchmarks issued by reputed PRA or daily prices emanating from commodity exchanges. It assumes the price discovery function, acts as a reliable contract reference, and serves as the basis for valuing holdings.

Finally, **the Dazzling CRP transparency level** is populated by the real-time stream of CRP generated by liquid commodity exchanges. The CRP assumes all typical CRP functions: undisputed price discovery, direct contract reference, anchor for comparing the transaction price performance, information source about the commodity fundamentals and trading context, and a tool for valuing holdings.

#### 5.2.2.1. Perfect alignment of CRP transparency attributes

Even though the CRP transparency attributes are independent variables, they exhibit significant transparency level consistency. In five cases, the same CRP transparency attribute level is observed across all four CRP attributes (see Table 41): Natural rubber by World Bank TSR20, Steel CRP from Internal report, Steel by SteelBenchmarker, Diesel by Platts, and Electric power best bid by EEX.

| CRP | CRP Transp. as Accuracy | CRP Transp. as Completeness | CRP Transp. as Pub. Frequency | Transp. as Methodology | CRPTI score |
|---|---|---|---|---|---|
| Natural rubber: World bank, TSR20 | 1 | 1 | 1 | 1 | 4 |
| Steel: Internal report | 1 | 1 | 1 | 1 | 4 |
| Steel: SteelBenchmarker | 2 | 2 | 2 | 2 | 8 |
| Diesel: Platts | 3 | 3 | 3 | 3 | 12 |
| Electric power: EEX best bid | 4 | 4 | 4 | 4 | 16 |

**Table 41: Perfect alignment of CRP transparency attributes**

Table 42 summarizes these “archetypal” and perfectly aligned CRP transparency attribute set-ups. **The Black Hole CRP transparency attribute alignment** was not observed in the data sample and would represent the total absence of CRP. **The Opaque CRP transparency attribute alignment** applies to two CRP in the format of a single CRP without additional details, mediating a somewhat unreliable image of the market and coming into existence monthly or quarterly through an internal, undisclosed methodology. The **Translucent CRP transparency attribute alignment** was observed with one CRP issued weekly based on a published, formal though judgmental procedure, which gives a good idea about market prices but offers only a limited breadth and depth of information about the CRP context. **The Transparent CRP transparency attribute** concerns

one CRP determined daily through a public, formal, and replicable procedure that provides a reliable image of market prices and is complemented with a wide range of price and trade information. Finally, one CRP correspond to the **Dazzle CRP transparency attribute alignment** where CRP are published continuously and mediate actual quotes and realization prices with a full rendition of the trading context.

| CRP Transparency level | Archetypal CRP | Accuracy | Completeness | Publication Frequency | Methodology |
|---|---|---|---|---|---|
| Black Hole<br><br>= 0 points | Not observed | Nonexistent | Nonexistent | Nonexistent | Nonexistent |
| Opaque<br><br>= 4 points | Natural rubber: World Bank, TSR20<br><br>Steel: Internal report | Somewhat unreliable benchmark of market prices, potentially disconnected from market | Single price for a given specification<br><br>No trading details | Published quarterly / monthly | Internal, not published procedure |
| Translucent<br><br>= 8 points | Steel: SteelBenchmarker | Gives a good idea about market prices | Limited breadth and depth of price and trade information | Published frequently (weekly) | Published, formal, judgemental procedure |
| Transparent = 12 points | Diesel: Platts | Reflects market prices | Wide range of prices and trade info. | Published very frequently (daily) | Public, formal, replicable procedure |
| Dazzle<br><br>= 16 points | Electric power: EEX best bid | Equals the transaction price | Full range of prices and trade information | Published continuously | Mediates actual quotes or realization prices |

**Table 42: Archetypal CRP with perfectly aligned CRP transparency attributes**

#### 5.2.2.2. Marginal misalignment among CRP transparency attributes

Fourteen CRP comprise CRP transparency attributes that differ by no more than one transparency level (see Table 43).

| CRP | CRP Transp. as Accuracy | CRP Transp. as Completeness | CRP Transp. as Pub. Frequency | Transp. as Methodology | CRPTI score |
|---|---|---|---|---|---|
| Technical gas | 0 | 1 | 0 | 0 | 1 |
| Concrete: Cemex | 1 | 1 | 0 | 0 | 2 |
| Steel alloy surcharge: Moravia Steel | 1 | 1 | 1 | 0 | 3 |
| Copper: Czech/Slovak cable industry | 2 | 1 | 2 | 1 | 6 |
| Banana: Sopisco | 2 | 2 | 2 | 1 | 7 |
| Carton paper: Euwid | 2 | 2 | 2 | 1 | 7 |
| Hydrochloric acid: ICIS | 1 | 2 | 2 | 2 | 7 |
| Methanol: ICIS | 3 | 2 | 2 | 2 | 9 |
| Steel: Platts | 2 | 3 | 2 | 2 | 9 |
| Sulphuric Acid: Fertecon | 2 | 3 | 2 | 2 | 9 |
| Electric power: EEX Settlement price | 4 | 3 | 3 | 3 | 13 |
| Aluminium: the LME Official Price | 4 | 3 | 3 | 4 | 14 |
| Steam Coal: Argus | 4 | 4 | 3 | 3 | 14 |
| Natural Rubber: Shanghai futures exchange | 3 | 4 | 4 | 4 | 15 |

**Table 43: Marginal misalignment among CRP transparency attributes**

Technical gases possess several CRP but none of them was considered relevant. Steel alloy surcharge by Moravia Steel, Carton paper by Euwid, or Banana CRP by Sopisco underperform just in the CRP methodology, which may be simply due to the publication omission or CRP issuer policy to protect their unique and differentiating know-how. Hydrochloric acid by ICIS underperforms in CRP accuracy, suggesting the difficulty in determining a narrow price range, standardizing logistics costs, and perhaps also incorporating regional specificities. Natural rubber traded on the Shanghai futures exchange slightly underperforms in accuracy due to a slight but structural lag between the central and regional price levels.

In contrast, the Steel CRP by Platts or Sulphuric acid CRP by Fertecon overperform in the CRP completeness attribute, which may be explained by the fact that both commodities have many variants and regional specificities. Methanol CRP by ICIS and Electricity Settlement price by EEX overweight the CRP accuracy attribute, which may accommodate CRP users who use this CRP directly in contracts or for valuing holdings.

Several CRP follow a similar pattern of two more transparent CRP attributes, which suggests a careful CRP fine-tuning to the commodity or user requirements. For example, concrete CRP by Cemex focuses on disclosing the sales price for specific grades once a year. Hence, the CRP publication frequency or methodology are not considered. Similarly, copper CRP by the Czech/Slovak Cable Industry Association focuses on frequent and accurate CRP updates to the detriment of methodological information and completeness. Steam coal CRP by Argus trades off Dazzle CRP accuracy and completeness for Transparent CRP publication frequency and methodology, reflecting the specificity of the world coal market and challenges in the data gathering process. Finally, the aluminium Official Price by LME suggests a deliberate decision to prefer CRP accuracy and methodology to completeness and publication frequency.

#### 5.2.2.3. Imbalanced CRP transparency attributes

Only three CRP in our sample could be labelled as imbalanced because the CRP attributes differ by at least two transparency levels (see The data did not reveal any practical concequence of CRP transparency attribute (mis)alignment on CRP functions or CPM practices and practitioners use these CRP the same way as other CRP occupying the same transparency level.).

| CRP | CRP Transp. as Accuracy | CRP Transp. as Completeness | CRP Transp. as Pub. Frequency | Transp. as Methodology | CRPTI score |
|---|---|---|---|---|---|
| Wood: Czech Stat. Office | 1 | 1 | 1 | 3 | 6 |
| Steel: MEPS | 2 | 3 | 1 | 2 | 8 |
| Diesel: Slovak Stat. Office. | 3 | 1 | 2 | 3 | 9 |

**Table 44: Imbalanced CRP transparency attributes**

- Wood CRP by the Czech Statistical Office boasts a very robust methodology. However, due to data gathering and processing constraints, low publication frequency makes the CRP lagged and hence inaccurate from the practitioner perspective. Furthermore, the nature of the data collected and the CRP presentation format hampers CRP completeness.
- Diesel CRP by the Slovak Statistical Office underscores the CRP methodological quality and accuracy to the detriment of completeness and only average publication frequency. The CRP issuer is motivated to supply an aggregate CRP that accurately reflects the average retail fuel price. Hence, it sacrifices important contextual factors such as regional price differences or fuel quality differences among retailers to achieve this objective. The decision to publish the CRP weekly suits the business needs of CRP consumers who use it in contracts: it is timely enough to mirror the market evolution but not administratively burdensome like a daily update.

- The imbalanced CRP transparency of the Steel CRP by MEPS reveals a tradeoff between the low CRP publication frequency and high level of completeness. Most CRP users appreciate this trade-off because Opaque CRP publication frequency corresponds to their price negotiation pattern:

> We secure [steel] volumes through an annual contract and negotiate prices monthly. . . . [We agreed to] MEPS as the basis for negotiation (a PM in a large metal processing company).

Furthermore, lower CRP accuracy is not problematic because CRP consumers are primarily interested in the overall CRP trend and negotiate the transaction price directly with the supplier*:*

> The price itself does not matter [because the exact price is negotiated bilaterally within the local context]. What matters [to me] is the trend and the quality of explanation why things happen the way they do and where the market is heading (a PM in a medium-sized metal processing company).

Finally, CRP users are aware of the data gathering constraints and, therefore, accept the lower CRP methodology level:

> “Their access to confidential data requires trust. They cannot say who gave them a hint that prices are going down. [You] pay the subscription and expect that they give you some confidential and unbiased information (a PM in a large metal processing company).

#### 5.2.2.4. Practical impact of internal CRP transparency attribute imbalance

The data did not reveal any practical concequence of CRP transparency attribute (mis)alignment on CRP functions or CPM practices and practitioners use these CRP the same way as other CRP occupying the same transparency level.

However, it is conceivable that internally imbalanced CRP may be of interest to CRP issuers and regulators who may consider improving less transparent CRP transparency attributes or save resources on the “overperforming” CRP transparency attributes as long as these are not fundamental for the CRP users.

### 5.2.3. **CRP transparency impact on CRP functions and CPM practices**

The Commodity Reference Price Transparency Index and its CRP transparency levels are only relevant if they improve business practice. This section, therefore, documents the importance of the CRP transparency level in shaping CRP functions and explores their impact on business practice, particularly the choice of CPM practices.

#### 5.2.3.1. Black Hole CRP transparency level

The Black Hole CRP transparency level covers all instances when the CRP does not exist. Hence, market participants must engage resources to gather information and discover the price through transaction cost intensive CPM practices like market research, bilateral negotiation, competitive bidding, or e-auctions. The performance of the price discovery process is then compared to alternative proposals or an internal reference price like the budget, historical price, or price objective.

Alternatively, buyers establish an informal communication channel to share and compare the price information with other buyers, which can be considered an ad-hoc CRP:

> “[Sharing price information among buyers] is much more difficult than people think. People are afraid they will lose their privileged price if they share it. [Also,] it is unethical . . . . [And there is] a practical problem [because the technical] specification is never quite the same . . . . [But] we do it [anyway], on bottleneck components (a PM responsible for rubber and resins).

The Black Hole CRP transparency level favours big, knowledgeable buyers who can leverage their purchase volumes and asymmetric information. Furthermore, the price adaptation across the supply chain is difficult due to a common CRP base. Large companies therefore propose piggyback contracting facilitation to their suppliers who can adhere to an existing contract and enjoy favourable terms:

> Our suppliers can either join our contract or buy [the commodity] independently. In any case, I will calculate the commodity share [of the total product cost] and only pay them our negotiated price . . . . They can buy a bit more for their other customers as well, [so] it is profitable for everyone (a PM in a large mining company).

#### 5.2.3.2. Opaque CRP transparency level

The Opaque CRP transparency level is occupied by a very heterogeneous set of CRP such as the technical gas report by USGS, copper by the Czech/Slovak Cable Producer Association, the Moravia Steel monthly scrap and alloy surcharge, sulphuric acid notation published by Fertecon, the World Bank natural rubber CRP, or even an internal steel price report. Opaque CRP may also stem from “unofficial” CRP sources such as irregular producer price lists or transfer prices available from various statistical data.

Opaque CRP are typically regional and coexist with more transparent CRP. Knowledgeable buyers do not consider them representative of the actual market and systematically replace them with more transparent CRP. A PM in the

automotive sector argues that there is no point in using a regional price when a world reference price exists:

> I did not know of [Copper CRP by Czech Cable Producer Association] existence. . . . We use [copper CRP by] the LME for our contract … [which is] known to everyone . . . . If a Czech supplier offered it? I would not accept it.

Furthermore, some buyers are worried about the potential bias of Opaque CRP:

> I do not challenge the [LME] CRP because they reflect the trading on the commodity exchange and the commodity exchange guarantees it. But if a supplier comes with a CRP that three companies made up, then I will want to know where the data comes from, how they calculated it, and what other factors were considered. (Expert 4)

Despite these reservations, the acceptance of Opaque CRP as an anchor may be warranted for small, one-off quantities for which the tendering effort would exceed the benefits. For example, a PM in the construction sector uses Opaque CRP for convenience reasons:

> We needed two cubic meters of concrete. I looked up local producers and bought it [for immediate delivery] at their list price.

Opaque CRP have been progressively institutionalised in the investigated companies. Small buyers or regional players may even incorporate them as the contract reference into long-term contracts to simplify price adaptation. For example, a mining company for whom the copper wiring represented only a minor category adopted the Czech and Slovak Copper Industry Association CRP because “copper prices change all the time. . . . I wanted an official reference in the contract . . . to save time and have something easily auditable.” However, other market participants strictly refuse the contract reference function of Opaque CRP due to their low level of accuracy.

The information source function of Opaque CRP is embodied by the internal steel report mentioned by several multinational companies. It is issued by central procurement departments and draws heavily on existing steel CRP and internal know-how. The CRP content is tailored to company needs regarding alloys and regional markets. A PM in the automotive industry emphasises that the CPR is not shared with the suppliers, and buyers use it for sense-making and negotiation preparation:

> There is the [stable steel] base price for the year and the surcharges that change. . . . We have [central] commodity buyers who negotiate the basic steel price and follow the relevant scrap and alloy surcharges . . . [So] if a supplier comes and says that surcharges are going up, I check it [against the internal CRP] and often find out that it is not true.

Opaque CRP facilitate the price discovery process as one argument among many. In commercial negotiations, Opaque CRP represent a hassle-free price level at which the supplier is willing to trade. Hence, it constitutes high-level information about the price and a target to beat for most buyers. Market participants often use Opaque CRP strategically if the CRP evolution is favourable and dismiss them as irrelevant or biased if the trend is unfavourable. Opaque CRP may also be used for budgeting purposes or as a convenient instrument for hiding the actual transaction prices in publicly available documents.

Opaque CRP require resource-intensive CPM practices focused on discovering the “true market price” like market testing and benchmarking, e-auctions, and bilateral negotiation. Several buyers note that the difficulty of linking contracts to Opaque CRP leads to highly repetitive, routinised negotiations between long-term business partners, as explained by a PM responsible for chemicals:

> We discuss every last week of the month. . . . We [both] know what price we want to achieve. . . . They tell their arguments, I

> tell ours. We have heard them 100 times already. . . . [Then] we settle on something.

As hedging is impossible, buyers stabilize prices through stockpiling or combining different price maturities. A PM in a wood processing company explains:

> If the price is right, I will buy a three-month quantity and stock it here or at the supplier. . . . Buyers [may] fix a portion [of the volume] on the spot and a portion is fixed for three months . . . [and] we change the percentage depending on our [price] expectations.

To eliminate cost-intensive price discovery related to haggling over the Opaque CRP "real value," buyers may completely bypass them through cross-hedging where they link the escalator clause to a cost driver with Dazzle or Transparent CRP, representing 70-80 % of total commodity cost. For example, a large mining company established an annual price escalator indexed to electricity for industrial gases:

> I cannot change the [industrial gases] supplier easily due to storage facilities. And the supplier does not want to give me a five-year fixed price. . . . I want to avoid haggling, so they proposed a price formula based on electricity, [oil CRP] Brent, and the official inflation rate. . . . Electricity [CRP] is based on the EEX [commodity exchange]. There is no ambiguity about this price.

#### 5.2.3.3. Translucent CRP transparency level

The Translucent CRP transparency level, represented by chemicals, packaging paper, or steel CRP, occupies the middle ground. On one hand, the CRP is considered reliable and accurate enough to inform business decisions and CPM practices. On the other hand, it is not viewed as reliable and accurate

enough to be accepted at face value. Hence, buyers leverage Translucent CRP but complement them with extensive search, e.g., combine several CRP reports, organize supplier meetings, consult media and supplier newsletters, subscribe to market analysis by independent experts, visit conferences, and establish informal information sharing channels. A PM specialized in steel procurement highlights the importance of fundamental analysis and market knowledge:

> Considering that steel is the main purchase category and a difficult one, you need a full-time person to deal with it. . . . A bad price and passive price-taker approach do not require much work. . . . [But if you want to buy steel well,] you have to feel the market: the steel mills' price strategy, supplier stock levels, antidumping laws, Ukraine exports. . . . I seek information from potential suppliers because they are more reliable than from the incumbent [ones] . . . I read the SteelBenchmarker . . . seek rumours. . . . According to the [CRP] report, the steel price is 600 [euro per ton], but you know you can push service centres 50-100 euro [per ton] cheaper. Why? Because they still have cheap materials in stock. [But to get all this leverage] you need a good relationship with the sellers and a lot of information.

Notwithstanding these challenges, practitioners use Translucent CRP as a useful information source and a benchmark around which the final bilateral price is discovered following extensive price search, negotiation, and monitoring. A PM in a multinational company acknowledges the usefulness of Translucent CRP:

> I developed my own tools to calculate the actual [steel] premium because the [Steel CRP] price [Incoterms] is Ex works and does not correspond to our exact chemical and mechanical specification nor the payment terms. But if I juxtapose the two curves, the trend roughly corresponds. Sometimes, we are slightly better or worse depending on whether the steel mills are sold out or fight for business.

Translucent CRP issuers provide a series of regional prices and grades, but these do not represent actual transactions nor seek to provide accurate price information about respondents' particular thickness, grade, or location. A PM specialized in steel procurement explains:

> [Steel CRP] quotes many variants, but their price cannot correspond exactly to our grade or thickness. To do so, [the report] would have to be this thick, have a team of 300 people, and get published just once a year.

Hence, market participants leverage Translucent CRP as anchors against which they evaluate the negotiation result. A purchasing director summarized the idea:

> I tell my buyers that they should always try to negotiate a discount [against the CRP]. But they must apply common sense. Sometimes the material is tight, and [so] the price is good even though it is more than you would like to pay [compared to the index]. I say, 'Don't wait, don't negotiate!'

Over time, buyers discover the CRP "real" value quantified as CRP plus/minus X and start using this theoretical CRP level as the legitimate anchor, as explained by A PM of commodity chemicals:

> [Normally,] we achieve a 200 € per ton discount against the [chemical] index. [Our] procurement performance is then judged against this standard discount. If we negotiate more, we count it as savings and vice-versa.

Furthermore, buyers know that Translucent CRP become unreliable during turbulent periods. Hence, they temporarily downgrade and leverage them as Opaque CRP. A PM specialized in steel procurement explains:

> [During crises] MEPS [CRP] becomes irrelevant because the market changes too fast and steel mills make daily [price] announcements. Do you want [to buy it at this price] or not?

> [CRP] only summarises what I already know. . . . [So, the supplier and I] forget the report and negotiate the prices based on the information we have.

Considering the structural Translucent CRP weakness in turbulent periods, it is logical that they are rarely used as a contract reference in escalator clauses. A steel PM highlights the barriers:

> We wanted to implement the [steel CRP] based escalator [clause], but we could not agree on the base price because both sides were afraid that they would lose. . . . I could never justify internally if the material [price informed by CRP] was cheaper [than the price available on the actual market].

In addition, Translucent CRP used as contract reference also fall victim to blatant opportunism, where parties abuse CRP weaknesses to extract profits, as documented by a PM responsible for the fuel cards who games the Diesel CRP published by the Slovak Statistical Office:

> This is an average price that is too low in the capital or on the highway and too high in the eastern regions. . . . Statistically, our employees use the highway a lot. [So] we turned the average to our advantage and required the supplier to charge us the average of all their service stations minus the negotiated discount. [Hence,] we achieved interesting savings.

Therefore, one buyer of carton packaging bypasses the Translucent CRP inaccuracy with a contractual provision that allows her to periodically benchmark the CRP accuracy and subsequently adapt the contract price to the actual market:

> The [packaging paper CRP] is one thing and the market evolution [for paper cartons] another one. . . . We benchmark [carton] prices with our sister plants and also tender cartons regularly because sometimes the market moves differently [from the CRP quotation]. And then we negotiate [the contract adaptation] very hard.

Similar to Opaque CRP, Translucent CRP may be used strategically in negotiation, as explained by a PM in a diversified holding:

> We use [packaging paper CRP] in negotiation to scare each other off. We say that [packaging paper] prices fell and we want a discount. . . . But if [CRP] goes up, we say that [the report] is not representative of the market.

#### 5.2.3.4. Transparent CRP transparency level

The Transparent CRP transparency level is populated by CRP issued by reputable PRA or generated by commodity exchanges. These CRP meet very high transparency standards, and market participants leverage them for all CRP principal functions. In addition, Transparent CRP enable a wide range of CPM practices.

Firstly, Transparent CRP are used for valuing holdings. For example, all open positions in the wholesale electricity market, such as futures contracts or options, are marked-to-market with the settlement price. Similarly, the Official Price by the LME is used as the global reference for physical contracts or valuing stocks.

Secondly, Transparent CRP are considered an excellent source of reliable information about prices, bids and offers, market dynamics, and background information. The information source function is particularly salient for commodities with many variations, such as coal or oil. A PM specialized in energy procurement explains:

> I study the [electricity] settlement price and the newsletter first thing in the morning. If nothing fundamental happens, I copy the values into my database and move on. [But] if I see a big price move or read some breaking news, I immediately make a few phone calls, inform the financial director, suggest the next steps.

In contrast, some buyers complain about information overload and only skim the CRP for “disasters and bad news that send the price up.

Thirdly, transparent CRP constitute an anchor against which the transaction performance is judged. Any deviation from the CRP has to be justified by technical or commercial reasons. For example, one PM boasted that he could buy electricity below the CRP level. However, other interviews revealed that this was not the case. Actually, when a chemical company buys wholesale electricity at a discount against the settlement price, it is not the settlement price that is reduced but the supplier's management fee. Indeed, the supplier may offer a negative management fee and remain profitable thanks to the buyer's specific consumption profile when more electricity is consumed at night and purchased at a lower price than the settlement price. It turns out that negative management fees are often applied to buyers with "non-standard" consumption profiles.

This example documents that Transparent CRP value is not disputed but may be adjusted for technical or commercial factors like the delivery cost, payment terms, additional quality requirements, or supplier margins. Consequently, buyers may not even tender the full price but set a base CRP value and only tender the premium or discount against the CRP. A PM in a mining company explains:

> We did not tender the diesel price but only the premium. . . . We use a formula based on the average of the last week [Platts Diesel CRP] and the USD exchange rate.

Fourthly, the previous paragraphs suggest that Transparent CRP significantly streamline the price discovery process. A commodity trader explains:

> If we speak about energy coal with 6,000 kcal for power stations . . . then the [coal] index has made its way into the local market. For example, after a long price dispute, [X] has linked its local lignite deliveries to [coal CRP]. . . . We like trading based on [the CRP]. . . It makes haggling simpler.

On the downside, Transparent CRP may not be available to smaller players, as a PM of several thousand tons of coal complains:

> We cannot buy [coal] at ARA price here. We tried this argument, but suppliers said, 'Well, go ahead and buy a full ship in Rotterdam.'

Similarly, it may be impractical to separate the commodity content covered by the CRP from the total price, and suppliers may refuse to apply the escalator clause. A PM in the energy sector was disappointed to find out that the supplier refused any discussion:

> I spent one month breaking down our steel portfolio to individual grades and calculating the steel scrap and alloy content. [When] I presented the analysis to our suppliers and suggested a price escalator [based on LME CRP], they refused, arguing that this may be possible in the automotive industry where they trade directly with steel mills. But in our business, the price depends on the total steel product price, and nobody will ever accept my breakdown.

Finally, Transparent CRP are widely used as a reference price for a wide range of sophisticated CPM practices, e.g., setting the future delivery price based on a future CRP price, inserting the automatic price escalator clauses into long-term contracts, managing the price risk through hedging, setting up effective commodity price risk management along the whole supply chain, combining spot and forward purchases, separating the base price and commodity, or establishing CRP plus or minus models.

#### 5.2.3.5. Dazzle CRP transparency level

The Dazzle CRP transparency level is achieved by electric power futures traded on the EEX in Leipzig, non-ferrous metals quoted on the LME in London, or other highly liquid commodity exchanges. These CRP have imposed themselves as the transaction price and contract reference, as a PM responsible for aluminium and copper procurement explains:

> We set the [Aluminium] LME level directly in the e-auction pre-conditions. . . . This level also serves as the contract basis and is later adjusted with the actual [LME aluminium CRP] price.

Hence, there is no discussion about the Dazzle CRP accuracy, relevance, or reliability, which significantly simplifies the energy procurement job:

> I must send the supplier the print screen of the [actual electricity CRP] price valid at the moment of purchase within 15 minutes. They then send me back the confirmation that the trade was executed. It is simple and transparent for both sides.

The overlap between CRP and actual transaction prices is such that buyers often forget that they represent different phenomena: Dazzle CRP represent standardised transactions executed through the commodity exchange. In contrast, the physical deal between the buyer and the seller concerning the same commodity is a bilateral, over-the-counter transaction that may or may not be executed through the commodity exchange. A PM responsible for electricity in the paper industry highlights the costly consequences of mixing the two constructs:

> When our [electricity] supplier went bankrupt, we thought we would recoup our fixed tranches [bought at a very low price]. . . . [Unfortunately for us,] the supplier speculated and did not hedge [back-to-back] on the commodity exchange. We ended up losing everything.

The previous paragraphs seem to substantiate the claim that market participants effectively hand over the price discovery function to CRP issuers (e.g., Radetzki, 2013). However, the data reveals that this claim underestimates four important factors. Firstly, buyers determine the timing and modality of purchase and thus impact the actual realization price, as a PM of extrusion profiles explains:

> We can choose whether the [extruded aluminium profiles'] price is fixed for five-ton quantity or changes with every delivery or

> follows the LME [CRP] average. . . . [Depending on our choice,] the commodity price will be stable or volatile. . . . I combine all three methods [to manage the commodity price risk]: fixed quantity for the high-runners, the [CRP] average for the low-runners, and the spot for the service parts.

Secondly, similar to Transparent CRP, some CRP adjustments reflecting the grade or commercial terms may be necessary, as an energy PM highlights:

> Virtually every institutional buyer knows there is a PXE [energy exchange] . . . and compares our proposal to the wholesale [CRP]. . . . . Even if I explain to [customers] that their [consumption] profile is nowhere near the standard futures contract, they keep insisting on [applying the CRP].

Thirdly, business partners may deliberately disconnect from the CRP because it suits their business objectives, as a PM in a high-tech industrial goods company suggests:

> [An aluminium] supplier offers the possibility to buy commodity aluminium following their actual average purchases [instead of LME CRP based average]. Their traders tend to be a few euros better than the average. . . . It's not much, but with our volumes, it gives a nice little bonus.

Finally, small market participants may not be eligible for the Dazzle CRP, as experienced by a PM in the window business:

> Our supplier [of aluminium profiles] regularly updates the price list. They often justify the increase with the evolution of prices on the London commodity exchange. We challenged them, and they answered that they only offer aluminium price formulas to customers who can plan their purchases and are willing to commit volumes [which we are not].

To complicate matters even more, some Dazzle CRP may not be relevant to a local market, and market participants must get actively involved in the price discovery. For example, the natural rubber traded on the Shanghai commodity exchange is not considered accurate for the Czech natural rubber spot market due to local traders' outstanding stocks, as the PM responsible for rubber explains:

> The Shanghai [commodity exchange] is important because it determines the EU market. But you must also look at the current stock level and [the supplier's weighted average] purchase price. You follow the [CRP spot] price one-to-one only if your warehouse is empty. . . . [Therefore, local] buyers do not use the index argument very often. They determine the market prices through quotes from several suppliers.

Turning attention to other Dazzle CRP functions, the instant access to information mediated by the CRP minimizes the transaction costs for all market participants. For example, a PM procuring large volumes of aluminium and copper explains:

> We adapt [the aluminium] prices every quarter following the LME [CRP] and tender only the premium. . . . The LME is very useful because we know what the aluminium price is . . . and can easily calculate our costs.

In addition, any new market information is immediately incorporated into the CRP through the real-time adaptation of quotes. Hence, buyers do not have to study all available market information but may rely on the price signal to take the decision. Thanks to the availability of market information, buyers have time to focus on CPM strategic aspects, such as purchase timing, spot/forward ratio, or even arbitrage, as explained by a large energy PM:

> It is important to have access to different trading platforms [because] the official commodity exchange may offer a price X,

> but a brokers' platform [the OTC price quote] may tick twenty cents lower at the same moment.

Dazzle CRP also allow buyers to set up automatic price triggers like moving averages, stop-loss, and dollar averaging. Finally, the parallel existence of physical and futures trading facilitates effective financial hedging, which is appreciated by a beverage industry PM:

> The LME [CRP] allows us to hedge our risk without coordination with the supplier. The physical [aluminium] flow is settled at the monthly average spot price. In parallel, we hedge our positions through futures directly on the LME. The advantage is that we do not have to disclose our hedging strategy [to the market] and retain flexibility if we need more aluminium.

Despite the widespread data availability and its immediate impact on price, even Dazzle CRP may be subject to opportunistic behaviour, which leverages asymmetric information stemming from the subscription-based access to real-time CRP. A PM responsible for electricity explained:

> Our consultant subscribes to real-time electricity prices [provided by the EEX trading platform] where he can see the actual offers. [In contrast,] I only have a 15-minute delayed view, which is fine when the market is stable, but the supplier may abuse it and rip you off in a turbulent market. I remember we called our supplier, who quoted a price 30 cents higher than [the actual CRP level]. Normally, the supplier would get away with it. But our consultant saw it on the screen and started shouting and helped us secure the real price.

The rapidity with which real-time CRP change somewhat complicates the CRP anchoring function, as was subject to several complaints by an energy PM:

> Even when we buy at the real-time price, the realization price differs by a few cents, [because] when you submit the 'at the market' order, the exchange will match you with the best offer

> available which may be slightly higher or lower than the price valid a few seconds ago. [To avoid this], we tried the limit orders but got it wrong and missed the best moment to buy.

It may surprise that Dazzle CRP are not directly used for valuing holdings, perhaps because the updates are too frequent, unstable, and noisy. Instead, market participants prefer Transparent CRP that are updated daily and are carefully curated for any manipulation.

#### 5.2.3.6. Summary of CRP transparency level impact on CRP functions

CRP transparency levels have significant and varying impact on CRP function (see Table 45 for summary). Black Hole CRP transparency obviously precludes any CRP function and will be excluded from further considerations. In contrast, other CRP transparency levels allow CRP users progressively leverage a wider range of CRP functions with a higher level of sophistication.

Depending on the CRP Transparency level, the CRP anchoring function ranges from an approximate value for official documents through a benchmark to beat, to expected level of performance when any deviation has to be commercially or technically justified. Related to that, the CRP price discovery function may be rudimentary as one argument among many for the Opaque CPR transparency. Alternatively, it may function as the value around which the price discovery happens and therefore significantly streamline the price discovery. Moving one level higher, the Transparent CRP transparency level becomes the basis for the transaction price, only adjusted for technical or commercial reasons. Finally, the Dazzle CRP may partially overtake the price discovery function as the undisputed reference and equal the transaction price.

CRP also differ in their information content. Opaque CRP offer only an aggregated, helicopter view of the overall market and pricing. In contrast, the Translucent CRP transparency level already provides good insight in the

commodity market and its pricing, which however may lack the required depth and breadth. Moving to the Transparent CRP transparency level, the information content becomes comprehensive and market participants turn to it for authoritative market coverage and interpretation. Finally, Dazzle CRP transparency mediates real-time information about the trading, which is immediately incorporated into the CRP.

Interestingly, only the Transparent CRP transparency level is used for valuing holdings. Lower levels of CRP transparency may be too inaccurate or too infrequent for the purpose, while Dazzle CRP, another natural candidate, may be too noisy, fleeting, and vulnerable to manipulation. Hence, even the LME, where the settlement and official prices are based on trading, first submits the quotes to the quotations committee, which has to validate them officially.

Finally, the CRP transparency level influences the CRP suitability as a contract reference. On the downside, Opaque CRP are considered too inaccurate and, therefore, only rarely used in contracts by small players. Similarly, the Translucent CRP transparency level occasionally used in escalator clauses because the price revision mechanism requires regular adaptation to the changing market reality. In contrast, Transparent CRP are routinely leveraged in long-term contracts and are used for financial hedging. However, they may not be available to smaller players. The Dazzle CRP transparency level is systematically included in contracts and offers a wide range of options, e.g., long-term fixed price, escalator clause, facility for financial hedging.

| CRP Function: | Anchor | Price discovery | Information source | Valuing holdings | Contract reference |
|---|---|---|---|---|---|
| **Definition:** | Compare the outcomes of business activities | Process of arriving at a specific realization price | A platform for sharing private information | Valuation tool for accounting purposes | Contract term to manage price adaptation |
| **Black Hole** | No | No | No | No | No |
| **Opaque** | Indicative price level.<br><br>Cited for disclosure purposes to hide actual transaction prices. | Not widely known.<br><br>One argument among many in price negotiations. Potentially biased,<br><br>Some regional relevance,<br><br>Significant and unstable difference between the CRP and the transaction price. | Aggregated.<br><br>Helicopter view of market evolution and pricing. | No | Occasionally used in by small players to avoid haggling.<br><br>Cross-hedging with more transparent CRP. |

| CRP Function: | Anchor | Price discovery | Information source | Valuing holdings | Contract reference |
|---|---|---|---|---|---|
| **Translucent** | Negotiation benchmark to beat. | Significantly streamlines the price discovery.<br><br>Value around which the price discovery happens,<br><br>While the difference between the CRP and the transaction price may be substantial, its magnitude remains stable over time. | Detailed insight in selected market and price aspects.<br><br>Respected indicator of market trends. | No | Sometimes inform the escalator clauses albeit with regular benchmark and adaptation to the actual market price level. |
| **Transparent** | CRP as expected performance level.<br><br>Any difference to CRP has to be justified. | Basis for actual transactions.<br><br>Standardised price adjustment for grade, distance, or quantity. | Authoritative information source.<br><br>Comprehensive coverage of the market and prices. | Yes | Routinely used in escalator clauses.<br><br>May not be available to smaller players.<br><br>Allows escalator clauses and financial hedging. |

| CRP Function: | Anchor | Price discovery | Information source | Valuing holdings | Contract reference |
|---|---|---|---|---|---|
| | | The difference between CRP and transaction price (for the pure commodity) is very small. | | | |
| **Dazzle** | CRP as performance objective.<br><br>Any difference to CRP has to be justified. | Undisputed transaction price.<br><br>Minimizes CPM related transaction costs.<br><br>The CRP and transaction price are equal. | Real-time information sharing.<br><br>Different levels of disclosure are subscription dependent. | No | Systematically included into contracts.<br><br>Offers a wide range of commodity price risk management tools such as long term fixed price purchases, financial hedging, escalator clauses. |

**Table 45: CRP transparency level impact on CRP functions**

#### 5.2.3.7. Summary of CRP transparency level impact on CPM practices

Table 46 summarizes CPM practices observed in the interviews and classifies them into six CPM groups identified in Section 2.2.1. It suggests that CRP transparency levels have significant impact on the CPM practices' availability, suitability, and execution modalities.

Firstly, some CPM practices may be available only from a certain level of CRP transparency. For example, financial hedging is available for the Transparent and Dazzle transparency levels only. Secondly, some CPM practices may be available for all five CRP transparency levels but may be not suitable for some CRP transparency levels, e.g., speculative stock-piling does not make sense for commodities with Transparent and Dazzle CRP prices because it is more efficient to execute the same objective through the forward buy or opening position on the futures market, which do not require onerous warehousing costs. Thirdly, the same CPM practice is executed differently depending on the CRP transparency level. For example, Black Hole CRP transparency requires comprehensive and extensive market intelligence; in contrast, Dazzle CRP transparency summarizes the market consensus in the CRP signal, allows the technical analysis to draw inferences from the CRP signal evolution, and provides ample and readily available market information for the fundamental analysis.

| CPM Practice | Search | Sourcing | Contracting | Hedging | Active trading | Adaptation |
|---|---|---|---|---|---|---|
| **Black Hole** | Comprehensive market intelligence,<br>Cost models, | Complex bilateral negotiation,<br>Competitive bidding,<br>E-auctions | Fixed price contracts,<br>Spot prices,<br>Forward buy and stockpiling,<br>Piggyback contracts | Price-in volatility into product price,<br>Pass price risk to suppliers | Speculative stock-piling/ timing of purchases | New tender/ Renegotiation,<br>Absorb price movement |
| **Opaque** | Market search to discover “true market price”<br>Internal platform for information sharing | Routinised haggling with beat the index attitude | Fixed price contracts,<br>Spot prices,<br>Forward buy and stockpiling,<br>Escalator only for small quantities,<br>Producer prices | Price-in volatility into product price,<br>Cross-hedging | Speculative stock-piling/ timing of purchases | Renegotiation,<br>Absorb price movement |

| CPM Practice | Search | Sourcing | Contracting | Hedging | Active trading | Adaptation |
|---|---|---|---|---|---|---|
| **Translucent** | Triangulation of market search and CRP | Negotiation around the CRP value, discount/premium against the CRP | Escalator clause with Changed conditions/ Termination clause<br>Forward buy with delivery at maturity | Align upstream and down stream CPM<br>Price-in volatility into product price | Speculative stock-piling/ timing of purchases | Renegotiation,<br>Absorb price movement,<br>Substitutes |
| **Transparent** | CRP observation,<br>Fundamental analysis | Adopt CRP with adjustment for technical and commercial differences.<br>Separate the base price and fee and only negotiate the fee | Automatic price escalators,<br>Long-term fixed price,<br>Forward buy with delivery at maturity priced at futures curve,<br>Future delivery at CRP future price | CRP-based pass through along the supply chain,<br>Financial hedging | Timing of purchases | Internal coordination, |

| CPM Practice | Search | Sourcing | Contracting | Hedging | Active trading | Adaptation |
|---|---|---|---|---|---|---|
| **Dazzle** | CRP observation,<br>Technical analysis | CRP at face value,<br>Deliberately bypass the CRP | Automatic price escalators,<br>Long-term fixed price,<br>Spot market adjustment.<br>Automatic price triggers like stop-loss | CRP-based pass through along the supply chain,<br>Financial hedging | Timing of purchases,<br>Speculative open positions,<br>Active trading through buy and sell | Buy more/less futures on commodity exchange,<br>Transfer booked quantities to a new supplier,<br>Hedging by separating financial and physical flows, |

**Table 46: CPM practices observed at different CRP transparency levels**

# 6. Discussion

This chapter discusses the theoretical and practical implications of the Commodity Reference Price (CRP) construct and CRP Transparency Index. It is split into three sections. The first section focuses on the CRP construct. The second section discusses the impact of CRP transparency on CPM practices.

## 6.1. CRP transparency

This section discusses the theoretical and practical implications of CRP transparency for several research streams. Firstly, it answers the Research question 1. Subsequently, it extends the research on reference prices and provides a finer-grained analysis of the relationship between transaction and reference prices. Next, it considers the implications of the multidimensional conceptualization of the CRP transparency concept and shows how this holistic view of CRP transparency enhances our understanding of CRP functions. Subsequently, the methodological challenges of CRP transparency assessment are discussed, and the way forward is indicated. The next two sections discuss the highly topical and theoretically poorly grounded question of improving the CRP transparency level. Finally, CRP rightsizing is discussed as a legitimate alternative to the relentless improvement of CRP transparency level, considering the barriers to CRP improvement.

### 6.1.1. Answering Research Question 1

CRP was explored as a fundamental but underresearched influencing factor that shapes CPM practices: their internal structure, availability, and suitability. However, the literature review showed that the CRP construct was poorly understood. Hence, to investigate the CRP impact on CPM practices in depth, it

is necessary to conceptualize the construct and identify its measured attributes. To achieve this research objective, Research Question One was proposed: *Considering CRP as a CPM influencing factor, what is the suitable commodity reference price conceptualization and measured attributes?*

The question was addressed in Chapter 4. Firstly, CRP transparency emerged as the most suitable CRP conceptualization and was grounded in existing transparency research. Subsequently, its measured attributes were identified through a combination of intuitive, interpretive, and empirical approaches. Finally, suitable CRP transparency attribute labels were determined through a combination of expert interviews and terminological literature recommendations.

This work empirically determined that CRP transparency is a multi-dimensional construct with four complementary and non-overlapping CRP transparency attributes:

*Accuracy* is defined as “the conformity to the actual or potential transaction prices” and highlights the efficiency with which a CRP aggregates and disseminates the price information to market participants.

*Completeness* was defined as “the breadth and depth of market information disclosed to market participants” and emphasises the amount of data the CRP mediates to market participants.

*Publication frequency* was defined as “the commodity reference price publication frequency” and informs about the frequency with which a CRP update is issued.

Finally, *Methodology* is defined as “a set of methods and principles used to determine the CRP” and underscores the quality of the CRP determination process.

In contrast, other potentially relevant CRP transparency attributes: *Accessibility*, *Representational transparency*, and *Acceptability* were not

considered important enough, distinctive enough, or both, and were therefore discarded.

### 6.1.2. Downsides of unidimensional view of CRP transparency

Previous research approached CRP as a unidimensional construct and focused on improving just one measured attribute. However, this research suggests that this strategy may be problematic, only marginally improve the overall CRP transparency, result in imbalanced CRP similar to Wood CRP issued by the Czech Statistical Office, and even hamper CRP utility.

Despite these reservations, unidimensional perspective may be warranted under very specific circumstances. For example, a group of energy agencies undertook a comprehensive task to assess the quality of oil benchmarks and suggested and implemented measures to improve their quality (IEA et al., 2011; IOSCO, 2013, 2015). Their effort concentrated on improving the CRP methodology, particularly operational, methodological, and governance enhancements. This single-minded focus on CRP methodology was warranted for two reasons. Firstly, the regulator assumed that by improving CRP methodology, they would automatically improve CRP Accuracy, e.g.,

“[Improving CRP methodology] is relevant for the *reliability* of PRA assessments … as an indicator of the underlying market values … accurately reflects the transactions in the market“ (IOSCO, 2013: 5-6).

Secondly, the project focused primarily on CRP that occupy the Transparent and Dazzle transparency levels which already have a very high level of CRP publication frequency and completeness. Hence, other CRP transparency attributes were not salient for the business problem.

The overreliance on a single CRP facet, such as CRP issuer reputation or CRP availability, as a proxy for CRP quality is potentially risky. For example, the Czech Ministry of Regional Development recently published a recommendation for public sector buyers concerning the price revision formulas for large

construction projects. The document places several CRP on the same quality level: the CRP issued by the London Metal Exchange, quarterly construction indices and consumer inflation by the Czech Statistical Office, and two monthly construction CRPs issued by private companies. Subsequently, the document recommends that public sector buyers use a series of quarterly construction indices published by the Czech Statistical Office, a well-respected institution:

“[to use the Czech Statistics Office] data on construction price indices, construction work price indices, and construction production cost indices … [however,] the buyer must determine which of the published indices is the most appropriate one.” (MMR-CZ, 2021).

However, the CRP transparency index reveals that recommended CRP differ in the level of transparency and, subsequently, suitable use. CRP issued by the London metal exchange probably witness Transparent or Dazzle transparency levels, and are suitable for escalator clauses. In contrast, despite the Transparent CRP methodology of construction indices published by the Czech Statistical Office, the CRP is published only quarterly (Opaque CRP publication frequency) and contains very high-level segmentation of construction works such as schools or hospitals (Opaque CRP completeness). Furthermore, based on the author’s private conversations with industry insiders, these indices are considered Opaque regarding CRP accuracy. Hence, in line with how practitioners use CRP occupying the Opaque transparency level, the CRP should be used as one argument among many but certainly not as a contract reference at its face value.

Finally, concentrating on a single CRP attribute while ignoring the others may backfire and lead to imbalanced CRP which may be less useful for market participants. The downside of an imbalanced CRP is clearly visible on the wood CRP by the Czech Statistical Office, which witnesses transparent methodology but only an Opaque CRP transparency level with other CRP attributes. Consequently, practitioners judged it unsuitable for some CPM practices, such as escalator clauses.

### 6.1.3. Benefits of multidimensional view of CRP transparency

Considering the risks related to unidimensional CRP conceptualizations highlighted in the previous section, multidimensional CRP transparency conceptualization significantly advances the understanding of CRP quality. Chapter 4 offers an extensive review and justification of each CRP transparency attribute, and Chapter 5 shows that the combination of four CRP transparency attributes offers a rich and holistic view of the CRP transparency construct.

Multidimensional CRP conceptualization meaningfully integrates the scattered proposals for CRP improvement which focus on only one CRP transparency attribute: methodology (IEA *et al.*, 2011; IOSCO, 2013, 2015; Rauterberg and Verstein, 2013; Verstein, 2015; Aspris, Foley and O'Neill, 2020), publication frequency (Figuerola-Ferretti and Gilbert, 2005), or completeness (Cinquegrana, 2008; UNCTAD, 2011; Veerman *et al.*, 2016).

Instead, CRP issuers can leverage CRP transparency multidimensionality to balance the CRP. For example, Moravia Steel or Sopisco News might adopt some methodological improvements recommended by IOSCO (2013, 2015). Similarly, the Czech/ Slovak cable industry association might improve the CRP completeness with more regional prices and background information about the local market recommended by Veerman *et al.* (2016).

Furthermore, multidimensional CRP conceptualization explains why it makes sense for commodity exchanges to increase CRP completeness to Dazzle by introducing futures contracts (CME, 2021; LME, 2022), and, in parallel, license CRP assessments by reputed PRA (Johnson, 2017). From the CRP transparency perspective, PRA reporting temporarily improves CRP accuracy, methodology, and publication frequency, which the low number of transactions might otherwise hamper during the CRP introduction period when the market liquidity is low. Hence, by leveraging the multidimensional CRP perspective, the combination of futures trading and PRA reporting achieves "the prevalence of financial markets with a sufficient number of participants … clearly defined specifications and a rich history of being traded on financial markets" (Gaudenzi et al., 2018: 11) which is key for high levels of CRP transparency.

Similarly, the following example, inspired by international arbitration between European Communities and South American exporters, documents that the simultaneous consideration of all four CRP transparency attributes provides valuable insight into a CRP quality analysis and a robust basis for assessing whether the CRP is fit for the intended use.

In the original ruling, the arbitrator accepted the European Communities' assessment of Sopisco News CRP as a relevant and reliable source of the banana prices. CRP quality criteria applied by the arbitrator were not explicitly stated but could be inferred from the ruling: (a) CRP issuer motivation to provide reliable prices to attract subscribers, (b) CRP public availability, wide recognition and dissemination, (c) the CRP is considered an accurate estimation of market prices (WTO, 2005).

In contrast, the analysis grounded in the CRP transparency attributes suggested by this research would provide a more objective basis for deciding whether the CRP is fit for purpose. Detailed analysis of the Sopisco News CRP (see Appendix 1) shows that the CRP would qualify as Translucent, suggesting that the CRP is an adequate proxy of general market prices around which the transaction price is negotiated. However, the CRP should not be accepted at its face value and inform automatic escalators. Hence, combining the four CRP transparency criteria gives the arbitrator a good understanding of the CRP transparency level, suitable use, and a robust basis for the ruling.

Furthermore, the existence of a battery of CRP whose CRP transparency level was already assessed would avoid similar legal battles or at least significantly streamline the assessment procedure engaged by the arbitrator.

### 6.1.4. Improving CRP Transparency level

Scholars and practitioners call for the improvement of the CRP transparency level (e.g., Cinquegrana, 2008; Rauterberg & Verstein, 2013; European Commission, 2011; IEA et al., 2011; Veerman et al., 2016), and many improvement measures were proposed (see Section A.14 for detailed outline).

This section discusses the merits of different CRP transparency improvement initiatives in the light of the CRP transparency index.

**Improving a single CRP transparency attribute**

The easiest way to improve the overall CRP transparency level is by focusing on a single CRP transparency attribute. The downsides of this approach were discussed in Section 6.1.2. and can be illustrated with a hypothetical example of argon.

Let us assume that transactions and contracts are concluded throughout the year, and market participants call for a reliable anchor and contract reference. Therefore, the regulator requires USGS to adopt the IOSCO principles (2013, 2015) recommended for argon in the hope that the argon CRP will assume the anchoring, contract reference, and information source functions. In consequence, the CRP methodology attribute improves to the Transparent transparency level. Nevertheless, despite this effort, the overall CRP transparency assessment remains Opaque because the CRP remains published only once a year (Black Hole Publication Frequency), provides little actionable information about the market, regional prices, or price trends (Opaque Completeness), and CRP accuracy remains reliable only for a short time (Opaque CRP Accuracy). Consequently, the CRP will not live up to its ambition and will probably remain ignored by most market participants.

At the same time, this research also provides evidence that even imbalanced CRP may be fit for purpose if the mix of CRP attributes is carefully calibrated, e.g., Diesel CRP by the Slovak Statistical Office or Steel CRP by MEPS where one CRP transparency attribute was overweighted to achieve specific objectives (see Section 5.2.2.3.for detailed outline). Hence, CRP issuers may improve CRP utility by improving just one CRP transparency attribute.

This was the case with lithium, whose CRP completeness was enhanced while other CRP transparency attributes were temporarily left unchanged. Lithium forms a significant portion of lithium-ion battery cost (CME, 2021). Maxwell (2015)

predicted that lithium would be introduced to commodity exchanges because its global volume reached critical mass and the industry structure was sufficiently decentralized. Furthermore, there was a growing demand from companies for enhanced price discovery and facility for managing lithium commodity price risk.

The CME Group, a major financial derivatives exchange, introduced lithium hydroxide futures contracts in May 2021, followed by the LME in July 2021 (LME, 2022). The availability of futures and the forward curve made financial hedging possible, greatly improving CRP completeness. In contrast, the CRP accuracy, publication frequency, and methodology level remained (temporarily) the same as the futures settlement price is not informed by trading- perhaps due to the low initial level of trading- but by a reputed PRA agency specialized in lithium. However, one may reasonably expect that the quotation-based price discovery will prevail as lithium hydroxide trading gains momentum. Similarly, the CRP publication frequency is maintained once a day for the CME Group and once a week for the LME, which currently suits the business needs of companies looking for long-term hedging. Finally, the CRP methodology remains on the Translucent level, which may suit the lithium market structure.

The lithium hydroxide example and the introduction of cobalt, molybdenum, aluminium scrap to the LME support Radetzki´s (2013) prediction about the relentless progress of commodity exchanges which generate the CRP with the highest CRP transparency levels. However, the example also suggests that the CRP transparency improvement is gradual and passes through an intermediate stage, when the CRP completeness is enhanced and only later followed by other CRP attributes.

The improvement of a single CRP transparency attribute will have differing impact on the aggregate CRP transparency level due to the uneven cut-off points. It is particularly significant for the Black hole CRP transparency level because any improvement means that the CRP moves to the Opaque CRP transparency level.

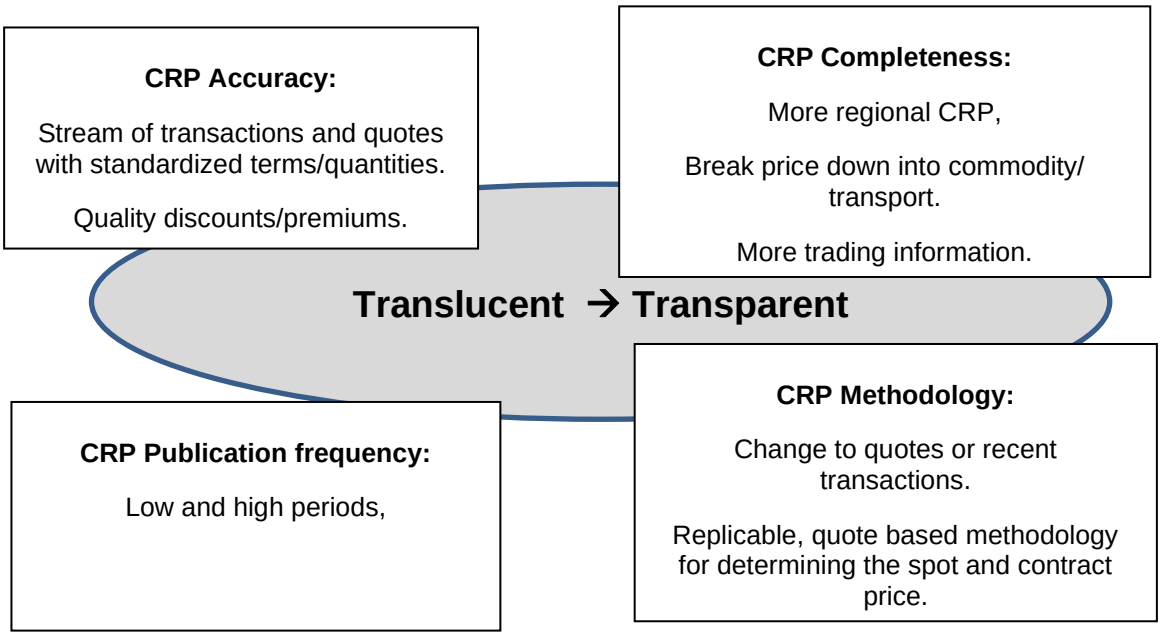
The model is not immune against “manipulative” improvements of a single CRP transparency attribute by 2 or more points. However, such improvement is

difficult to implement without improving other attributes as well. For example, Dazzling Publication frequency will probably require more transparent methodology and will trigger greater accuracy.

**Improving multiple CRP transparency attributes**

Extant literature outlined several examples of a coordinated leapfrog increase of several CRP transparency attributes. In particular, Radetzki (2013) and Figuerola-Ferretti & Gilbert (2005) show how the aluminium CRP moved from producer-posted price through PRA reporting to commodity exchanges. This radical increase was motivated by fundamental market structure changes and the evolution of CRP consumers' business requirements.

The dynamics of the aluminium CRP transparency improvement process could serve as a blueprint for other CRP issuers interested in improving the aggregate CRP transparency level. For example, the Translucent CRP transparency level occupied by many chemical CRP could move to the Transparent CRP transparency level through simultaneous and meaningful improvement of all four CRP transparency attributes suggested in Figure 13.



Starting with CRP *publication frequency*, it makes little sense to increase the overall CRP publication frequency for most chemical CRP, as prices tend to be negotiated monthly or quarterly. However, during the active purchase window (Kingsman, 1986), typically the last few days of the month for the spot price and the last weeks of the quarter for the quarterly contract price, the CRP issuer could set up a platform where buyers and sellers would post their quotes and recent transaction information. This platform would be similar to the marketplace model recommended by Hofmann (2011) through which market participants access suppliers and offers.

Regarding **CRP completeness**, an online platform that immediately shares

**Figure 13: Example of coordinated improvement from Translucent to Transparent CRP transparency level. Source Author.**

important commodity information might be complemented with relevant regional prices emphasised by Veerman *et al.* (2016). Furthermore, the CRP could inform transport prices or quality premiums/discounts. In addition, the addition of trading on a commodity exchange would enhance CRP completeness with financial hedging and a forward curve. CRP completeness was particularly

**CRP methodology** might evolve from statistics of past evolution to quotes or recent representative transactions selected based on a replicable methodology. In addition, IOSCO's (2013) methodological recommendations might be adopted to increase confidence in the data quality.

Finally, concerning **CRP accuracy**, standardization of commodity specifications, terms, and quantities would make quotes and transaction prices comparable. Anonymously communicated quality discounts/premiums would make prices even more reliable and easy to interpret.

In summary, CRP issuers may leverage two strategies for improving the CRP transparency level. They may focus on a single CRP transparency attribute and create an imbalanced CRP, which is, however, perfectly fit for a specific purpose.

Alternatively, they might adopt a holistic approach to CRP transparency improvement and simultaneously increase the transparency level of all four CRP transparency attributes.

Unfortunately, the author cannot recommend a universally valid improvement process, because every CRP is issued in a specific context and has a specific mix of CRP transparency attribute levels and what works for one may backfire for a seemingly equivalent CRP.

### 6.1.5. Limitations to CRP transparency improvement

Extant research shows that more transparent CRP progressively eliminate their less transparent siblings (e.g., Figuerola-Ferretti & Gilbert, 2005; Radetzki, 2013). This is understandable since the findings corroborate and extend numerous advantages related to high levels of CRP transparency identified by Radetzki (2013b). Yet, there are still commodities that do not have a CRP, and many CRPs occupy the Opaque and Translucent CRP transparency levels, which preclude market participants from reaping the benefits of highly transparent CRPs.

One possible explanation for this puzzling fact is evolutionary. Lower-level CRPs represent a stage of CRP evolution towards Dazzle CRP transparency. This explanation is supported by many CRPs that progressively improve, e.g., aluminium (Figuerola-Ferretti and Gilbert, 2005; Radetzki, 2013b), lithium (Maxwell, 2015), gas (Roeber, 1996), iron ore (Wårell, 2014), oil (Fattouh, 2011). On the downside, these examples may represent isolated “success stories,” a few dozens of widely known and discussed CRPs issued by commodity exchanges that hide tens of thousands of CRPs issued by PRA, which are virtually unknown to the non-professional public (Johnson, 2017).

An alternative explanation is that there are legitimate reasons why more transparency is not better, and some latent variables hamper CRP transparency improvement. For example, these “hidden factors” resurface when one juxtaposes the scholarly and practitioner view on CRP publication frequency:

Scholars argue that higher CRP publication frequency improves market transparency and efficiency through faster absorption of new information into the CRP (Figuerola-Ferretti and Gilbert, 2005; Radetzki, 2013b). In contrast, this research shows that practitioners advocate meaningful CRP publication frequency that reflects their business needs and prefer the daily Transparent to real-time Dazzle CRP publication frequency for convenience reasons. Findings show that even very large buyers with sophisticated procurement processes and skills agree that Dazzle CRP publication frequency leads to information overload.

Triangulation of extant literature and findings identified several sources of legitimate barriers to "relentless" CRP transparency improvement advocated by Radetzki (2013):

Firstly, extant research convincingly challenged the Information transparency hypothesis assumption that open information sharing, measured as the degree of visibility and accessibility of information (Zhu, 2005), is beneficial to all market participants (Zhu, 2004) and demonstrated that information transparency is a double-edged sword (e.g., Reischauer & Ringel, 2023; Molnár et al., 2013). Hence, the benefits of a high CRP transparency level are contingent on the market structure (Molnár *et al.*, 2013): in competitive markets, they promote efficient allocation of resources; however in concentrated markets, they may foster collusion among buyers/sellers, price fixing by professional associations, and accentuate seller's information asymmetry. Sellers could, for example, collude by pre-announcing price changes and thus align their negotiation strategy (Marshall et al., 2008).

There is strong support for this argument in the findings; in particular, for the Opaque and Translucent CRP transparency levels where buyers complain about the collusion among sellers. Three manipulation-enhancing factors identified by Rauterberg and Verstein (2013) were found in the data, suggesting that CRP manipulation is a pervasive problem. For example a PM highlighted manipulation by a data source: "as luck would have it if the demand is slow, there is always an accident in one of the plants." Some respondents even suspect the conflict of interest by the sellers: "[the CRP] is falsified by the sellers … to delay price

decreases … [in the hope] they find a fool who buys at the index price." Finally, one respondent suspects CRP manipulation related to the quality of the benchmark methodology: "big [German] energy producers know how to game the rules … they can easily manipulate the spot price." At the same time, it should be noted that most observations were based on respondents' subjective assessments, and only limited first-hand evidence of manipulative behaviour was provided to substantiate the claims.

In addition, some sellers may prefer non-transparent prices because market knowledge is a major source of their competitive advantage (Humphreys, 2011). This argument resonated with respondents, particularly for steel, packaging paper, and hydrochloric acid. Following the same logic, one respondent argued that price reporting agencies might prefer less transparent prices because they make their services more valuable.

Finally, customers may also oppose increased CRP transparency for a variety of reasons: they are happy with the current level of CRP transparency, which grants them control and opacity of their product pricing, they fear increased commodity price volatility, they lack experience with managing transparent CRPs (Radetzki, 2013b), or they believe they hold asymmetric information and can achieve lower prices than the rest of the market (Jones et al., 2007).

However, this research found no supporting evidence for this argument. In contrast, respondents argued that low CRP transparency complicated the customer pass-through because customers did not believe the evidence of downstream price increases presented by the sellers.

Secondly, CRP transparency contributes to turning products and services into commodities where the price remains the only selection criterion (Bertini and Wathieu, 2010). This argument is especially relevant for pseudo-differentiated commodities, which sellers present as differentiated products but actually lack tangible differentiating attributes (Enke et al., 2012). The buyer-induced commodification manifests itself in the data through price breakdown requests that isolate the commodity from the rest, pegging it to a CRP evolution. In addition, buyers push sellers to commodify the added value portion by linking it

to a transport index, energy exchanges, or reference prices that track key added value activities such as the billet premium.

Thirdly, stringent regulatory CRP transparency requirements may discourage market players from sharing information that explains their activity and fosters the dialogue about where the prices are moving (Stewart, 2013). Hence, CRP transparency is hampered because market participants can see the numbers but struggle to understand their meaning.

This research supports this argument and shows that buyers are extremely worried about unmanaged transparency required by CRP regulators, defined as disclosure at one's own discretion and uninhibited by others (Reischauer and Ringel, 2023). Therefore, they require absolute anonymity before they disclose any information, limit the breadth and depth of information disclosed to the market, take measures to delay information submission, and deliberately provide incomplete or biased information to conceal their real trade intentions.

Fourthly, commodity exchanges are difficult to set up, expensive to run due to oversight and clearing requirements, and face difficulty attracting enough users because market participants may be extremely resistant to changing existing business practices. Hence only the most liquid and standardized commodities are traded on commodity exchanges (Johnson, 2017), while the vast majority of "smaller" commodities are covered by less transparent CRPs issued by PRA.

The findings give some support to this argument, e.g., a large plastics resin buyer noted that only simple, commodity resins were traded on commodity exchanges. In contrast, other grades may involve "microscopic quantities" of several thousand tonnes per year, cannot be completely standardized, have only a few buyers and sellers, and have a long private, bilateral trading history. Hence, he was sceptical that these commodities ever become traded on commodity exchanges.

Finally, the findings nuance the optimism of Rauterberg & Verstein (2013) or Roeber (1996) that the invisible hand of the market will resolve Blackhole CRP transparency because PRA will step in as soon as there is sufficient demand.

Despite PM calls for CRP covering major technical gases, there is no relevant regional CRP. Regulatory involvement recommended by Cinquegrana (2008) may be the only realistic solution for commodities that face obstacles discussed in this section.

In summary, there are compelling reasons for the existence of lower levels of CRP transparency. While these limitations do not challenge the validity and relevance of the CRPTI index, they highlight the fact that (1) CRP will not automatically improve their transparency level over time and that there may be important institutional pressure and barriers to keep them a specific transparency level or even preclude a CRP from emerging, (2) different levels of CRP transparency may coexist for a particular commodity, as documented by the multiple steel CRP, serving different business needs and informing different CPM practices.

It follows that the relentless progress toward CRP generated by commodity exchanges (Radetzki, 2013b) will not be automatic, smooth, and universal. More likely, the push for more or less CRP transparency will stem from an evolving market structure and CRP user requirements as described by Roeber (1996), regulatory measures as demonstrated by Koontz and Ward (2011), or even random incidents such as the emergence of a more transparent CRP as a by-product of some other activity.

### 6.1.6. CRP transparency level: Fitness-for-purpose perspective

The previous section outlined legitimate reasons why the relentless improvement of CRP transparency may not benefit all market participants. This section develops the argument further and considers the concept of punctuated equilibrium where the level of CRP transparency and the configuration of CRP transparency attributes is contingent upon the social benefits the CRP transparency should achieve, the intended CRP users, and the CRP issuer objectives (Rauterberg & Verstein, 2013).

Following CRP transparency right-sizing logic advocated by Rauterberg & Verstein (2013), CRP issuers should not aspire to achieve the highest possible level of CRP transparency. Instead, they should configure individual CRP transparency attributes to achieve an optimum CRP that is fit for purpose. The data provides overwhelming evidence that practitioners adhere to the idea of CRP right-sizing. For example, Steel CRP by SteelBenchmarker are accurate enough to mediate the market trend for a CRP that is distributed free of charge; Steel CRP by MEPS is considered an acceptable trade-off between CRP completeness and accuracy; Electricity Settlement CRP is preferred to Dazzle real-time CRP for convenience reasons; and methanol CRP Translucent publication frequency is more than sufficient for the quarterly contract price negotiations.

However, the fundamental question is who determines what represents a fit-for-purpose CRP transparency. Stakeholder management theory (Freeman *et al.*, 2010) recommends stakeholder influence visualising and mapping to determine the most important stakeholders, understand their needs, and decide whether and how to address them in a most efficient way. While extant literature does not provide a list of CRP stakeholders, they can be easily inferred: CRP issuers (Rauterberg & Verstein, 2013), CRP consumers (Roeber, 1996), CRP regulators (Cinquegrana, 2008), reporters and respondents (Johnson, 2017). The following section will consider the former two since no relevant insight was gained regarding the other three.

Rauterberg & Verstein (2013) advocate the most intuitive answer which assigns the responsibility for the CRP right-sizing to CRP issuers and their objectives. The prevalence of marginally disbalanced and imbalanced CRP observed in the sample gives some support to this claim. For example, CRP issuers may decide on Dazzle CRP accuracy thanks to frequent and comprehensive updates. Alternatively, they may consider CRP accuracy as just one virtue among many and trade it off for other legitimate objectives such as CRP stability and consistency (Rauterberg & Verstein, 2013).

CRP transparency´s fitness for purpose may also be assessed from the perspective of CRP consumers (e.g., Roeber, 1996; Veerman *et al.*, 2016). However, Radetzki (2013) shows that CRP consumers have contradictory expectations and CRP right-sizing becomes highly contextual. For example some market participants may require stable and methodologically robust CRP; others may seek dynamic and accurate CRP; still others may prefer inaccurate CRP to maintain an asymmetric information advantage (Rauterberg & Verstein, 2013).

This research finds evidence of diverging stakeholder expectations. For example, a large steel PM prefers a wide CRP range, “which I can beat to show my value for money.” While a small stainless steel buyer would prefer “the exact EXW [INCOTERMS] price to avoid [competitive] disadvantage.”

The relevance of CRP transparency fitness for purpose is reinforced by the co-existence of Steel CRP that cover the Opaque, Translucent, and Transparent CRP transparency levels which are configured for different objectives, audiences, and market segments. Therefore, steel CRPs embody prosthetic prices produced at temporally and geographically specific places that market participants leverage to discover their specific transaction price (Caliskan, 2007). Hence, it is logical that these CRP will show diverging configurations and appeal to different stakeholders.

However, observing how practitioners use steel CRPs also reveals the fundamental weakness of CRP transparency fitness for purpose—the blind spots. Indeed, none of the steel CRPs is sufficient, not even the internal steel market report tailored to the company’s needs. Buyers, therefore, subscribe to at least two CRPs and triangulate them to compose a comprehensive picture of the market and prices. A PM observes:

> “I consult MEPS, Platts, the internal steel report and compare it to the information I get from the media, suppliers and fellow buyers and then determine the purchase strategy. … [And] we purchase a comprehensive steel market forecast from [X] before the annual negotiations.”

Finally, CRP transparency fitness-for-use may be considered from the perspective of relevant contextual factors and dynamically evolve with the change of these factors. For example, Radetzki (2013) shows how new entrants disrupted the stable system of producer-posted aluminium prices, which became progressively less accurate due to secret discounting. The demand for more accurate CRPs was initially met with more frequent updates and was progressively supplemented by commodity exchanges. In contrast, Maxwell (2015) shows that the arrival of new lithium suppliers disrupted the existing level of CRP transparency, and widespread secret discounting downgraded the CRP to the Opaque transparency level.

In summary, CRP fitness-for-purpose and different drivers that determine CRP configurations could be the missing piece of the puzzle which explains why CRPs do not exist for some commodities and why CRPs occupy all five CRP transparency levels. At the same time, the existence of blind spots is a strong argument for pursuing the ideal of Dazzle CRP transparency.

The CRPTI developed in this study provides CRP issuers and users with an actionable model for right-sizing the CRP transparency level by reconfiguring the CRP transparency attribute levels. At the same time, it allows them to estimate the impact of these changes on the overall CRP transparency level and the impact for business practice.

### 6.1.7. Extension of reference price research

While previous sections concentrated on the main research question, this section discusses how CRP transparency extends the existing reference price research.

Lowengart (2002) notes that most reference price research focuses on internal reference prices, and his taxonomy provides a fine-grained two-level categorization of internal reference prices while external reference prices are treated as a single undifferentiated group. Building on the taxonomy, this research first positions CRP as a distinct type of external reference price

applicable only to commodities (see Figure 14). This positioning is coherent with Rauch (1999), who argues that CRP is structurally different from reference prices for differentiated products. Subsequently, CRP is meaningfully classified into five categories depending on their transparency level, determining their functions and suitable use in business practice.

Digging deeper into individual CRP transparency levels, a more detailed categorization might inform specific CRP mechanisms. However, the limited research sample of CRP does not allow for discussing the suitable finer-grained segmentation criteria. Hence, Figure 14 only tentatively suggests a segmentation into Product, Public, and By-product CRP suggested by Rauterberg & Verstein (2013) based on the CRP issuer type and potential CRP vulnerability. However, other relevant segmentation criteria are plausible, such as the price discovery mechanism outlined by Maxwell (2015) or Radetzki (2013). This lack of guidance concerning CRP segmentation suggests that the CRP research field is still in its infancy, and more research is needed to understand this fundamental institution of CPM.

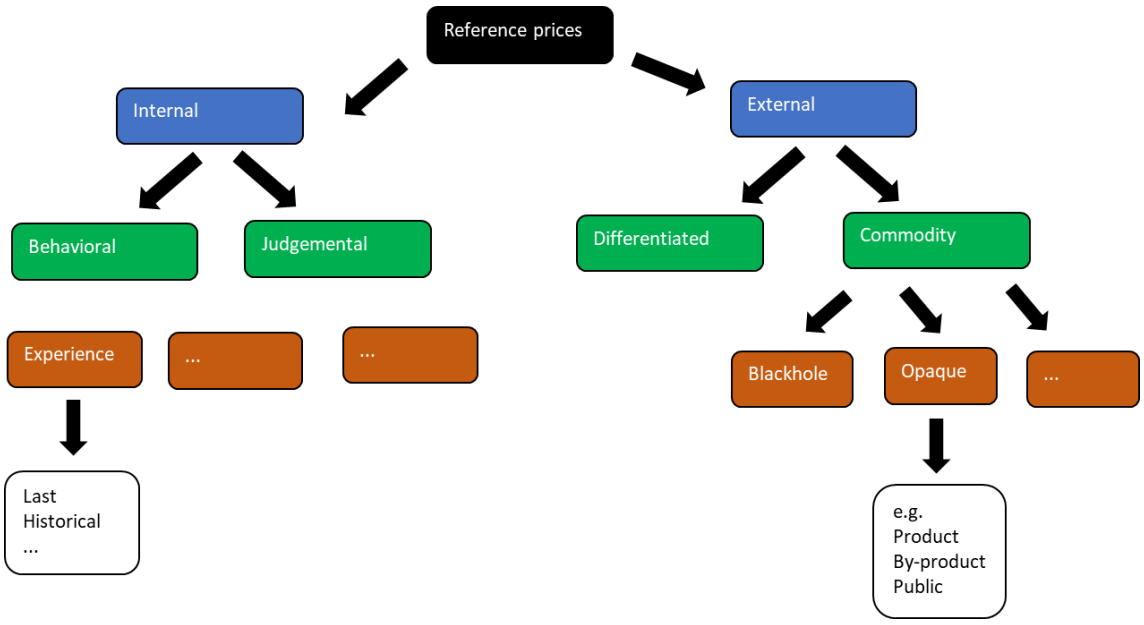



**Figure 14: Extended taxonomy of Reference prices, adapted from Lowental (2002)**

Secondly, this research supports the argument that CRP are structurally different from transaction prices (Caliskan, 2009). CRP denotes standardized product quality and terms, while the transaction price accounts for specific products and terms. For example, even though 70% of oil trade is referenced against the Brent CRP, the final transaction price has to be adjusted to oil density and sulfur content, and these discounts and premiums tend to be extremely volatile (Fattouh, 2011). Hence, in the most generic sense, the transaction price stands for the exact value at which the buyer and seller settle the trade, while CRP only represents the possibility of trading the commodity, a prosthesis to discover the actual transaction price (Caliskan, 2009): “At this point, the trader poses his final question: ‘Do you want a quote or a firm offer?’ By doing so, the trader wants to learn whether the buyer is after his price of SLM, or whether he is just inquiring about the general prices.” (Caliskan, 2009: 243).

From this perspective, poor CRP quality reported by market participants in Nguyen & Arnsdorf (2013) may result from ignoring the structural difference between the CRP and Transaction prices. For example, nickel CRP quoted on LME represents a highly standardized futures contract with the financial settlement. In contrast, an over-the-counter transaction involves additional administrative and physical delivery costs, specific terms, and risk. Hence, it is conceivable that the “quote” will always slightly differ from the “general prices.”

Scholarly research unintentionally increases the confusion between the CRP and transaction price by systematically assuming that CRP is equivalent to transaction prices and using CRP in simulations and analyses. For example, Hofmann (2011:134) uses the aluminium, steel, and oil CRP monthly averages as “approximate market prices” to illustrate the principles of commodity price risk for SMEs. Similarly, Christopher & Holweg (2011) leverage CRP to construct the Supply Chain Volatility Index to explore historical supply chain volatility and highlight increased environmental turbulence in recent years. While this confusion may not be problematic for Dazzle CRP, it may invalidate recommendations for less transparent CRP. For example, a researcher, who does not understand that the size of the discount against an Opaque CRP may

vary significantly depending on the phase of the business cycle, might recommend an escalator clause which would, however, increase adaptation-related transaction costs.

Data revealed that market participants recognize the structural difference between the two constructs and the implications of different levels of CRP transparency (see quotations in Section 5.2.). Consequently, they do not accept a CRP at its face value when they should fiercely search and negotiate for the "true" transaction price level, do not insert a low transparency CRP into an escalator clause and create adaptation problems. A few exceptions to this rule were observed: Section 5.2.3.5. mentions examples when small or geographically distant buyers do not have access to Dazzling CRP price as the transaction price. Similarly, less informed or smaller buyers of the Opaque and Translucent commodities mistakenly accepted the CRP at face value in the contract, e.g. a PM in a processing company said:

> "The contract clause refers directly to the quarterly CRP value called the "contract" … the [transaction] price is automatically updated at the beginning of each quarter as soon as the new CRP "contract" value is known."

To assist practitioners, this research provides new insight into the relationship between CRP and transaction prices by documenting that the difference decreases with the growing CRP transparency level (see Table 45 in Section 5.2.3.6.) and may even equal zero for standardized, financially settled transactions referenced to Dazzle CRP. Implications for the theory and practice of this empirical observation are summarized in Table 47 and are coherent with Caliskan's (2009) argument that CRP are created for different purposes and inform price discovery in different ways.

| Commodity reference price transparency level | Guidance for practitioners | Guidance for scholars |
|---|---|---|
| Black Hole | - | - |
| Opaque | Significant and unstable difference between the CRP and the transaction price. | CRP unsuitable as a market price proxy. |
| Translucent | While the difference between the CRP and the transaction price may be substantial, its magnitude remains stable over time. | CRP is a suitable indication of the overall trend but not of the market price. |
| Transparent | The difference between CRP and transaction price (for the pure commodity) is very small. | Suitable market price proxy. |
| Dazzle | The CRP and transaction price are equal. | Very suitable proxy for market price. |

**Table 47: Recommended commodity reference price use in business practice and scholarly research**

### 6.1.8. Challenges of CRP Transparency assessment

This section reflects on the challenges related to CRP transparency assessment. While the assessment of CRP publication frequency, methodology, and completeness was straightforward, CRP transparency assessment for accuracy encountered three challenges that may have important implications for the smooth operation of the CRPTI and should be therefore considered in some detail as potential limitations of the model: (1) resource intensity, (2) accuracy differences within a single CRP report and (3) the reliability of market participant assessments.

**Resource intensity.** Multiple interviews with procurement and sales professionals were conducted to assess the CRP transparency attribute “accuracy” qualitatively. The assessment of CRP accuracy level proved relatively

straightforward thanks to signpost words, and respondent accounts were easily attributable to individual levels.

However, several respondents observed during the interviews and feedback sessions that the multiple-interview approach to exploring the CRP accuracy was resource-consuming and impractical due to the difficulty of accessing the relevant informants. Instead, they suggested basing the CRP accuracy assessment on independent third-party inputs. Unfortunately, this approach proved impossible for the dearth of such assessments.

**Accuracy level differences within a single CRP report**. The process of CRP accuracy assessment revealed that a CRP report might contain multiple CRP prices with potentially different levels of CRP accuracy. For instance, for the quarterly "methanol contract," CRP accuracy is considered Transparent because multiple and large transactions inform it. In contrast, the weekly spot price is deemed Translucent because it may incorporate only a few non-standard transactions with low volumes and is not representative of the aggregate market. A large methanol PM observes:

> "You must understand the difference between the contract and spot price [of the chemical CRP report]. The [quarterly] contract price is accurate because it is based on extensive negotiation and industry consensus. The weekly spot price is just a rough, backward-looking indication of the price of residual volumes or emergency buys. [So] you cannot base your price formula on the spot price because you would have no control over the reference price [evolution logic]."

Therefore, the CRP accuracy level has to be checked separately for each CRP. Furthermore, particular care has to be paid to any new CRP emerging within the report because CRP consumers must not infer the habitual level of CRP accuracy without a comprehensive check and time test.

**Reliability of market participant assessments.** Finally, findings showed that less knowledgeable participants expressed outlier assessments liable to bias the final CRP accuracy assessment. Therefore, some care has to be paid to the sample selection, and only knowledgeable respondents with extensive experience with a CRP should be considered. Furthermore, probing questions should be asked to understand the degree of CRP (in)accuracy. For example, an energy buyer called the Dazzle front-year baseload electricity CRP highly inaccurate because the actual realization price varied by around 0.1 €, less than 0.3 % of the CRP value. In contrast, a buyer of chemicals considered the hydrochloric acid CRP highly accurate because the EUR 15 range covered the realization price level, even though it represented a 35% spread against her actual transaction price. Finally, the data suggest CRP accuracy assessments should not be drawn from the negotiation process. Several respondents mentioned instances of opportunistic behaviour when market participants overweighted or downplayed the CRP accuracy during the CPM process to extract benefits. A PM explains:

> "When prices increase, we challenge the report accuracy and argue that it is not representative of the true market prices. . . . and when prices go down, we treat the same report as the holy word."

> "I always argue [during commercial negotiation] there is a significant upward bias [in the CRP report]. Big ticket [buyers] never buy at this level! [I know] the sellers trick less informed buyers into accepting these prices at face value." (large PM of chemicals)

> "We tried to squeeze in [this] CRP into the contract. But we got no offers and had to discuss directly with the [incumbent] to supplier and agree a [different] formula." (energy sector PM)

Considering these challenges, the author suggests several venues for colleting the CRP accuracy data, e.g., CRP issuers, regulators, and trade associations

may start collecting the CRP accuracy data. Perhaps, the centralized CRP body recommended by Cinquegrana (2008) might undertake this cumbersome task. The CRP accuracy assessment might even make way into CRP completeness if issuers started mentioning a “typical” level of inaccuracy in monetary terms and provided some contextual factors that increase/decrease CRP accuracy so that market participants could calibrate their expectations.

## 6.2. Commodity reference price transparency index

Having conceptualized the CRP transparency construct and identified its measured attributes, Research Question Two explores and operationalizes the relevant CRP transparency’s contingency levels and subsequently aggregates them into the CRP transparency index.

The section is structured as follows: It first answers the Research question 2. Subsequently, it discusses the implications of CRP transparency index for extant literature. Next, it discusses CRP transparency influence on CPM practices which is fundamental for the construct´s theoretical and practical relevance. The following sub-section discusses the interplay between CRP transparency and other influencing factors. Finally, the extended taxonomy of CPM practices is discussed.

### 6.2.1. Answering Research Question 2

Having conceptualized the CRP transparency attributes, it is now possible to develop a tool for measuring the level of CRP transparency contingency. Therefore, Research Question 2 was proposed:

*What are the relevant commodity reference price contingency levels?*

This research empirically operationalized individual CRP transparency attributes into five transparency levels following the geological metaphor

conceived by Lamming et al. (2001). Evaluation of a sample of 22 CRP demonstrated that CRP transparency attributes occupy five transparency levels.

Subsequently, individual CRP transparency attributes were aggregated into a single number that represented the aggregate CRP transparency value. The aggregation revealed three basic configurations: (a) balanced CRP with all transparency attributes perfectly aligned, (b) marginally imbalanced CRP where transparency attributes did not differ by more than one CRP transparency level, and (c) imbalanced CRP with transparency attributes differing by more than one two levels.

Thirdly, the uneven cut-off points between CRP transparency levels were determined to achieve maximum within-group homogeneity and cross-group heterogeneity in terms of the CRP functions and CPM practices used. The black hole CRP transparency level is conceptualized as a single point forming one extreme of the continuum at 0. The opaque CRP transparency level ranges from 2 to 6.5. The translucent CRP transparency level occupies the range from 7 to 10.5. The transparent CRP transparency level is represented by CRP ranging from 11 to 15 points. Finally, the Dazzle CRP transparency level is conceptualized as a single point on the other extreme of the continuum.

Finally, five CRP transparency levels were described in detail. The findings show that their impact on CRP functions and CPM practices differs substantially, giving support for the relevance of the CRP transparency index.

#### 6.2.1.1. Generalizability and extendibility of the CRPTI model and its construction method

The CRPTI model was developed for assessing the CRP transparency level and thus help CRP users understand how the CRP fulfils different CRP functions and which CPM practices should be leveraged. As such, the model is generalizable to all CRP and even commodities that do not possess a CRP.

On the down side, the model was developed from a relatively small sample of CRP. To gain confidence the CRPTI should be cross-validated with a different sample of CRP.

The CRPTI model is relatively rigid. For example, any change of CRP transparency attribute number or weighting, or the number of CRP transparency levels would alter the *y*-axis and disrupt the cut-off points as CRP transparency level intra-group homogeneity and cross-group heterogeneity would have to be reassessed.

In addition, extreme caution is needed when extending the CRPTI model to other contingencies, because they may command different measured transparency attributes, different operationalization of measured transparency attributes and different meaningful cut-off points that guarantee the within-level homogeneity and the cross-level heterogeneity.

Unlike the CRPTI model which is difficult to extend, the method used for constructing the model is easily replicable to practically any contingency factor and could serve as a blue-print for a contingency factor operationalization. The method consists of nine consecutive and interrelated steps (see Table 48). At the same time, it should be noted that the method is relatively resource intensive and is warranted primarily for contingency factors with multiple variants such as financial indices, raw material sustainability, or supplier disclosure level.

| |
|---|
| Determine the contingency factor, its functions and practices it impacts, |
| Determine the relevant measured attributes, |
| Operationalize the attributes, |
| Define attribute weights, |
| Explore the impact of different contingency factor levels on the factor´s functions and practices it impacts, |
| Determine the number of relevant contingency levels, |
| Establish the cut-off points reflecting sufficient within-level homogeneity and the cross-level heterogeneity, |
| Construct the index, |
| Apply your index in practice. |

Table 48: The transparency index construction process

### 6.2.2. CRP transparency index relevance for extant literature

The CRP transparency index divides CRP into five distinct transparency levels and thus provides a finer-grained insight into CRP contingency levels and allows for a more precise analysis of CRP contingency impact than polar opposite cases such as liquid vs. illiquid futures markets (Gaudenzi et al., 2018), biased vs objective third-party indices (Zsidisin & Hartley, 2012), or inaccurate vs. accurate and representative of actual transactions (Hayenga & Schrader, 1980).

Furthermore, the CRP transparency index extends existing CRP contingency classifications which typically have three levels, e.g., low- medium- high (Valiante and Egenhofer, 2013), *Information- Information and Data–- Benchmark*

*(*Johnson, 2017), or the producer price- CRP issued by a PRA- CRP issued by commodity exchanges (Figuerola-Ferretti and Gilber, 2005),.

Furthermore, careful reading of the extant literature reveals that some CRP transparency levels were already implicitly substantiated. For example, Cinquegrana (2008) observes that some commodities do not possess CRP which equals Black Hole CRP transparency. Valiante and Egenhofer (2013) note that the rolling front-month futures price is considered a useful proxy for physical market prices, which would correspond to the Transparent CRP transparency level.

Similarly, Radetzki (2013b) outlines a continuum of CRP price discovery mechanisms that can be reinterpreted as CRP transparency levels (see Table 49). Compared to a potentially endless list of CRP price discovery mechanisms, CRP transparency index represents a taxonomy that is sufficiently parsimonious and yet sufficiently distinctive barriers to inform business practice. Furthermore, the CRP transparency index immediately highlights potential CRP weaknesses, e.g., irregularity of commodity auctions.

| Price discovery mechanism by Radetzki (2013b) | CRP transparency level (tentative, based on information from the article) |
|---|---|
| Transfer prices<br>Bilateral contracts | Black Hole, if internal<br>Opaque, if published |
| Posted price<br>Producer dictated prices<br>User driven prices | Opaque |
| Auctions | Translucent, if held irregularly |
| Specialized journals | Translucent |
| *Not observed* | Transparent |
| Commodity exchanges | Dazzle |

**Table 49: Reinterpretation of CRP price discovery mechanisms by Radetzki (2013b)**

The CRP transparency index helps researchers in analyzing the evolution of commodity markets. For example, the establishment of the spot gas market outlined by Roeber (1996) can be interpreted as a progressive improvement of CRP transparency. The original Black Hole transparency bilateral market was supplemented with Translucent reporting by PRA, which provides the context to price negotiations. Subsequently, CRP issued by PRA improved into Transparent CRP transparency level, and the CRP were quoted in price clauses. Finally, regulated commodity exchanges introduced the spot and futures contracts, which can be classified as the Dazzle CRP transparency level.

Similarly, structuring CRP evolution along the CRP transparency levels reveals interesting differences among commodities. For example, Maxwell (2015) shows that the CRP progression was not linear but moved from Black Hole to Translucent, then temporarily regressed to Opaque before improving to Transparent and potentially to Dazzle.

The CRP transparency model can elucidate these transparency level changes through the analysis of individual CRP transparency attributes and document that a substantial change of CRP transparency level has to entail simultaneous change of several CRP transparency attributes. Thus it provides a richer explanation of CRP transparency evolution. At the same time the model predicts a change of CPM practices which was substantiated in Roeber (1996), Radetzki (2013b), and Maxwell (2015).

Finally, CRP transparency index offers a more precise assessment of CRP quality and predicting CRP transparency evolution. For example, Valiante and Egenhofer (2013) might assess CRP transparency for gas indexed to the oil price as Opaque because precise formulas are not made public, different indexation methods are used, and the gas-to-oil correlation is low. This CRP opacity would also explain why market participants move toward spot gas prices indexation in long-term contracts, which can be considered Dazzle due to high market liquidity, high gas-on-gas price correlation, futures curve, a number of regional prices, and a facility for hedging. This observation provides additional support for Radetzki's (2013b) observation that more transparent CRP progressively dominate the price

discovery. Furthermore, Valiante and Egenhofer (2013) provide a detailed review of 11 major commodities. A CRP transparency perspective would provide an interesting insight into the evolution of CRP transparency of individual commodities and may highlight any accelerators and289arrierss.

The CRP transparency index also addresses concerns raised by alternative taxonomies. In particular, the taxonomy by Rauterberg and Verstein (2013) is based on the CRP issuer, and the authors note that by-product indices are the most vulnerable ones to manipulation. The CRP transparency index addresses this important issue through the CRP methodology attribute: if a by-product CRP is informed by privately available data, its methodology attribute would score as Opaque and immediately highlight a potential problem to CRP consumers or regulators.

Finally, the CRP transparency index nuances the applicability of CRP functions outlined by IEA et al. (2011). Following Table 45, only Transparent and Dazzle CRP levels boast all functions mentioned such as (a) the settlement of physical trades, (b) undeclared and unreported OCT derivatives, (c) cleared, standardized OTC derivatives, (d) the price indexation of contracts,€) tax reference prices, or (f) cash settlements on futures. In contrast, the Translucent CRP transparency level rarely witness (d)€ (e) and do not command (c) and (f). Finally, Black Hole and Opaque CRP transparency levels cannot leverage (a), (c), (d), (e), (f).

It is important to highlight this difference because the extant literature bias toward CRP generated by commodity exchanges creates a false impression that CRP have a similar level of quality.

In summary, this section showed that CRP transparency index with its five CRP transparency levels extends and details existing extant literature, and how it can be used to advance existing research.

### 6.2.3. CRP transparency interplay with other influencing factors

Despite their importance, contextual factors impacting CPM practices have received scant attention (Fischl et al., 2014), and the body of knowledge is growing only slowly (Gaudenzi et al., 2018; Jones et al., 2007; Mayer & Gleich, 2015). While this research focused on the CRP contingency as a stand-alone phenomenon of interest, empirical findings provide strong empirical support for the relevance of influencing attributes highlighted in Gaudenzi et al. (2018) taxonomy.

There is an ongoing discussion whether companies must account for multiple influencing factors and their interrelation in selecting CPM practices (e.g., Boer et al., 2015) or whether one primary influencing factor may be isolated and the company may select a CPM practice consistent with the requirements of this single influencing factor (e.g., Fisher, 1995). This research expands our understanding of the interplay of influencing factors in several ways:

Firstly, it suggests that CRP transparency is a dominant influencing factor for CPM practices. Especially the Transparent and Dazzle CRP transparency levels “impose” the “best-practice” CPM practices. Hence, an aluminium buyer can choose between the spot, forward, or futures, but cannot negotiate the actual aluminium price level or decouple from the CRP value.

This finding has important implications for designing a suitable natural hedging policy recommended by Hofmann (2011): the pass-through along the supply chain may be straightforward for Transparent and Dazzle CRP because all supply chain members may adopt the same CPM practice. In contrast, the CPM alignment may be more difficult in instances where the level of CRP transparency is lower and the choice of CPM practice is impacted by numerous other influencing factors.

Secondly, this research shows that it is difficult to fully isolate CRP transparency from other influencing factors whose presence explains the observed misfit between the CRP transparency level and the choice of CPM practices. In particular, company size, procurement sophistication, buyer

knowledge, commodity importance to the buyer, relative power, and market turbulence impacted the CPM choice. For example, Translucent CRP transparency generates less accurate prices in turbulent periods, less knowledgeable buyers may accept an Opaque CRP transparency level price at the face-value in the contract, or buyers for whom the commodity is relatively less important may opt for a less suitable, convenient CPM practice.

This finding corroborates Gaudenzi et al. (2018) claim regarding the complex interplay of influencing factors. It also explains different CPM practices outlined by Jackson (1980) to manage risk in industrial pricing even for Transparent and Dazzle CRP transparency levels. For example, Jackson (1980) argues that a battery supplier will seek an escalator clause with its customer because lead constitutes an important cost factor (commodity importance to the buyer). In contrast, a car manufacturer may decide to hedge the exposure (procurement sophistication), or absorb it (commodity importance to the buyer).

The interplay of influencing factors also explains why some sellers of integrated circuit sockets deviate from CPM practices “typical” for highly transparent CRP like gold. Instead of escalator clauses or hedging, they leverage the technical capability contingency to develop substitutes or reduce usage or leverage their relative market power to impose frequent list-price revisions (Jackson, 1980).

Thirdly, one may argue that other influencing factors are present even when a perfect fit is achieved. In these instances, the alignment and mutual corroboration of key influencing factors reinforce the fit making other influencing factors not observable. For example, high storage requirements could be considered the key influencing factor for the spot purchase strategy in Jones et al. (2007) and leave high market efficiency and budget constraints unobserved. However, all three are equally important.

Findings corroborate the importance of these “invisible” reinforcing influencing factors, e.g., when a multinational company with robust and sophisticated processes and a knowledgeable procurement team leverages financial hedging to purchase large volumes of aluminium, the case can be

reinterpreted as the alignment of size, processes, skills, volume, and commodity type influencing factors to Dazzle CRP which results in the adoption of hedging, a suitable CPM practice.

In contrast, respondents recounted several instances, when influencing factors were in conflict and resulted in sub-optimum CPM practices compared to the CRPTI recommendations. Firstly, companies may apply one dominant influencing factor, select a CPM practice accordingly, and ignore the rest. For example, a case study company decided to absorb the copper volatility because the copper share in the total product cost was negligible, and parties agreed to negotiate prices if the copper price increase was “devastating for the product margin.” While this CPM practice is misaligned with the copper Transparent CRP transparency level, it works for this combination of influencing factors.

Unfortunately, the “steamroller” approach may backfire and block the transaction. For example, a small buyer focused on CRP transparency and wanted to use an escalator clause pegged to a Transparent CRP for coal. However, this request was refused by the supplier, who argued that the CRP was irrelevant to the volumes bought by the buyer. Similarly, returning to Jones et al. (2007), a company may enact forward purchases despite high storage requirements because the market is inefficient and the company has enough free cash. However, this strategy may backfire, if the customer requirements change.

Secondly, despite the clash of contingency factors, the “ideal” CPM practice may be pursued but will result in a sub-optimum fit. For example, a case study company started using financial hedging for a commodity with the Dazzle CRP transparency level. However, they soon realized that they did not have the processes, skills and purchase volume stability to make it work internally. The misfit resulted in unexpected transaction costs and increased risk exposure, and the CPM practice was abandoned.

Finally, companies may accept the conflicting nature of influencing factors and seek a CPM practice that results in some misfit. For example, a case study company recognized the impracticability of hedging and adopted hedging through OTC forward contracts. Thanks to this “compromise,” the transaction costs

decreased significantly. However, the misfit also increased the counterparty risk. When the supplier declared bankruptcy, the focal company lost all its advantageous over-the-counter contracts resulting in a net loss of over EUR 600.000.

### 6.2.4. Influence of CRP transparency on CPM practices

This section discusses CRP transparency influence on CPM practices. While this point was not central to the RQ2, it is important for justifying the CRP transparency index theoretical and practical relevance.

To achieve this objective, the influence of CRP transparency on CPM practices will be discussed from two complementary theoretical perspectives:

(1) Contingency theory puts great emphasis on the notion of fit and formulates clear guidelines on how to recognize different types of fit, and
(2) Transaction cost theory formulates predictions about the optimum fit between a governance mechanism and influencing factors based on governance-related transaction costs.

#### 6.2.4.1. Reconceptualizing CPM practices as governance mechanisms

Contingency theory a priori assumes the relationship between CRP transparency and CPM practices. In contrast, TCE argues that the relationship should not exist for commodity products due to autonomous adaptation of the market governance set-up (Peterson, Wysocki and Harsh, 2001; Williamson, 2008). The findings are in stark disagreement with this conclusion and warrant an in-depth analysis of this TCE prediction.

**TCE predictions for commodity products**

TCE predicts that the market governance set-up is the most transaction cost economizing setup for commodities because it leverages all transaction cost

reduction opportunities that the highly competitive commodity market offers: hard bargaining (Williamson, 1991), economies of scale and flexibility (Blomqvist et al., 2002), information mediation through the price mechanism (Butler & Carney, 1983), no dependency (David & Han, 2004), rapid and seamless partner switch, short term and unrepeated transactions (Kwon et al., 2009; Yeung et al., 2013), result orientation, and the lack of concern with the manner the results are achieved (Masten, 2000).

Therefore, the exchange of commodities should be governed by the classical contract where all conditions are specified ex-ante, the transaction partner identity is irrelevant (Williamson, 2002), and there is very limited command and control at the interface (Williamson, 2010). Furthermore, parties do not expect future exchange (Argyres & Liebeskind, 1999), and contracts are repeated only if the incumbent partner offers the best deal or matches the best bid (Williamson, 1991). There is hardly any joint action between the partners, information sharing is intensive only at contract negotiation time, is followed by subsequent routine tasks (Bensaou, 1999), and 'the whole man' is not required to perform the market-like transaction (Butler and Carney, 1983), unlike more integrated governance forms where some interpenetration of organizational boundaries happens (Heide & John, 1990), and some coordination is needed (Williamson, 1991).

Adaptation to uncertainty is autonomous because the adversarial nature of transactions does not incentivize the parties to resolve adaptation problems (Yeung et al., 2013). Furthermore, the scope for opportunism scope is extremely limited because (1) the adaptation is automatic, unilateral, and autonomous (Geyskens et al., 2006; Masten, 2000), (2) there is a permanent replacement threat (Bello et al., 1997), (3) all conditions are specified ex-ante (Hobbs, 1996) (4) in a precise, formal contract where strict legal rules apply (Williamson, 1991). (5) Therefore, there is no uncertainty about prices or behaviour (Hobbs, 1996), and (6) disputes are resolved through a third party, usually the court (Masten, 2000).

**Inconsistency with empirical observation**

Transaction cost theory (TCE), conceived as the theory of governance (Williamson, 2002), views companies and markets as governance structures for managing transactions (Williamson, 1996). From this perspective, CPM practices can be considered special types of governance structures, understood as control mechanisms designed to assure fairness among transactors (Dyer, 1997), mitigate conflict and realize a mutual gain (Williamson, 2000). Following the same logic, CRP transparency can be conceptualized as a specific form of uncertainty that shapes the performance of CPM practices. This conceptualization is coherent with previous uncertainty conceptualizations compiled by David and Han (2004), e.g. decision making uncertainty of buyer, price changes, volatility, or currency risk.

Scholars conceptualize governance structures as a continuum ranging from the *market* through *hybrid* to *hierarchy* modes of governance (e.g., Williamson, 2008; Peterson et al., 2001). Hence, CPM practices can be viewed as governance mechanisms that manage the transaction between the buyer and the seller. Following the TCE prediction, only CPM practices with the market hierarchy characteristics, particularly the ease of autonomous adaptation, should be observed, such as the fundamental analysis, producer-posted price, absorption of the price increase, financial hedging, or automatic escalator clauses.

However, the taxonomy of CPM practices abounds with CPM practices typical for the hybrid governance mode where some coordination between business partners is necessary, e.g., information sharing with suppliers, bilateral negotiation, controlled purchases for the supplier, changed conditions clause, forward purchases, or tournament pricing.

Similarly, vertical integration or transfer prices represent the hierarchical form of governance where the control over the pricing is managed within the company.

However, according to TCE prediction, CPM practices corresponding to hybrid and hierarchical forms of governance should not exist for commodity products.

**Existence of specific assets**

Two possible explanations exist for the inconsistency between the TCE prediction and empirical observation. Firstly, the observed hybrid and hierarchical set-ups represent a misfit, a wasteful expenditure of resources. Over time, these inefficiencies will be corrected and move toward the market governance setup, in line with the cost economizing hypothesis (Williamson, 1991).

Yet, this explanation does not withstand detailed scrutiny. For example, autonomous adaptation through substitutes may be perfectly acceptable in most B2C markets where the producer replaces one commodity or supplier with another. However, such discretion is inconceivable in B2B transactions where the supplier has to coordinate this change with the customer through the change request sheet, specification update, validation test protocol, and safety stock for the switching period, which is typical for the hybrid governance setup.

A detailed discussion of Hybrid governance set-ups and their applicability to commodity procurement is outside the scope of this thesis. However, works by (Peterson, Wysocki, & Harsh (2001) and Hennart (1993) provide additional arguments on why hybrid governance may be relevant even for commodity products.

The alternative explanation draws upon the existence of transaction-specific assets defined as investments and commitments that cannot be easily redeployed to other use (Oliver E. Williamson, 1985; Williamson, 1996), such as buildings, production, transport and warehousing equipment, or set-up and validation costs (Bensaou, 1999). Without specific assets, the adaptation to uncertainty would be completely autonomous and trigger zero transaction costs, corresponding to the pure market governance set-up.

Even though commodities are often considered perfectly homogenous and undifferentiated (e.g., Roeber, 1996) and hence perfectly interchangeable, the findings show that commodities sometimes witness significant specific assets which preclude autonomous adaptation, e.g., assembly line adjustment, capacity reservation, supplier-financed silos, product revalidation costs, volume or price commitments, or supplier lock-in due to transport costs. This observation is coherent with Levitt (1980) or Schrage (2007), who argue that undifferentiated commodities exist only in economy textbooks because commodities are always differentiated in real business transactions.

Having established commodities as containing specific assets, the CRP transparency conceptualized as uncertainty[1] in TCE comes into play because the effect of uncertainty is conditional upon the existence of specific assets to a non-trivial degree (Williamson, 1975).

Consequently, following the original schematic TCE prediction, higher degrees of uncertainty lead to more integrated governance (e.g., Williamson, 1979). However, subsequent empirical testing offered a more nuanced conclusion that different uncertainty conceptualizations have a contradictory impact on governance choice (Klein, 1989): uncertainty related to environmental "complexity," defined as the number of sources of uncertainty, leads to more integrated governance (Geyskens et al., 2006; Masten, 2000). In contrast, environmental "dynamism," such as the rate of technological obsolescence, leads to more market-like governance setups (Song et al., 2005).

As CRP transparency may be understood as environmental complexity, the following proposition can be formulated:

The lower the CRP transparency level, higher the uncertainty level and subsequently, the more collaborative the CPM practice.

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[1] Considering David & Han's (2004) taxonomy of uncertainty conceptualizations, CRP transparency might classify as *others* alongside regulatory uncertainty, component complexity, or transaction idiosyncrasy.

In summary, this section substantiated the CRP transparency relevance from the TCE perspective thanks to the existence of transaction-specific assets. Without specific assets, the effect of CRP transparency on CPM practices would be nil. Furthermore, classifying CRP transparency as environmental complexity suggests that the hybrid and hierarchical governances will be more appropriate for low degrees of CRP transparency, while market governance should prevail for high levels of CRP transparency.

#### 6.2.4.2. CRP transparency impact on the internal structure of CPM practices

Fischl et al. (2014) pointed out that financial hedging a specific CPM practice was over-represented in CPM research and called for deeper exploration of other CPM practices. In response to this call, the literature review identified a large number of “exotic” CPM practices only present in specific fields, such as agriculture, e.g., product pricing classified by end-use, price window, or tournament pricing (Mussell et al., 2003) (see Section 2.2.1. for definitions). Unfortunately, these “exotic” CPM practices were absent from the findings. When suggested in the follow-up interviews and listening sessions, the respondents did not know them. Hence, the provisional conclusion is that these “exotic” CPM practices are industry specific and unknown to the wider procurement community and, therefore, not used even if potentially suitable.

Focusing on more “traditional” CPM practices, the research extends the notion of internal CPM practices’ heterogeneity which is mentioned in passing by Mussell et al. (2003), who show that formula prices are based on the spot market, external benchmarks, estimation of production costs, or potential profits estimation, by Hofmann (2011) who outlined several variants of the natural hedging approach, and by Kang and Mahajan (2006) who propose six types of forward contracts configurable following “the basis for pricing, flexibility over timing the pricing; flexibility over timing the receivables; ability to participate in favourable price movements etc.” (Kang and Mahajan, 2006:9).

The findings extend Kang and Mahajan (2006) criteria (see Table 50Table 50: Forward contract modalities) and confirm that forward buying is an umbrella term for several CPM practice configurations with important implications on transaction terms, costs, and risk. More generally, scholars so far have not investigated internal structures of CPM practices nor considered the interplay of key contingency factors that would drive the choice of a particular CPM practice variant, even though this knowledge would significantly advance our understanding of CPM practices.

| Forward contract modalities | Observed variants/ Variants from the literature |
|---|---|
| **Price setting** Similar to the basis for pricing, flexibility over timing the pricing and ability to participate in favourable price movements in Kang and Mahajan (2006) | Spot price valid at the moment of transaction<br>Spot price adjusted for financing and warehousing costs until the moment of physical material delivery<br>Specific future price different from the spot price, negotiated<br>Future price agreed based on futures curve<br>Future price adjusted with bonuses contingent on delivered volumes<br>Price-to-be-fixed or Deferred pricing means that parties negotiate the price at the moment they deem the most opportune (Kang and Mahajan, 2006)<br>Minimum price contract allowing the seller to participate in future price gains (Kang and Mahajan, 2006) |
| **Material ownership** Similar to flexibility over timing the receivables in Kang and Mahajan (2006) | Immediate transfer of ownership to the buyer<br>Material remains the property of the seller until delivery at a future date |
| **Physical material emplacement** | Material is physically stored at the customer<br>Material is physically stored at the customer in the form of consignment stock owned by the supplier<br>Material is physically stored at the supplier or third-party facility |
| **Material production moment** | The material was manufactured prior to the transaction moment<br>Material is produced immediately after the transaction<br>Material is produced at the future moment |
| **Payment terms** (Kang and Mahajan, 2006) | Advance payment by the customer<br>Payment on delivery vs. deferred payment as a tax-saving strategy (Kang and Mahajan, 2006) |

**Table 50: Forward contract modalities**

Regarding the forward buying, a CPM practice “which locks in the prices of future purchases … and store the material” (Zsidisin & Hartley, 2012: 51) or “acquire commodities well in advance and store them in inventory until use (forward buying)” (Gaudenzi et al., 2018), the findings revealed that CRP transparency is important though not a unique contingency factor shaping its internal configuration.

In a basic forward buying scenario, the customer has to bear the warehousing and material financing costs and faces the obsolescence and damage risk (Zsidisin and Hartley, 2012) because the material is produced prior to the transaction, the transaction price equals the spot price, the material is owned by the customer, and physically stored in the customer warehouse. This set-up was observed with low/high volume Opaque and Translucent CRP levels and low volume Transparent and Dazzle CRP levels, such as spare parts aluminium extrusions.

In the medium scenario, which was observed with Translucent CRP transparency level, the material is produced at different moments prior to delivery, is stored at the customer in the form of consignment stock, and the price is agreed ex-ante through bilateral negotiation informed by the Translucent CRP. The material ownership is transferred only at future delivery. Compared to the previous scenario, the financing and warehousing costs are split, the counterparty risk remains with the supplier, and the risk of forced renegotiation is minimized because the customer is legally obliged to take the physical material in consignment stock.

Finally, in the sophisticated scenario, the material is produced only shortly before future delivery, and the transaction price equals the ex-ante agreed future price resulting from bilateral negotiation or the futures curve. The material ownership is transferred only at future delivery time. This layout was observed with electricity (Transparent or Dazzle CRP). The customer avoids the financing and damage risks but bears the counterparty risk related to supplier bankruptcy, late delivery, opportunistic attempts to renegotiate the terms, or shirking.

From the TCE perspective, the base scenario can be described as a market governance set-up where both sides opt for autonomous adaptation where all effort is concentrated into the search, negotiation and contracting phases. In contrast, no collaboration is expected after the contract signature.

The medium and sophisticated scenarios correspond to different levels of hybrid governance set-ups where relatively intensive collaboration between partners is expected after the contract signature. When coordination is required, hybrid governance is considered less vulnerable to opportunism than market or hierarchy and, therefore, less transaction cost-intensive (Hennart, 1993). On the downside, hybrid governance always faces the risk of opportunism, which may outweigh the savings related to financing and warehousing. Hence, the overall efficiency of the three scenarios can only be evaluated in a particular transaction context.

Continuing the discussion, the author leveraged findings from Sections 5.2.3.6. and 5.2.3.7. and estimated the impact of the Blackhole/ Opaque/ Translucent CRP transparency levels (low CRP transparency) versus Transparent/Dazzle CRP transparency levels (high CRP transparency) on different forward contract types outlined by Kang and Mahajan (2006). Table 51 shows that low CRP transparency levels complicate the CPM, while high CRP transparency levels significantly streamline it. In particular, the Minimum price forward and Reference-price forward contracts may be very difficult to enforce in the absence of a highly transparent CRP.

| Contract type | Low CRP transparency (Blackhole-Translucent) | High CRP transparency (Transparent-Dazzle) |
|---|---|---|
| Fixed price contract | Complex price search and negotiation | Price negotiation around the CRP |
| Price-to-be-fixed contract | Complex price negotiation | Easy to fix the price based on actual CRP level |
| Deferred pricing contract | Complex price negotiation | Agreed as a CRP value at the future moment |
| Deferred payment contract | No impact | No impact |
| Minimum price contract | Complex discussion at maturity about the actual reference value | Compared to future CRP value |
| Reference-price forward contract | Complex discussion at maturity about the actual reference value | Realized at CRP value on delivery |

**Table 51: CRP impact on different types of Forward contracts outlined by Kang and Mahajan (2006)**

In summary, CRP transparency was found to impact the CPM practice modalities. Findings also suggest that high levels of CRP transparency allow a wider range of CPM practice configurations and higher level of CPM practice sophistication. So far, this topic has not been the subject of focused scholarly research; therefore, the presented findings must be considered emerging and provisional.

#### 6.2.4.3. Fit between CRP transparency and CPM practices

Contingency theory posits that the optimum level of performance, called fit, is achieved when an organizational setup is perfectly aligned with the level of a contingency factor. Applied to this research, the optimum level of performance is achieved when a CPM practice is aligned with the CRP transparency level.

To illustrate how the CRP transparency construct shapes the availability and suitability of CPM practices, the CPM practices recommended by Zsidisin & Hartley (2012) to manage expected commodity price increase will be re-examined through the fit-as-matching approach (Venkatraman, 1989) where the congruence between the CRP Transparency level and CPM practice will be estimated by the author and based on the findings from Sections 5.2.3.6. and 5.2.3.7. Hence, if findings suggest that practitioners heavily used a CPM practice for a given CRP transparency level, it will be marked as ✓; if they did not use it or even warned against using it, it will be marked as X; if the data shows that a CPM practice is not available for a given CRP transparency level, it will be judged as N/A; finally, if findings were split about the suitability of CPM practice, it will be marked as ?.

Table 52 provides strong empirical support for the fundamental contingency theory claim that different contingency levels result in different types of fit. Firstly, some CPM practices are not available for some CRP transparency levels. For example, financial hedging is not available to the lower levels of CRP transparency.

Secondly, the same CPM practices are available for different CRP transparency levels. However, they differ in relative suitability (indicated with ✓ for suitable and X for unsuitable). For example, customer/supplier pass-through represents perhaps the best example of CPM suitability contingent on the CRP transparency level: passing the commodity price increase to customers/suppliers is straightforward with the Transparent and Dazzle CRP transparency levels because parties can agree on a standardized mechanism which follows the CRP. However, the same CPM practice is significantly more complicated with Translucent CRP transparency level because parties may struggle in separating

the base price and commodity content, may struggle in turbulent periods when the CRP loses its accuracy, or may face opportunism due to asymmetric pricing information triggered by the less transparent CRP. Finally, the pass-through may be next to impossible for the Black Hole and Opaque CRP transparency levels which face prohibitive transaction costs related to negotiating the price formula, monitoring the price evolution, agreeing on the value of adjustment and enforcing compliance with the price changes in the absence of a recognized CRP.

Other examples are equally straightforward: buying ahead on stock is a suitable CPM practice for the Black Hole CRP transparency level. However, it would be considered wasteful for the Dazzle CRP transparency level because the material can be easily bought forward without the warehousing costs. Similarly, cross-hedging may be the only way to financially hedge commodities whose CRP transparency level does not provide financial hedging. In contrast, cross-hedging would not make sense with the Transparent and Dazzle CRP transparency levels as the commodity can be hedged directly.

Thirdly, some CPM practices are available for a given CRP transparency level, but their suitability is heavily impacted by other CRP contingency factors (indicated with ?).

| | Black Hole | Opaque | Translucent | Transparent | Dazzle |
|---|---|---|---|---|---|
| **Substitute** | ✓ | ✓ | ✓ | X | X |
| **Pass/share with the customer** | X | X | ? | ✓ | ✓ |
| **Pass/share with the supplier** | X | X | ? | ✓ | ✓ |
| **Buy ahead on stock** | ✓ | ✓ | ✓ | X | X |
| **Forward buy** | X | X | ? | ✓ | ✓ |
| **Financial hedging** | N/A | N/A | N/A | ✓ | ✓ |
| **Cross-hedging** | ✓ | ✓ | ✓ | X | X |
| **Absorb and reduce demand** | ✓ | ✓ | ✓ | X | X |

**Table 52: Suitability of CPM practices suggested by Zsidisin & Hartley (2012)**

### Fit through the Transaction theory lens

The concept of fit in contingency theory is similar to the discriminating alignment hypothesis (Williamson, 1991) in TCE, which posits that CPM practice choice is driven by transaction costs and companies seek to adopt the most transaction cost-economizing CPM practice (Williamson, 1981) relative to alternative CPM practices (Wang, 2007).

This TCE prediction was already implicitly substantiated by scholars who studied CRP discovery mechanisms and documented how companies

continuously adapted their CPM practices to the evolution of CRP transparency (e.g., Figuerola-Ferretti & Gilbert, 2005; Maxwell, 2015; Radetzki, 2013; Roeber, 1996). Furthermore, Chapter Five implicitly documented multiple examples of the most cost-economizing setups between the CRP transparency level and CPM practices, summarized in Table 46.

TCE requires some “measurability” of CPM practices to determine the most cost-economizing setup. The original conceptualization of transaction cost theory, which focused on exploring the costs of carrying the transaction or using the price mechanism (Coase, 1937), seems particularly suitable for this purpose. Following this “calculative” approach, the sources of transaction costs can be grouped into distinct categories, such as the discovery of trading partners, specification of the terms, contract negotiation and drafting, contract compliance monitoring, and adaptation to unforeseen disturbances (Coase, 1960). Transaction costs can be assessed following a simple procedure that builds on Hobbs (1996), who warned against conceptualizing transaction costs as costs in the accounting sense and instead recommended focusing on identifying the major sources of transaction costs and measuring their importance in absolute or relative terms.

Hence, to document explicitly how the CRP transparency level shapes the choice of optimum CPM practices, the *relative* magnitude of transaction costs of individual CPM practices outlined by Zsidisin & Hartley (2012) was estimated by the author on a Low-Medium-High scale for each CRP transparency level (summarized in Table 53). It has to be noted that the transaction cost evaluation is based on author´s subjective assessment which significantly weakens the validity of coclustions.

| CRP Transparency level/ CPM practice | **Black Hole** | **Opaque** | **Translucent** | **Transparent** | **Dazzle** |
|---|---|---|---|---|---|
| Substitute | Medium | Medium | High | High | High |
| Pass/share with customer | High | High | Medium | Low | Low |
| Pass/share with supplier | High | High | Medium | Low | Low |
| Buy ahead on stock | Low | Low | Low | High | High |
| Forward buy | High | Medium | Low | Low | Low |
| Financial hedging | N/A | N/A | N/A | Low | Low |
| Cross-hedging | Low | Low | Medium | High | High |
| Absorb and reduce demand | Medium | Medium | High | High | High |

**Table 53: Estimated Transaction costs for CPM practices recommended by Zsidisin & Hartley (2012)**

Starting with the **Black Hole CRP transparency level**, cross-hedging requires the lowest relative transaction costs because the price revision is pegged

to Dazzle CRP, which minimizes the search, negotiation, monitoring, adaptation and enforcement transaction costs. This CPM practice was also widely leveraged by practitioners who, for example, hedged technical gases against electricity CRP, representing the most significant cost driver. The transaction cost perspective also supports Zsidisin & Hartley's (2012) implicit warning that the cross-hedging transaction cost may explode if the CRP is only poorly correlated with the Black Hole commodity market price evolution. Buying ahead on stock is also relatively transaction cost efficient but triggers significant warehousing and financing costs, as well as some counterparty risk, should the final customer refuse to buy the commodity. The perils of the forward buy are supported by a steel dealer who warned against speculative purchases, which may result in a significant loss should the price suddenly decrease.

Absorbing the cost increase and reducing demand triggers medium transaction costs equal to the expected price increase. Companies view it as a major risk for the revenue and accept it only if a sufficient reserve is priced into the selling price. Similarly, substituting a commodity with a cheaper material also triggers medium transaction costs due to adaptation costs, such as product development, validation, and coordination with the customer.

Finally, three CPM practices face high transaction costs, which may prevent the transaction from realizing: firstly, the buyer may not find a counterparty willing to enter the forward contract because the risk of adverse price evolution is too high and cannot be hedged. Secondly, sharing the price increase with the customer/supplier may be impossible because the transaction costs of setting up a price adjustment mechanism and dealing with adaptation challenges without a third-party benchmark may be too high. Thirdly, the Black Hole CRP transparency precludes financial hedging.

**Dazzle CRP transparency level** occupies the opposite side of the CRP transparency continuum. It offers four CPM practices with low transaction costs: (1) financial hedging thanks to the standardized facility for hedging (Radetzki, 2013b), (2) forward buying thanks to the existence of futures price curve, which streamlines the negotiation of the forward price; (3) and (4) the customer/supplier

pass through mechanism which is simple to set-up and operate because Dazzle CRP accuracy is not challenged (Figuerola-Ferretti and Gilbert, 2005). In contrast, CPM practices like buying ahead on stock, absorbing the price increase or developing a substitute trigger significant transaction costs and, therefore, may seem irrational as long as more transaction-cost-effective CPM practices are available.

Yet, service parts with low volume demand are a notable exception. Here, absorbing the price increase or buying ahead on stock may trigger lower transaction costs than setting up and operating an automatized price revision system disrupted by numerous adaptations that the service part business requires. However, this example does not disprove the CRP transparency impact but highlights other important contingency factors shaping CPM practices' suitability.

The same in-depth analysis could be performed for the Opaque, Translucent, and Transparent CRP transparency levels, but it would bring limited additional insight into the CRP transparency – CPM practices fit.

Despite reservations about the relative transaction costs assessment validity and reliability, the assessment strongly supports the discriminating alignment hypothesis as some CPM practices witness significantly lower transaction costs than others for a given CRP transparency level and, therefore, may be considered to achieve a perfect fit.

**Section summary**

This section discussed the fit between CRP transparency and CPM practices from two rival theory standpoints.

Both theoretical perspectives also substantiated the CRP transparency influence on the availability and suitability of CPM practices.

Despite highly subjective assessments of fit a matching and of transaction costs, the application of both theories rendered very similar results, e.g. "pass/share with customer" would be assessed as misfit for the Black hole and

Opaque transparency level by the contingency theory (high transaction cost by the TCE), a potential fit for Translucent (medium transaction cost by the TCE), and good fit for Transparent and Dazzle CRP transparency (low transaction cost by the TCE).

Neither assessment method seemed easier as both required relatively good knowledge of the CPM practice under assessment and understanding of the potential CRP transparency level impact.

#### 6.2.4.4. Hetero-performance of CRP transparency

The concept of hetero-performance assumes that fit to a higher level of the influencing factor has higher performance than fit to a lower level. Hence, organizations have a strong incentive to move to a higher level of contingency variable (Donaldson, 2001). Applied to CRP transparency, the Dazzle CRP transparency level should lead to better CPM performance than the Black Hole transparency level. By analysing the literature through the CRP transparency lens, we identify several instances where scholars, practitioners, and regulators are intuitively and implicitly aware of the performance implications of higher levels of CRP contingency (e.g., Cinquegrana, 2008; IEA et al., 2011; IOSCO, 2013; Prakash, 2012; Swieringa, 2012; Veerman et al., 2016) and provide support for the hetero-performance assumption, e.g., Radetzki (2013) shows that the move towards commodity exchanges brings numerous advantages to CPM. Similarly, the CRP transparency lens elucidates why CPM become more efficient along with the improvement of gas CPR transparency in Roeber (1996) or why higher CRP transparency results in higher CRP information content in Figuerola-Ferretti & Gilbert (2005).

Findings strongly corroborate the hetero-performance assumption. For example, Table 45 in Chapter 5 shows that increasing CRP transparency improves the information content of the CRP. Similarly, Table 46 in Chapter 5

implies that the effort triggered by search, contracting, hedging, and adaptation decrease with increasing CRP transparency.

The hetero-performance of CRP transparency can also be substantiated through the TCE lens. Table 54 reinterprets the findings from the Section 5.2.3. from the TCE perspective and documents that the level of CRP transparency has a significant impact on different classes of transaction costs. For example, it may be impossible to agree on a price revision formula in a long-term contract for the Black Hole transparency level due to the obvious monitoring and enforcement issues resulting from the absence of a CRP. The Translucent CRP transparency level also faces difficulties in establishing a price revision formula, but at least the CRP provides some basis for the discussion and significantly reduces transaction costs compared to the Black Hole transparency level. Finally, the Dazzle CRP transparency level offers an accurate basis for the escalator clause and reduces the monitoring and enforcement costs to zero because the CRP is not disputed and is easily observable.

| **Transaction cost** | **Definition** | **The degree of transaction costs for Black Hole – Translucent – Dazzle CRP transparency levels in the long-term contract scenario.** |
|---|---|---|
| Price search | Information and search costs related to accessing the price information, transaction price discovery, price from alternative sources, or price uncertainty (Woldie and Nuppenau, 2011). | Low: Dazzle CRP used at face value with an auditable difference for terms and grade.<br>Medium: Translucent CRP accepted as a price signal around which the deal is done.<br>High: Black Hole CRP requires extensive market and price search. |
| Negotiation | Drafting, negotiating and safeguarding an individual contract for each transaction or specifying terms in a | Low: Standardized contractual provision for Dazzle CRP.<br>Medium: Translucent CRP witness some difficulty in agreeing on the price revision |

| Transaction cost | Definition | The degree of transaction costs for Black Hole – Translucent – Dazzle CRP transparency levels in the long-term contract scenario. |
|---|---|---|
| | long-term contract (Oliver E Williamson, 1985), as well as physically carrying out the transaction (Hobbs, 1997). | formula, e.g., separate the base and commodity price, and accept the CRP as a valid reference.<br><br>High: Very difficult to agree on a formula with Black Hole CRP. |
| Monitoring | Screening and supervisory actions to ensure supplier performance during the supply agreement execution (Noordewier, John and Nevin, 1990). | Low: Check the compliance with the CRP and agreed price revision mechanism with Dazzle CRP.<br><br>Medium: Follow the Translucent CRP during periods of stability, and complement it with the market search during turbulent periods.<br><br>High: Continuous monitoring by market observation and testing the Black Hole CRP level. |
| Enforcement | The severity of disciplinary response to a supplier's violation of contractual obligation (Antia and Frazier, 2001). | Low: Simple enforcement of Dazzle CRP escalators.<br><br>Medium: Translucent CRP witness supplier/ customer opportunism in applying the CRP.<br><br>High: Black Hole CRP is subject to interpretation and opportunism, difficult to enforce due to the absence of an "objective and auditable" CRP level. |
| Adaptation | Contract modification to reflect changes in the external environment (Rindfleisch and Heide, 1997). | Low: Straightforward adjustment of CPM terms to reflect the new reality with Dazzle CRP.<br><br>Medium: Complicated adjustment and some opportunism from both sides with Translucent CRP. |

| Transaction cost | Definition | The degree of transaction costs for Black Hole – Translucent – Dazzle CRP transparency levels in the long-term contract scenario. |
|---|---|---|
| | | High: Black Hole CRP adaptation often results in contract termination and is subject to blatant opportunism like shirking or refusal to adapt. |

**Table 54: Impact of CRP transparency on different classes of transaction costs in the long-term contract scenario.**

Similarly, the reinterpretation of the findings documents that the relative transaction costs related to search CPM practices significantly decrease with the increasing CRP transparency level (see Table 55).

| CRP Transparency level | Nature of search costs | Estimation of relative search transaction costs |
|---|---|---|
| Black Hole | Fundamental analysis, intensive information sharing,<br>Primarily private search and specialized reports. | Base level |
| Opaque | Fundamental analysis with CRP as one information source among many. | Somewhat lower |
| Translucent | Triangulate CRP with private search and information sharing. | Sensibly lower |
| Transparent | Interpret CRP with the information included in CRP | Significantly lower |
| Dazzle | All information included in CRP → make sense of price. | Marginal compared to the base level |

**Table 55: Hetero-performance of search strategies**

**(1) Black Hole CRP level.** Findings corroborate the importance of a fundamental analysis for estimating current prices and future commodity price evolution (Zsidisin and Hartley, 2012). The search triangulates private search, horizontal and vertical information sharing, and subscription to specialized reports and triggers immense search costs because the buyer has to find out the market price from scratch.

Intensive information sharing was observed on the horizontal (among buyers) and vertical levels (cross supply chain) for the Black Hole, Opaque, and Translucent CRP transparency levels. However, it remained mostly informal, and only a few information-sharing platforms suggested by Hofmann (2011) were observed, e.g., an internal platform where buyers exchanged prices about ongoing negotiations or the publication of negotiated prices that suppliers could leverage. The sensitive nature of transaction commodity prices seems like the most plausible explanation for the scarcity of intercompany information-sharing platforms.

**(2) The Opaque CRP level** somewhat simplifies the buyer's job because they can complement the search with an indication of the market price mediated by the CRP. However, the Opaque CRP is just one information source among many. Buyers consider a fundamental analysis key to successful commodity procurement despite the ongoing discussion on whether commodity prices follow the random walk pattern (e.g., Kingsman, 1986) or can be forecasted (Zsidisin and Hartley, 2012). An empirical study by Mayer & Gleich (2015) of 42 CRPs provides ambiguous evidence. On the one hand, it suggests that the risk of future price movements and fluctuations can be empirically determined through a wide range of general economic and commodity-specific indicators. This holds especially for metals traded on commodity exchanges driven by a few price factors. On the other hand, less traded metals that face heterogeneous demand structure seem vulnerable to structural and technological breaks, which cannot be captured by statistical models.

**(3) The Translucent CRP transparency level** triggers sensibly lower search costs because buyers can limit the private search and leverage the CRP instead.

Data revealed that buyers did not search the market continuously. Instead, the search concentrated on relatively short periods when they intensively observed the CRP level, short-term equilibrium in the form of quotes, market evolution through formal and informal information channels, made sense of the market, and almost overreacted to any new information. In contrast, buyers did not actively search the market the rest of the time and only reacted to randomly received information, skimmed the CRP and did not take any action even if the market situation radically changed. This puzzling behaviour can be explained through the "active buying period" within which the commodity must be purchased (Kingsman, 1986). However, punctuated market observation can damage the company, especially for commodities bought regularly but at distant intervals. For example, several buyers avoided the steep electricity CRP drop in 2020 and increase in 2021 because they had a contract until the end of 2022.

**(4) The Transparent CRP transparency level** practically eliminates the need for information sharing and private search because the CRP contains all relevant information. Hence, the CRP becomes dominant in the search process.

**(5)** With **the Dazzle CRP transparency level,** buyers consider that all information is already included in the CRP, and their role is to make sense of the price movement and decide what should be done. This approach is coherent with the efficient market hypothesis formulated by Fama (1970, 1991). Despite the belief in the wisdom of the markets, technical analysis was only rarely leveraged. Buyers were either unfamiliar with its principles, voiced scepticism about its efficiency, or did not realize they were using it, e.g., one buyer was using a report whose recommendations were based on technical analysis. In contrast, one respondent praised simple purchase rules based on technical analysis because they avoid decision paralysis and reduce the search costs to zero.

There is an ongoing discussion about the technical analysis efficiency for commodities. For example, Park & Irwin (2007) show that the evidence of technical analysis profitability suffers from methodological bias, and Meng-Feng Yen & Hsu (2010) suggest that most rules do not beat the buy-and-hold or cash strategies.

### 6.2.5. Extended taxonomy of CPM practices

Purchasing and supply chain functional strategy is accomplished using a wide array of specific actions called purchasing/ procurement practices, also labelled strategies (Nollet and Beaulieu, 2005) or levers (Hesping and Schiele, 2015). Commodity price management practices constitute a specific group of procurement practices aimed at managing commodity prices and volatility. To be effective, the choice and execution of these CPM practices need to be tailored to individual situations (e.g., sourcing category, purchase context) (Hesping and Schiele, 2015). Companies underperform when they select inappropriate practices or implement them wrongly (Bensaou, 1999). Hence, to achieve the fit between contextual variables and CPM practices, companies must understand existing CPM practices and their influencing factors that shape their availability and suitability for a given context.

Previous taxonomies investigated CPM practices from a specific viewpoint, e.g., agricultural commodities (Mussell, 2003b) or commodity price risk (Jackson, 1980; Finley and Pettit, 2011), and its mitigation (Fischl et al., 2014; Gaudenzi et al., 2018; Zsidisin & Hartley, 2012; Zsidisin, Hartley, & Collins, 2013).

In contrast, this thesis defines CPM practices more broadly as all activities through which the commodity price management objectives are realized. This broader conceptualization revealed that the existing taxonomies did not account for all meaningful groups of CPM practices and should be expanded and reconfigured (see Section 2.2. for the extended taxonomy of CPM practices).

Compared to Gaudenzi et al. (2018), the new taxonomy significantly expanded our understanding of the sequence and range of CPM practices.

Firstly, market participants must choose from a diverse portfolio of **Search CPM practices** to explore the relevant market and pricing information. Even though this CPM category was omitted in all previous taxonomies (Fischl et al., 2014; Gaudenzi et al., 2018; Mussell et al., 2003), it has strong support in the extant literature (Halldórsson & Svanberg, 2013; Kingsman, 1986; Hobbs, 1997; Mayer & Gleich, 2015; Zsidisin & Hartley, 2012; Maxwell, 2015; Hofmann, 2011).

Unlike Sourcing CPM strategies that focus on discovering the exact transaction price, search is focused on a more generic price determination and is, therefore, distinct from Sourcing CPM strategies.

The findings show that Search CPM practices are not continuous but concentrate on the active buying period (Kingsman, 1986) – see Section 6.1.4. for a detailed outline. This observation is coherent with Ocasio's (1997) attention-based theory of the firm, which argues that managers have only limited attentional capability and, therefore, focus attention on CPM search only when the commodity must be procured (focus of attention), or when the context makes the commodity salient (situated attention), or when a company's rules, procedures, or communications force them to search for CPM information (structural distribution of attention). Data shows that organizational distribution of attention is mostly left to chance and leads to punctuated surges of attention, with all risks that such unsystematic CPM search triggers.

The **Sourcing CPM practices** category roughly corresponds to Gaudenzi et al. (2018). It is the most heterogeneous category and requires a careful selection and combination of CPM practices. In contrast to the Search CPM strategies, which may be spread across the whole procurement process, Sourcing CPM strategies are concentrated into what Kingsman (1986) labelled as the active buying period.

Extant research provides little actionable insight for practitioners concerning the contextual suitability of different CPM Sourcing practices and only contends with generic suggestions and illustrative examples (e.g., Gaudenzi et al., 2018; Zsidisin & Hartley, 2012; Zsidisin et al., 2013). Hence, more research is needed in this area.

**Contracting CPM strategies** are widely covered by scholarly and practitioner research (e.g., Haksöz and Kadam, 2009; Zsidisin and Hartley, 2012; Gaudenzi *et al.*, 2018). The findings confirm that practitioners leverage a wide range of Contracting CPM practices. At the same time, they show that Contracting CPM strategies are particularly vulnerable to CRP transparency, and their misapplication may trigger significant monitoring, enforcement, and

adaptation problems. For example, Zsidisin and Hartley (2012) recommend objective third-party indices for escalator clauses without further elaboration. This research argues that transparent and dazzle CRP transparency are suitable for automatic escalator clauses. In contrast, translucent and opaque CRP transparency may serve as a trigger for a price adjustment negotiation but should not be used in automatic escalators. Finally, black hole and opaque CRP are unsuitable for escalator clauses.

The **hedging** construct is broader than Gaudenzi et al. (2018) because it also encompasses non-financial hedging practices, which are currently somewhat neglected by scholarly literature. In contrast, the extant literature widely studies and recommends financial hedging (e.g., Carter, Rogers, & Simkins, 2006; Aber & Santini, 2003; Dahlgran, 2000; Fu, Zhang, Yao, & Zhang, 2012; Gaudenzi, Zsidisin, & Pellegrino, 2020; Ni, Chu, Wu, Sculli, & Shi, 2012; Pellegrino, Costantino, & Tauro, 2019).

However, surveys document that the use of this CPM practice is unevenly distributed. For example, some 40% of respondents leverage commodity derivatives to hedge commodity price risk, yet a finer-grained analysis shows that German companies hedge predominantly through forwards (50%) while 43% of US companies prefer futures (Bodnar and Gebhardt, 1999). Similarly, DIHK (2012) shows that only 25% of German companies use financial hedging, compared to 68% for long-term contracts or 35% for substitutes.

Finally, this research confirms that financial hedging remains reserved for the biggest companies, while the rest leverage forwards and other non-financial CPM hedging practices. The relative underrepresentation of financial hedging in current business practice may be conditional on important barriers, such as incorrect understanding of derivative markets, fear of financial consequences of erroneous decisions, administrative complexity and credit constraints (Prakash, 2012).

**Active trading CPM strategies** were deliberately separated from the hedging strategies because they imply the active creation of speculative open positions, which increase a company's risk exposure. Current contributions to this group of CPM practices are mostly conceptual (e.g., Finley & Pettit, 2011; Manuj & Mentzer, 2008) or anecdotal (Jones *et al.*, 2007). The findings suggest that practitioners assign them highly negative connotations, e.g., "risky," "hazardous," and "speculative," and internal procedures strictly forbid active trading.

However, the research also uncovered several instances where buyers "secretly" engaged in highly controversial trading activities like selling their forward contracts when they considered the CRP high in the hope of buying the contract back at a lower price later, thus improving the average forward price. Some buyers also intentionally delayed the forward purchase in breach of the approved purchase strategy or manipulated the forward-spot ratio. While the extant literature abounds with examples of the devastating impact of such behaviour (e.g., Kuprianov, 1995; Poitras, 2013; Till, 2008), practitioners did not seem aware of the financial and reputational danger.

Finally, **Adaptation CPM practices** are separated from proactive hedging because they are reactive and leveraged to manage ex-post disturbances not accounted for in the original contract. All CPM practices highlighted by the extant literature were observed in the findings and substantiated by practitioner surveys (e.g., DIHK, 2012). In addition, instances of opportunistic behaviour were observed on both sides and gave strong empirical support for Wathne & Heide's (2000) taxonomy of manifestations of interfirm opportunistic behaviour:

(1) Evasion of obligations when a buyer used an economic slump as a pretext for not buying the contractually committed volumes and instead bought the material "secretly" at a much lower price on the spot market.

(2) Refusal to adapt takes the form of strict contractual terms negotiated from the position of power, which do not reflect the commodity fundamentals such as perishability. Subsequently, buyers insist on these contractual terms even though they do not make economic or practical sense due to the material constraints outside the supplier's control.

(3) Violation covers instances when one party engages in behaviour that was implicitly or explicitly forbidden, e.g., when the buyer saw that steel prices were increasing, he “stole” material from the consignment stock well above the contracted monthly quantity and stored it for future use to avoid paying a future higher price following the escalator clause.

(4) Forced renegotiation was the most widespread type of opportunistic behaviour. For example, the seller terminated the fixed-price contract when prices started to increase dramatically and only accepted spot transactions.

# 7. Conclusion

This chapter formally concludes the thesis. First, it briefly restates the research problem. Next, it outlines the main contributions for theory and managerial implications. Finally, it discusses the limitations of the study followed by directions for future research.

## 7.1. Research phenomenon and question

Despite is practical relevance, the relationship between commodity price management practices and contextual influencing factors is poorly understood (Fischl, Scherrer-Rathje and Friedli, 2014). Considering the complexity and interplay of influencing factors (Gaudenzi *et al.*, 2018), this thesis focused on a single influencing factor, the commodity reference price, which has so far been only implicitly recognized as an important influencing factor.

The literature review revealed many instances where CRP played an important role in shaping CPM practices, however, the construct itself was poorly understood. To close this gap, two complementary research questions were formulated:

*RQ1: What is the suitable commodity reference price conceptualization and measured attributes?*

*RQ2: What are the relevant commodity reference price contingency levels?*

To answer these questions and considering the prior state of the theory, a qualitative research approach was selected that drew on three sources of data: directed expert interviews, semi-structured interviews with purchasing managers, and documentary evidence.

The research was grounded in contingency theory which was complemented with transaction cost theory in the Discussion chapter to consider the meaning of the findings from a rival theory standpoint.

Chapter 4 was dedicated to answering the RQ1. CRP transparency was identified as a suitable CRP contingency conceptualization and, subsequently, four key CRP transparency attributes were identified: accuracy, completeness, publication frequency, and methodology.

Chapter 5 was dedicated to answering the RQ2. The CRP transparency attributes were operationalized and aggregated into the commodity reference price transparency index. Subsequently, a sample of 22 CRP was assessed and classified into the five transparency levels of the CRP transparency index. Finally, the relevance of the CRP transparency levels was evaluated following their impact on CRP functions and CPM practices used.

## 7.2. Implications for theory

This study is the first to develop a holistic, multidimensional, and complementary conceptualization of CRP contingency, which was frequently implicitly mentioned in scholarly literature (e.g., Mussell *et al.*, 2003; Figuerola-Ferretti and Gilbert, 2005; Fattouh, 2011; Radetzki, 2013; Rauterberg and Verstein, 2013; Maxwell, 2015; Verstein, 2015; Johnson, 2017; Gaudenzi *et al.*, 2018) but not explicitly recognized as an important contingency factor. The multidimensional conceptualization of the CRP transparency construct provides a more holistic and precise representation of the CRP contingency than previous studies focusing on a single CRP transparency aspect (e.g., IEA et al., 2011; IOSCO, 2013, 2015). It also provides a unifying lens for those contributions in which several CRP contingency attributes can be inferred without being recognised as such (e.g., Azzam, 2003; Cinquegrana, 2008; Valiante and Egenhofer, 2013; Veerman *et al.*, 2016; Duffie, Dworczak and Zhu, 2017).

A multidimensional CRP conceptualization also allows researchers to investigate the balance of individual CRP transparency attributes suggested by Rauterberg and Verstein (2013) and to explore the advantages and disadvantages of different CRP transparency attribute set-ups and thus nuance Radetzki's (2013) view of universal superiority of commodity exchanges' generated CRP.

The findings regarding the barriers to CRP transparency improvement further extend our understanding of CRP improvement in different contexts. Firstly, the hypothesis of the relentless progress of CRP transparency formulated by Radetzki (2013) is substantiated for highly liquid and standardized CRP. In contrast, the evolutionary assumption is more nuanced for the less liquid or standardized commodities where legitimate barriers to trading on organized exchanges may exist. Hence, lower levels of CRP transparency may not be a temporary and evolutionary phenomenon. Instead, the concept of fitness-for-purpose advocated by Rauterberg and Verstein (2013) or Johnson (2017) seems more plausible for explaining the co-existence of different CRP transparency levels embodied by "archetypal" CRP transparency set-ups where all four attributes are aligned. Finally, fitness-for-purpose also explains a number of imbalanced CRP where CRP issuers deliberately trade-off individual CRP attribute transparency to serve particular business purposes.

Furthermore, CRP transparency generates theoretically important recommendations for scholarly research regarding the suitability of CRP use as proxy of transaction prices and may help scholars evaluate the representativeness of the source data and interpret results accordingly. The CRP transparency index with empirically determined and asymmetric cut-off points also allows researchers to evaluate and compare the CRP transparency level to other CRP. The proposed method is much simpler than Figuerola-Ferretti and Gilbert (2005) and also applicable to comparing CRP covering different commodities.

Using contingency theory as a theoretical lens, this research brings important new insights into how CRP transparency impacts CPM practices:

(1) CRP transparency shapes the internal structure of CPM practices. While various configurations of CPM practices can be found in the extant literature (e.g., Mussell et al., 2003; Kang and Mahajan 2006), this research highlights the importance of contextual variables in shaping their internal configuration. Hence, current CPM practices should be considered an umbrella term for multiple variants that fulfil the same basic CPM function through different configurations that trigger different opportunities and risks.

(2) This research substantiates the observation of Zsidisin and Hartley (2012) and Gaudenzi et al. (2018) that no CPM practice is universally suitable. Hence, depending on the CRP transparency level, CPM practices may achieve a fit or under- or overfit. The exploratory nature of this research contends with the fit as a congruence approach, where the fit is determined as a CPM practice used by market participants. While this approach provides some interesting insights and shows that different CPM practices should be used for individual CRP transparency levels, more sophisticated types of fit are necessary to generate theoretically sound recommendations about a particular CPM practice fit to a CRP transparency level.

(3) This research provides contrasting evidence for ISO-fit prediction (Donaldson, 2001) where different CPM practices may suit a CRP transparency level. Especially the TCE perspective suggests that perfect ISO-fit does not exist because CPM practices always differ in transaction costs or risks. However, the salience of these differences depends on the granularity of the analysis. This finding is theoretically important for advancing the research into CPM practices because it may shed light on the exact mechanisms through which companies select a particular CPM practice from a battery of “equally” suitable CPM practices.

(4) CRP transparency hetero-performance is strongly supported by the data, and the hetero-fit prediction (Donaldson, 2001) explains why more transparent CRP oust their less transparent siblings as demonstrated by Figuerola-Ferretti and Gilbert (2005) and Radetzki (2013). Hence, companies may improve CPM performance by moving to a higher CRP transparency level by adopting a more transparent CRP.

(5) Finally, contingency theory is instrumental in resolving a puzzling problem related to the use of clearly underfit CPM practices by some companies. It explains the existence of “outlier” CPM practices by the impact of contradictory contingency factors, e.g., company size, purchased volume, or supply market structure. This finding supports Gaudenzi et al. (2018), who argue that the choice of suitable CPM practices is complex and impacted by an array of contingency factors.

A transaction theory approach (Coase, 1937; Williamson, 1985) to CRP transparency impact on CPM practices extends and complements the contingency theory insights and allows theorizing that:

(1) Different CPM practices generate different types and amount of transaction costs for a given CRP contingency level. These aggregate transaction costs can be compared and, in line with the transaction cost economizing hypothesis (Williamson, 2008), the most suitable CPM practice chosen. Hence, in line with the cost economizing hypothesis, the level of fit between the CRP transparency level and CPM practices corresponds to the magnitude of transaction costs generated by the CPM practice compared to transaction costs generated by an alternative CPM practice.

(2) Different CPM practices may generate a similar amount of transaction costs for a given CRP contingency level but differ in the type of transaction costs. The mix of transaction costs can be compared, and the most suitable CPM practice can be chosen based on the company's preference.

(3) Some CPM practices may not be available for some CRP contingency levels because the transaction costs are too high for the transaction to happen.

(4) Consistent with the observation of Chiles and McMackin (1996) on the impact of trust and risk appetite variables on the optimum governance mechanism choice, a CPM practice generates different amounts of transaction costs for different CRP transparency levels. Therefore, a CPM practice is relatively more or less suitable for different CRP transparency levels.

While coherent with TCE predictions (e.g., Williamson, 1981, 1985, 2007), these observations are theoretically important for theorizing CPM practices and

explaining why companies select different CPM practices for different CRP transparency levels, why some CPM practices are not available or suitable for some CRP transparency levels, and why even seemingly equally suitable CPM practices are not equivalent from a transaction costs point of view. Furthermore, these observations provide strong evidence for the dynamic equilibrium phenomenon where the change in contingency factors leads to a change of CPM practices to maintain optimum fit (Donaldson, 2011). For example, the improvement of CRP transparency level may trigger new CPM practices, such as financial hedging, and may change the way existing CPM practice are performed, e.g. the escalator clause.

Besides these fundamental contributions to the CRP transparency construct and its impact on CPM practices, this thesis extends reference price research (e.g., Lowengart, 2002) (a) by identifying the CRP as a specific type of external reference price, (b) by providing a grounded definition of the construct which clearly differentiates it from the other external reference prices, (c) by providing a grounded segmentation of CRP transparency levels which may be applicable to other reference prices.

Finally, although a few recent studies have dealt with the difference between the CRP and the transaction prices (e.g., Caliskan, 2007, 2009), extant literature lacks actionable tools that would assist scholars and practitioners in understanding the degree of overlap. To close this gap, this thesis provides a theoretically grounded framework based on the level of CRP transparency, which informs the degree of mismatch between the CRP and the transaction prices.

## 7.3. Managerial implications

This research has important implications for CRP consumers, issuers, and regulators by providing a tool for assessing quality, evaluating fitness for purpose, and determining what CRP functions are available and CPM practices suitable.

### 7.3.1. Implications for CPR consumers

Starting with CRP consumers, they have traditionally applied intuitive strategies or combined several randomly selected CRP transparency attributes to evaluate CRP quality. Thanks to the clear operationalization of CRP transparency attributes and the CRP transparency index, such strategies should no longer be necessary. Instead, practitioners acquire an actionable tool for assessing the CRP transparency level and determining how to use the CRP in their business practice and deciding whether the CRP is fit for the intended purpose.

Furthermore, companies may use the CRP transparency index to audit the CRP leveraged or considered by the procurement/ sales department. Especially if alternative CRP exist, companies may compare their transparency levels, consider their implications, and choose the most suitable one. This is particularly important during periods of high turbulence when business partners may act under stress and (a) accept an unsuitable CRP, (b) accept a suitable CRP but apply an unsuitable CPM practice, (c) accept an unsuitable CRP and misapply it.

In addition, companies may leverage the CRP transparency index to investigate existing CPM practices and determine whether they correspond to recommendations and whether there is a good reason for any deviation.

Buyers may also optimise the internal structure of CPM practices to minimise transaction costs and address the most relevant classes of risks. Hence, the challenge is not just about choosing the right CPM practice but also about using the right internal configuration of the CPM practice.

Companies may also consider the CRP vulnerability to market disturbances. Especially the Translucent CRP transparency level is potentially susceptible to the hikes of market volatility. In consequence, the CRP accuracy may have to be temporarily discounted and delayed CRP publication accounted for.

A finer-grained insight into CRP configuration reveals the existence of imbalanced CRP. These are potentially dangerous for companies who leverage heuristics for selecting CRP. For example, a reputed institution may fulfil high

methodological requirements, but the CRP may be highly lagged, inaccurate and incomplete. The analysis of the CRP transparency index decomposed into individual CRP transparency attributes may reveal these structural CRP weaknesses.

The CRP transparency index also allows companies to assess the magnitude and implications of any CRP change. Some CRP transparency changes may be negligible, do not alter the overall CRP transparency level, and require only limited action. In contrast, some changes may fundamentally alter the CRP transparency level and require a major overhaul of the CPM practices.

Findings also showed that practitioners only follow the CRP during the active buying window with potentially devastating consequences. While this feature is not inherent to the CRP transparency level, higher levels of CRP transparency streamline ongoing search. In contrast, lower levels of CRP transparency act as a barrier to continuous market observation because important and sustained search effort is required. Companies may decrease the missing-out risk by putting in place systems encouraging more systematic search for lower CRP transparency levels inspired by Neely´s (1998) three modes of measurement: (1) put in place 'diagnostic controls' against a critical performance parameter, e.g., periodically mark-to-market the existing contract and react when a significant CRP deviation occurs, (2) widen the purchase window and regularly 'check health' that the required performance is achieved through the right tools and processes, and (3) periodically challenge the assumptions that underpin existing strategy by encouraging buyers to observe the CRP and compile intermediate reports during the "inactive window" that would be reviewed with the management.

In addition, the development of a measurement scale based on a geological metaphor provides a valid and reliable instrument to evaluate the exact level of CRP transparency, which has thus far been absent and had to be supplemented by *ad hoc* defined and vaguely justified CRP attributes (e.g., WTO, 2005; Johnson, 2017).

Finally, this research focused on a single contingency factor which makes it vulnerable to business situations when several, potentially contradictory contingency factors are at work simultaneously. The research suggests that CRP transparency may be the dominant contingency factor in some contexts but may be of less importance in others. Consequently, companies must complement CRP transparency with other relevant influencing factors. They may conclude that company size, commodity importance, regional idiosyncrasies, or any other contextual factor may call for (a) not using an otherwise suitable CRP, (b) using a CRP that is not fit for purpose, or (c) using CPM practices that are in misfit to the CRP transparency level. While these situations cannot be precluded, CRP transparency index allows companies to evaluate the degree of risk and search for an alternative CRP, CPM practice or both.

### 7.3.2. Implications for CRP issuers

The research also has important implications for CRP issuers. First, the CRP transparency index is a simple tool for determining the CRP transparency level and CRP issuers can evaluate whether the CRP is positioned as intended. Any deviations may then be immediately addressed by reconfiguring the CRP transparency attributes.

Second, the CRP transparency index can structure the dialogue between CRP issuers and users about the CRP fitness for purpose, market demand for a CRP transparency evolution, CRP issuer intentions, effort required to improve the level of a CRP transparency attribute. Importantly, the reconfiguration may go both ways, the CRP issuer may reinforce some CRP transparency attributes and decrease others.

Third, focusing specifically on CRP improvement, the multidimensionality and complementarity of CRP attributes signal that significant investments in improving just one CRP transparency attribute may result in negligible overall CRP improvement. In addition, CRP issuers should carefully evaluate whether

improving a CRP transparency attribute does not hamper the other CRP attributes.

Furthermore, the CRP transparency index provides some guidelines regarding what and by how much the CRP transparency attribute has to be modified to achieve a better mix of CRP attributes or a different CRP transparency level. CRP issuers may therefore experiment with different attribute configurations and see what benefits and risks they bring, what additional effort is required, and how the change potentially enhances/ disrupts existing business practices.

Fourth, on a purely practical level, the incumbent CRP issuer may leverage the CRP transparency index for comparing and evaluating the properties of a new rival CRP and estimate whether the new CRP transparency configuration brings significant added value and puts the existing CRP at risk. In addition, CRP issuers may search for inherent weaknesses of rival CRP and offer specific improvements such as additional regional prices, selectively increased publication frequency for some quotes, or limit access to some valuable information to premium subscribers only.

Fifth, while the CRP transparency index operates with four transparency attributes, nothing prevents CRP issuers from taking a broader view and differentiate the CRP in lesser attributes, e.g., representational transparency or acceptability. These aspects may be salient to some market participants and bring significant added value.

### 7.3.3. Implications for regulators

Recent regulatory effort in the CRP domain suggests that regulators believe that the more transparency, the better. However, this research brings important insights that nuance this claim. Firstly, different stakeholders have different CRP transparency expectations. By imposing a regulatory framework, regulators

necessarily favour some stakeholders. Regulators should therefore explain the rationale for the regulation, consider its practical feasibility, and impact on the market. In contrast to the prevailing opinion that more CRP transparency is always better, the fitness-for-purpose perspective suggests that regulators should consider the requirements of different CRP consumer groups and define the appropriate trade-offs as well as the optimum CRP transparency level. More research is needed to determine whether fitness for purpose is a better measure for configuring CRP than the perhaps elusive target of Dazzle CRP.

Secondly, regulatory efforts focused on just one CRP transparency attribute may backfire and lead to an imbalanced CRP which fails to achieve its objective. In addition, regulators should be mindful that any improvement in one CRP attribute may trigger unexpected second degree consequences such as limiting CRP completeness or publication frequency, which may disrupt existing CPM practices and temporarily destabilize the market. Finally, regulators should consider the time and effort needed to modify a CRP transparency level.

## 7.4. Avenues for further research

Scholars may find this study useful in advancing several avenues of reference price research. In particular, future research may find the CRP transparency dimensions and aggregate CRP transparency levels from this study applicable to other types of indices and benchmarks, such as the financial indices and other types of external reference prices. Furthermore, future studies could examine a larger and more versatile sample of CRP, or explore different industries and regions.

This research revealed that little is known about the impact of various stakeholders groups on the CRP transparency attribute configuration and evolution. Further research may therefore shed more light on this fundamental issue. Related to that, a potential future research direction would be the adoption of a seller, regulator or CRP issuer perspective, which might reveal new CRP

transparency attributes or reconfigure their relative weights.

Future research could further explore the shape and relative strength of the proposed relationship between CRP transparency and CRP functions or CPM practices. In addition, the relationship may be tested quantitatively on a large sample.

Scholars may use this research as a stepping stone for investigating and testing the relevance of the CRP transparency cut-off points. In particular, a combination of qualitative and quantitative methods might bring insightful insights. Furthermore, the CRP transparency instrument developed in this study should help researchers to investigate the level of CRP transparency surveys and thus quickly provide practitioners with actionable information about CRP they are using in their business practice.

This research offers a more nuanced view of the CPM practices ISO-fit, emphasising the level of granularity. However, only an empirical study can substantiate this tentative proposition.

Furthermore, a more detailed study examining and quantifying the performance benefit of higher levels of CRP transparency would represent a valuable contribution to CRP and CPM literatures.

This research has established an interplay of CRP transparency with other contingency factors. Further research is recommended to explore this interesting and so far untested relationship.

Future studies may also explore the hierarchy of CPM influencing factors. Subsequently, researchers may develop actionable frameworks for selecting effective CPM practices under different configurations of influencing factors. In particular, the critical realist ontology focused on exploring the underlying causal mechanisms (Mingers, Mutch and Willcocks, 2013) may be a promising research perspective.

## 7.5. Limitations

Although this research contributes to theory and practice in multiple ways, several limitations should be considered when interpreting the findings. First, a purposive sampling of CRP and interviewees, a non-probabilistic data sampling method, offers a low likelihood that the data is statistically representative of the whole population (Saunders, Lewis and Thornhill, 2009). Secondly, the sample is heavily biased toward the manufacturing and processing sectors. Furthermore, this research takes primarily the procurement manager perspective and may be therefore biased towards some CRP transparency attributes while ignoring others.

Third, while the sample of 22 CRP was selected for maximum heterogeneity as recommended by Patton (2014), there are tens of thousands of CRP (Johnson, 2017) and it cannot be excluded that imbalanced CRP are the norm rather than the exception as observed in this research, that the frequency of CRP transparency levels is completely different, or that there exist distinct transparency levels that were not captured by this research.

Fourth, the semi-structured interview data collection method is by definition non-standardized and the order of questions or additional questions may have biased the answers. Fifth, neither the interviewer nor respondent bias (Saunders, Lewis and Thornhill, 2009) can be excluded: respondents may have felt uncomfortable with the novelty of the topic and the researcher may have misunderstood or misinterpreted the complex descriptions of CPM practices and their interplay with the CRP. Sixth, many respondents required total confidentiality, hence the single researcher coding was the only alternative. While precautions were taken to ensure reliable coding, the researcher coding bias cannot be excluded. Furthermore, due to the highly specialized and also confidential nature of the phenomenon of interest, the research relied on a single respondent and the most obvious corrective measure in interviewing multiple informants recommended by Kumar, Stern and Anderson (1993) could not be taken. While there were no indications of deliberate manipulation by the respondents, the single informant bias cannot be excluded.

Finally, interviews were conducted in multiple languages and the results had to be subsequently translated into English. The domestication approach following Czarniawska´s (2004) recommendations should minimize the translation bias, yet, some loss or shift of meaning cannot be excluded during the translation process.

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# APPENDICES

**Appendix 1: Commodity reference price analysis**

## Commodity reference price analysis

Commodity reference price

| |
|---|
| Banana CRP by Sopisco News |

Assessed

| Report name | Web page: | Date assessed |
|---|---|---|
| Sopisco news | https://issuu.com/sopisconews/docs/demo | 11.12.2022 |

Accuracy

| **Respondent n.** | **Relevant quote** | **Assessment** |
|---|---|---|
| 1.<br>Buyer in retail | I never heard about Sopisco report and assume that neither did my suppliers because they would have used it during negotiation. … We have four frame agreements with suppliers. … selected based on e-auction. … [suppliers] can change prices every month based on market evolution. … we want to move toward short-term prices tendered through e-auction. | (0) Blackhole |
| 2.<br>Buyer in retail | We have our internal report [issued by headquarters], which is informed also by Sopisco | (1) Opaque |

| | | |
|---|---|---|
| | news. … [But it was much more important to] follow competitors' prices and actual supplier offers. … We had no contract with the suppliers, so there was no point in tracking any index, and I still think it would be useless because [the price] depends on how much they bought [bananas] for and [for how much] they needed to sell it. | |
| 3.<br><br>Buyer in retail | I heard about this index. … The headquarters gave us a [internal] report with maximum prices for all fruit. … I am sure [HQ] look at the index … we did not use it in our negotiations – we wanted very specific banana grades. | (1) Opaque |
| 4.<br><br>Buyer in retail | I've never heard of Sopisco's price. We never used it in negotiations. Maybe it's used by the ripeners and our suppliers, but we've never discussed it. … I only care about bananas that are available locally. … Competition and negotiation with suppliers (are key). | (0) Blackhole |
| | **TOTAL assessment** | **(1) Opaque** |

Completeness

| |
|---|
| Chart with weekly average selling price for European Union, Mediterranean and Russia, Italy, Germany, Spain, CIF incoterms, USA, 9 wks history, single price. Small and Large vessel value per cubic feet. Average prices per brands in Italy (5 brands) – single price or narrow range.<br><br>Detailed specification of the product, cargo, port, charges.<br><br>Bananas selling prices in EU – different grades.<br><br>Bunker prices for different destinations, |

Market information about various destinations – prices as range, number of boxes, price evolution to previous week, background information such as meetings, market sentiment.

Ships loaded during the week – vessels, number of boxes, destination, banana grade. Summary information of banana ships loaded.

Review of banana related press-releases.

Publication frequency

Weekly

Methodology

Sopisco News edited by Nova Media Publishing Inc.-Panama, is a weekly publication for the exclusive use of its subscribers who are aware that the information supplied, is not supported by any official institution such as commodities exchanges, mercantile exchanges, freight exchanges etc. Sopisco News is addressing sectors involved in the banana industry, exporters, traders, logistics, transportation, government bodies, analysts and public entities in general. The publication delivers referential selling prices of bananas in the international spot markets, freight rates related to the banana transportation as well as news for the interested subscribers. Being bananas not a commodity negotiated in trading or agricultural exchange boards, price information is obtained verbally from market sources, from traders, or market watchers of places where exports or sales originate.

On occasions Sopisco News reports prices offered by sellers to buyers which might then differ from the actual prices finally agreed between sellers and buyers depending also on volumes traded.

In the case of freight rates for banana cargoes, fixtures do not reflect terms of Charter Parties or Contracts of Carriage but are obtained from information circulated among brokers.

Although Nova Media Publishing Inc. considers it's sources to be reliable, cannot guarantee the accuracy and therefore the following disclaimer published within each issue must be taken into consideration:

… FACTUAL MATERIAL IS OBTAINED FROM SOURCES BELIEVED TO BE RELIABLE, BUT THE PUBLISHER IS NOT RESPONSIBLE FOR ERRORS OR

OMISSIONS CONTAINED HEREIN. RIGHTS OF REPRODUCTION AND DISTRIBUTION ARE RESERVED TO THE PUBLISHER.…"

There are different modalities of purchase and sales for bananas in the international trade, regulated mainly by the Incoterms 2010 … under which the purchase and sale of fruit could be arranged. Due to the different modes of negotiations among the participants, prices published by Sopisco News-Nova Media Publishing Inc. could show significant differences according to the specific sale agreements as per Incoterms or other international regulations. There are mayor differences according to the cases, per fruit Delivered at the Terminal (DAT) or Delivered at Place like the case of a wholesale retailer could be (DAP) and for ripened fruit.

The referential prices published by Sopisco News-Nova Media Publishing Inc., for the United States, Europe, Mediterranean countries, Ukraine, Russia and other markets are based on the Incoterms 2010 rules which are more adapted to the moderns trade than its previous editions. Prices published for the USA and EU markets particularly refer to the spot prices of bananas sold each week and do not reflect prices for sales under contracts for one, two or more years, which in the case of some countries might represent up to 90% of the fruit sales and where in most cases prices agreed are lower than the spot market prices. Prices under contract may have terms very different from those of the bananas sold on spot basis during the period of the year taken into consideration.

… In the shipments by containers following additional costs (but not limited to them) might be involved, depending also from the port and the terminal:

1. Terminal handling charges
2. Transit documents from container terminal to shipping location/cold storage location

…

**Figure 15: Excerpts from CRP methodology. Source: https://sopisconews.com/disclaimer**

Commodity reference price functions observed

| CRP function | Observed | Quote / Comment |
|---|---|---|
| Anchor | | |
| Price discovery | | Suppliers never used it as negotiation argument. |

| | | |
|---|---|---|
| Information source | (R2)<br>(R3) | Informs the central report. |
| Value holdings | | |
| Contract reference | | |

Commodity price management practices observed

| CPM practice category | CPM practice | Quote / Comment / Description |
|---|---|---|
| Search | | Benchmark price with other regions, benchmark with other suppliers, permanent market observation for prices (R1),<br>Follow price report issued by HQ, observe competitors and their prices, observe available supplier capacity, market conditions (R2), (R3), (R4),<br>Importance of central intelligence about actual situation in ports (R4)<br>Follow consumer price index (R1),<br>Share competitor prices with other suppliers during the negotiation phase (R1), |
| Sourcing | | E-auction to select long-term supplier and monthly renegotiation (R1), (R2),<br>Weekly tenders with approved suppliers (R4)<br>Regular tenders with other market participants (R1),<br>Weekly tenders because price changes daily + negotiation (R2)<br>Negotiation informed by green bananas plus labour plus ripening plus brand plus transport. But final negotiation always haggling. (R4) |
| Contracting | | Long-term frame agreement with monthly renegotiation clause (R1)<br>Short term fixed price contracts (R1) (R2) (R3), (R4)<br>No-point in pegging prices to an index because the prices were driven by actual market situation (R2)<br>Volume discounts and back-bonuses forbidden by the regulator, they used to be calculated annually depending on actual volumes. (R4) |
| Hedging | | Not observed |

| | | |
|---|---|---|
| Active trading | | Not observed |
| Adaptation | | Monthly renegotiation based on vague criteria like alternative offers, supplier input prices, availability of ripened bananas → replace with regular quarterly tenders and agree fixed price to avoid haggling and streamline the delivery chain (R1)<br>Autonomous adaptation based on price offers (buy more or less bananas) (R3)<br>If bananas price moves within the contract period, both sides try to renegotiate or buy from other supplier (R4) |

**Appendix 2: Coding scheme for directed expert interviews**

# Coding scheme for directed expert interviews

Figure 16 outlines the coding scheme for the directed expert interview. Table 56 shows illustrative quotes for the main Accuracy label, subdivided into three labels: definition, label, and relevance. The same pattern was applied to all other main labels.

'1.7. Generic comments concerning CRP transparency ' gathered relevant comments about the CRP transparency construct. They were revisited in conjunction with CRP transparency construct conceptualization.

'1.8. Miscellaneous' contained all potentially relevant codes unrelated to existing codes. They were later revisited and reclassified, turned into a code, or discarded.

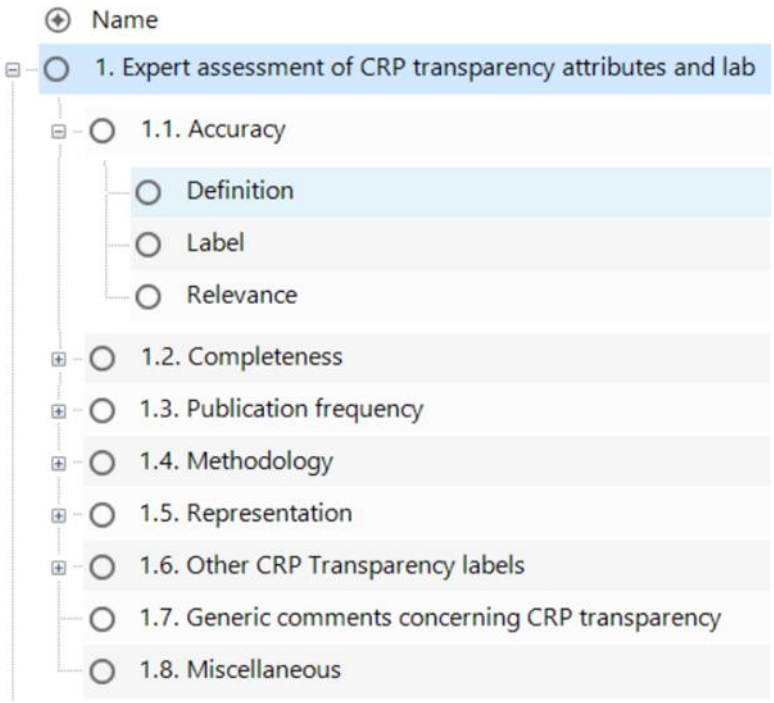


**Figure 16: The coding scheme for the directed expert interviews. Source: Author.**

| | |
|---|---|
| Accuracy | Yes, I prefer the more objective and respected LME for non-ferrous metals. I know there are other exchanges, such as Central Asian Exchange etc., but it is not objective for our location. It reflects the strength of the market where the index is displayed. But in Europe, the index lacks objectivity because I buy locally. But if I am in the South America the other index will be relevant for me. So relevant to the area and the type of business I'm in.<br><br>The objective price reflects that market or reflects that exact transaction. For example, the exact price is the LME price. On the contrary, some other prices may be calculated from some statistics. And it tells you where that market is, but it's not the exact price, it's not traded for that. That's what we have to watch out for.<br><br>… maybe a fictitious index may exist, and I would assign it a relevance rate of 65%, so I can trust that index because it reflects that market. But it's not the actual cheapest price at which somebody is buying. I would like to have this information that my competition does not get, and I am ready to pay a lot for it. |
| Definition | How it fits the reality of the market.<br><br>What is the rate of extrapolation? How can I predict that price into the future? Can I rely on it? For what period of time? How do I know that the price is objective? How should I work with that price? How can I be sure that I don't have old data? I want to say, but here's what the data say.<br><br>What counts for me is the accuracy of that price, its reliability, and how it matches that real market price. The robustness tells me how that price was obtained.<br><br>Well, I'd like it to tell me exactly where the market price is.<br><br>I hadn't thought that much about the definition. I focused on the main factors.<br><br>Accuracy means quality. That it says what it says correctly without error.<br><br>The price is not distorted, there's no hidden interest, and it's consistent with what it's trading for.<br><br>Here we have to separate accuracy - information transparency - how accurate that index information is and then how accurate it is methodologically. |

| | |
|---|---|
| | Accuracy is a relative thing. It depends on what volumes you buy and what you do with the benchmark price. |
| Label | Objectivity<br><br>Objective peg to reflect what is happening in the market<br><br>I'll take it line by line. Internal transparency, it's relevant. I wouldn't categorize it into multiple categories. But now it looks like I'm contradicting myself, I would give away fairness, the index will never be fair because it's fair to both sides. If the index suits you, you think it's fair, but the other side may look at it differently,<br><br>I've got Simple and Accurate as the best labels. But internal transparency, I understand. The word unbiased is too complicated. Average buyer won't understand it. No let's stay with accurate.<br><br>I would rename it to a measure of objectivity.<br><br>To me, objectivity is the first choice. The second guess is relevance, I would say it's irrelevant until both sides agree,<br><br>Accuracy, I understand it. It's OK.<br><br>Narrowing it down on internal transparency,<br><br>Should the price really be Representative of my market?<br><br>The central reference price doesn't have to be exactly for me. Maybe I'm not interested in the absolute amount, but just the relative movement<br><br>When I think about it, the internal accuracy is not at all clear to me. It may be similar to accuracy, but it doesn't have the same meaning.<br><br>Reliability of information source and Trustworthiness don't belong here for me.<br><br>I suggest Fairness.<br><br>Accuracy- you can actually go to the stock market for that. This is where the distinction between reference price and reality gets blurred. |
| Relevance | Definitely relevant<br><br>should include it |

| | |
|---|---|
| | I look for accuracy in a reference price. What is the point if it is not accurate?<br><br>It is fundamental. The objective price reflects the market. The reference price reflects the transaction exactly. For example, LME represents the exact price. On the contrary, other reference prices may be calculated from some statistics. This other reference price tells you where that market is, but it's not the exact transaction price. That's what we have to watch out for. |

**Table 56: Coding scheme with illustrated examples**

**Appendix 3: Coding scheme for interviews with purchasing managers**

# Coding scheme for interviews with purchasing managers

The interviews were coded into four thematically separate categories.

- Individual CRP transparency attributes (see Figure 17). The findings were leveraged to operationalize the CRP transparency attributes and get insight into how practitioners perceive and manage individual levels.
- CPM practices observed (see Figure 18). The findings were leveraged to explore within-group homogeneity and cross-group heterogeneity of individual CRP transparency levels.
- CRP functions observed (see Figure 19). The findings were leveraged to explore within-group homogeneity and cross-group heterogeneity of individual CRP transparency levels.
- Individual CRP (see Figure 20). The findings were leveraged to create the aggregate CRP transparency index.

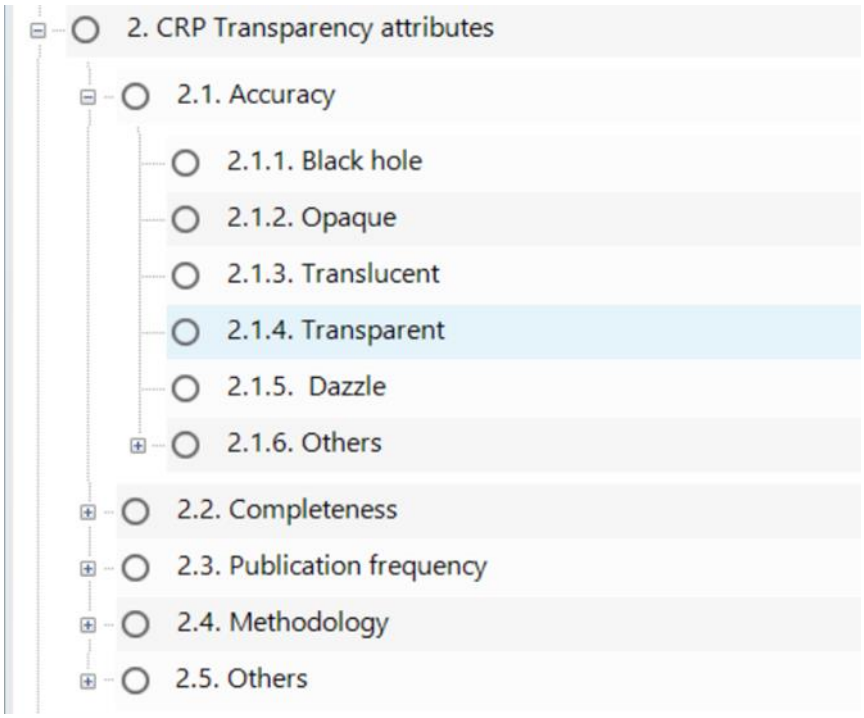


**Figure 17: Coding scheme regarding CRP Transparency attributes extracted from NVivo11. Source: Author**

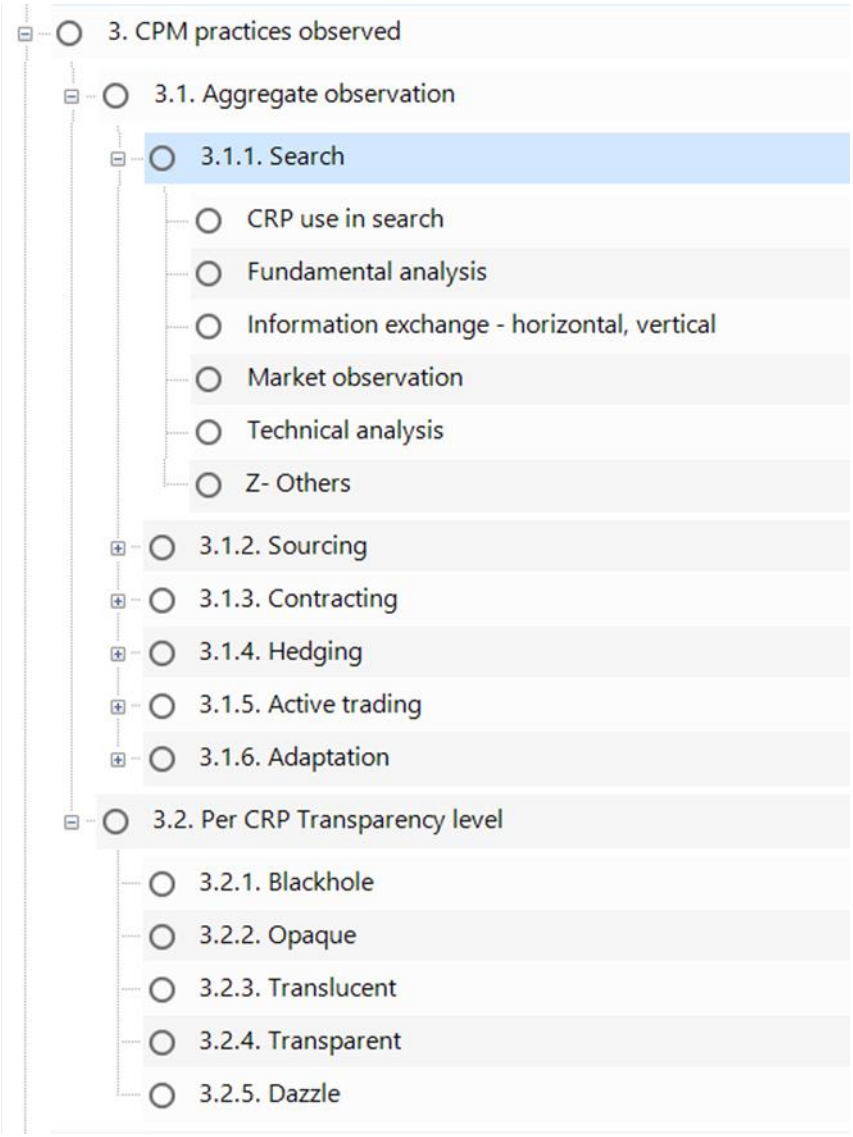


**Figure 18: Coding scheme regarding observed CPM practices, extracted from NVivo11. Source: Author**

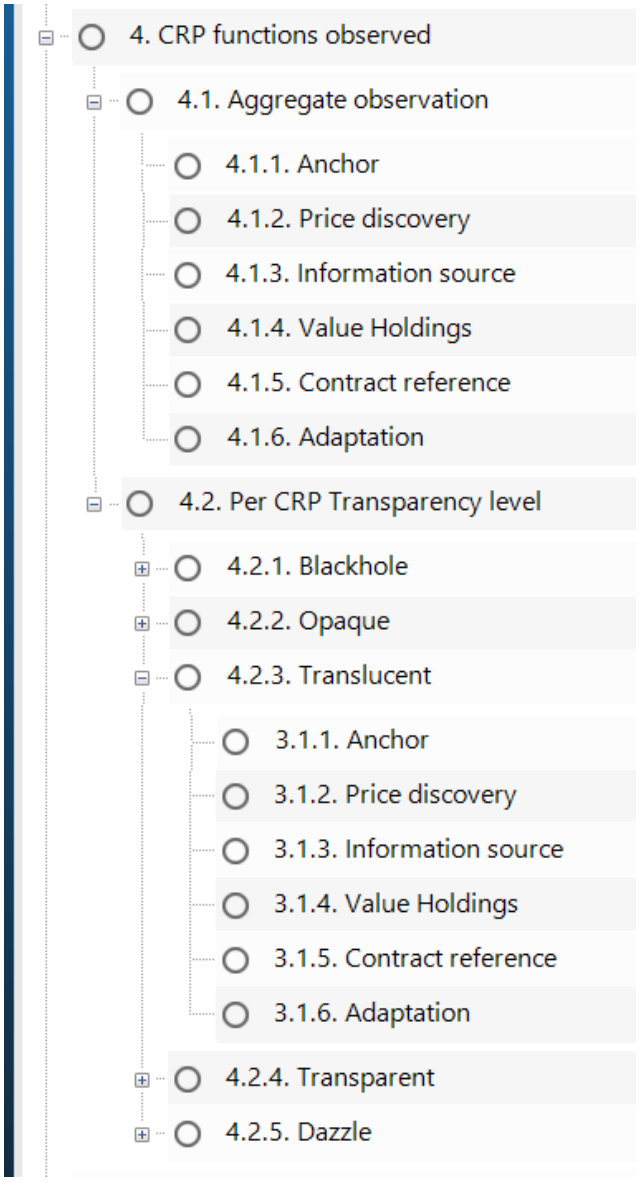


**Figure 19: Coding scheme regarding observed CRP functions, extracted from NVivo11. Source: Author.**

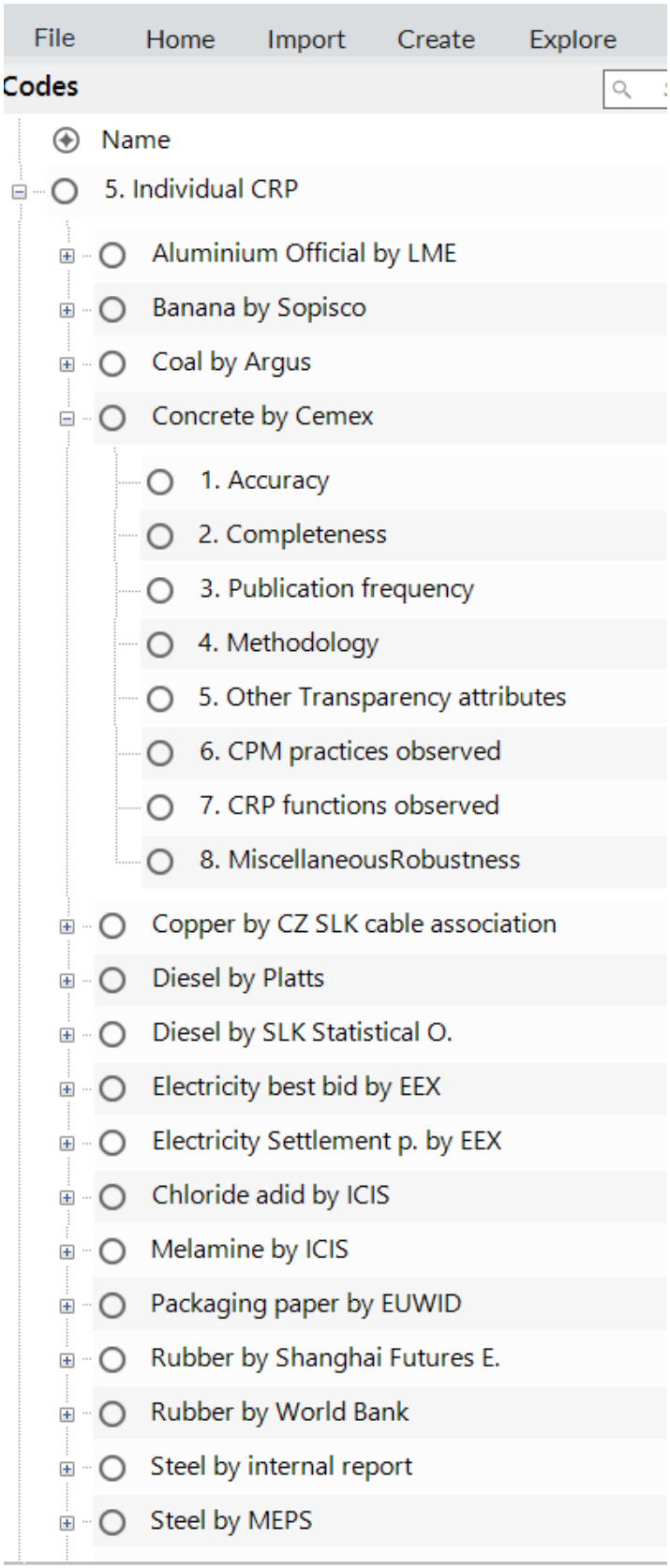


**Figure 20: Coding scheme regarding the assessment of individual CRP extracted from NVivo11. Source: Author.**

# A.1 Detailed overview of CRP transparency functions

This section provides a detailed overview of CRP transparency functions.

## A.1.1 Anchor

Anchors, or reference points, serve as a basis for comparing and evaluating the outcomes of business activities (Kahneman, 1992). Anchors are normative, aspirational, expectational, or a combination of the three (Mazumdar, Raj & Sinha, 2005).

With ***expectation-based*** **CRP**, buyers expect to pay a price equal to the CRP. The mechanism can be illustrated by the "world reference price," defined as the CRP prevailing in a market where most trade occurs (Bukenya and Labys, 2005). It emerges wherever commodity markets develop into hubs capable of determining and imposing the price for the whole market (Defeuilley & Meunier, 2006). For example, the London Metal Exchange (LME), with more than 80% of global non-ferrous trading, provides expectational CRP for a standardized quality of base metals, which is used as a reference for business-to-business trading across the world (Enke, Geigenmüller and Leischnig, 2012). Market participants then judge the performance by comparing the price offered to the world CRP (Mattos, 2015). A price difference must be justified by grade, location, and other conditions, but the CRP value is not subject to negotiation (Figuerola-Ferretti and Gilbert, 2005).

Expectational CRP not only shapes the price discovery process but also triggers the standardization of contract terms in terms of the quality, delivery terms, and volume traded. This trend is particularly palpable in energy exchanges, where large volumes are traded daily based on these standard terms (De Almeida, 2020).

However, expectational CRP backfires when suppliers deliberately bias the CRP and then apply discriminatory pricing or secret discounting against the official CRP. For example, such manipulative behavior was observed in the aluminum market in the 70s (Radetzki, 2013) or impacted lithium trading in the 90s (Maxwell, 2015). Needless to say, it causes significant price differences across market participants, harms less informed/smaller buyers, and reduces the CRP utility.

***Aspirational* anchors** are based on comparing what others pay for the same product and serve as the basis for setting organizational goals (Mezias, Chen and Murphy, 2002). Thus, the fact that somebody pays a higher/lower price leads to upward/downward aspiration level adjustment for other social group members. For example, the internal reference price among farmers was positively impacted by the highest price of the year, price expectations for the next month, estimated break-even price, and the external reference market price that served as the aspirational anchor (Mattos, 2015).

The aspirational CRP function is also apparent in “Champion” negotiations: once the leading sellers and buyers had fixed the iron ore price, it became the benchmark for the rest of the market for a given year (Sukagawa, 2014). Another clear-cut example is the “beat the index” attitude in annual steel negotiations (Moosmayer et al., 2012). Finally, Boyce (1998) leverages the CRP aspirational anchor to compare the zinc transaction prices achieved by the procurement syndicate and concludes that the syndicate progressively increased the savings from 2% in 1924 to 15% in 1934.

However, aspirational anchors may be problematic in some contexts. For example, Raskovich (2007) and Cason et al. (2003) explore aspirational CRP and conclude that haggling against the posted price in oligopolistic markets encourages suppliers to inflate posted prices and subsequently grant discounts only to some customers. Thanks to this strategy, buyers end up paying higher prices despite the discounts received on the aggregate level. At the same time, large price dispersions among buyers are observed, suggesting that inflated

posted prices may favor large or informed buyers and, therefore, create a disincentive for the joint effort to improve the anchor quality.

**Normative** anchors are those that market participants consider “fair.” This generally means that the observed price is coherent with a previous price level, competition prices (Bolton, Warlop and Alba, 2003), or equal to actual costs plus a reasonable profit (Sinha, 2000). Normative anchors are often evoked when prices are not transparent, or buyers are locked into the category (Mazumdar, Raj and Sinha, 2005). The former is apparent in the wine trade, where the most prestigious Bordeaux wines serve as a reference for pricing lesser brands (Chauvin, 2010). The latter prevailed when two dominant producers controlled 90% of the sugar produced in the UK and ran the risk of being accused of abusing their market dominance. Therefore, British sugar applied transparent volumetric pricing to all customers and granted additional discounts to merchants to create competition in the small account market (Cox et al., 2003).

Yet, there are several problems with normative price anchors. Firstly, they encourage buyers to focus on seasonal peaks, treat CRP differently in increasing and falling markets (Mattos, 2015), and lure buyers into risky behavior such as (a) stockpiling when the CRP is perceived as low, (b) speculative waiting for the price to go down to a previous level, (c) or buying lower than needed quantities if the price is perceived as high (Bruno, Che and Dutta, 2012). Secondly, normative anchors may be detrimental to the buyers. For example, Peltzman (2000) documented a rampant and pervasive trend where prices rise faster than they fall. As a result, buyers systematically overpay in the decreasing market.

Thirdly, buyers may abuse the normative anchors and require the “lower and later” price adjustment (Gelderman and Semeijn, 2006) during the commodity price hikes, damaging the relationship with their suppliers. Finally, normative anchors may serve as a “price transparency weapon,” a coercive tool to drive inefficient producers out of the market (Duffie, Dworczak and Zhu, 2017). For example, the introduction of steel futures triggered a 9 percent reduction in steel product prices and resulted in a 20% market share increase for low-cost producers (Martin, 2019).

### A.1.2 Price discovery

A distinction should be made between price determination and price discovery. The former is defined as the process of determining the equilibrium price for a commodity (Ethridge *et al.*, 1981). The latter is defined as the process of arriving at a specific realization price for a given commodity in a given location and time (Ethridge *et al.*, 1981), very often with the help of CRP determined in other markets (Madhavan, 2000). The difference is epitomized by Caliskan (2009) who distinguishes between the general price which informs the buyer about the actual CRP level, and the quote which represents a binding price offer reflecting the current price level and the delivery conditions at which the seller is willing to trade.

Regarding commodities, CRP play an essential role in both mechanisms: they are the outcome of the price determination process and an enabler of the price discovery process.

### A.1.3 CRP price determination

In an ideal world, commodity markets act as price-determination mechanisms where market participants make rational decisions based on their expectations (Kingsman, 1986). The ensuing CRP reflects the equilibrium at the intersection of short-term demand and supply (Radetzki, 2013b). However, researchers have convincingly challenged this idealized view (e.g., Caliskan, 2009) and demonstrated that CRP emerge through many different mechanisms (e.g., Radetzki, 2013). To shed light on the range of CRP price determination mechanisms, the author arranged them in a continuum (see Table 57), reflecting the degree of CRP issuer discretion conceptualized by Radetzki (2013).

Highly liquid and transparent commodity exchanges occupy one extreme with the continuous stream of prices. The CRP issuer has little discretion in the price

determination process because the CRP is determined through double auction bidding, which approaches the perfect market equilibrium of the short-term demand and supply (Radetzki, 2013). Scholars agree that commodity exchanges are the most efficient commodity price determination mechanism (e.g., Maxwell, 2015; Radetzki, 2013), with futures aggregating all available market information (Cinquegrana, 2008). In particular, the nearby futures price, adjusted for quality, location, terms, or bargaining power (Gilbert, 2012), serves for pricing cash market transactions (Wiese, 1978). Similarly, the LME official price, which corresponds to the last bid and ask quoted during the second Ring session (LME, 2018b), approaches the idealized invisible hand of the market.

The middle ground is occupied by a wide range of price determination mechanisms that combine the market data with judgment. For example, the LME closing price is determined through social devices drawing on arbitration and deliberation of the quotations committee (LME, 2018a). Similarly, “Champion” prices mediate the outcome of negotiation between large consumers and producers, but may not reveal all contractual terms (Li, 2010).

The “arbitrary” extreme is represented by the Permanent Working Group of Cotton, whose front-year price is created before the supply and demand are known and is fiercely negotiated to accommodate varying stakeholders’ interests (Caliskan, 2007). Finally, administrative transfer prices are the most arbitrary ones because the headquarters of a multinational company administratively set them for accounting and tax purposes only.

The overview of CRP suggests that CRP differ significantly in the price determination process quality, which may substantially impact their fit for use. This observation emphasizes the relevance of methodology as a CRP transparency attribute.

Finally, whenever several CRP coexist, their relative contribution to price determination[2] is defined as the extent to which a price series is the first one to reflect the new information about the asset value (Putniņš, 2013). From this perspective, *timeliness* understood as the relative speed of CRP updates, and *efficiency*, defined as the absence of market imperfections, are the two fundamental CRP price determination characteristics (Putniņš, 2013).

[2] Scholars actually speak about the CRP contribution to *Price discovery (*e.g., Putniņš, 2013). However, the author believes that this term is confusing because the *Price discovery* refers to a specific realization price and not the determination of equilibrium price. This distinction may be irrelevant if the CRP and realization price are equivalent, as is the case with transactions realized directly on commodity exchanges. However, when considering CRP series generated by different institutions, e.g., commodity exchanges, price reporting agencies, and leading market participants, scholars should speak about the CRP contribution to *Price determination*.

| CRP determination mechanism | CRP form | Issuer (Example) |
|---|---|---|
| Continuous double auction bidding (Figuerola-Ferretti & Gilbert, 2005; Radetzki, 2013) | Actual commodity exchange quotes or transaction records | Commodity exchange (natural rubber real-time quotation) |
| The last bid and offer quoted during the second Ring session (LME, 2018b) | LME Official price published as a string of prices for different maturities | London Metal Exchange (copper official price) |
| Volumetric dominant producer price (Cox et al., 2003) | Regularly published list price | Producer (sugar in the UK in the 90s) |
| Price based on mandatory data collection and statistical treatment (Koontz and Ward, 2011) | Public agency reported price | Governmental body (livestock mandatory reporting) |
| Comprehensive price report based on an extensive market survey (Caliskan, 2009) | A report containing the reference price, trading information, and possibly comments about the market evolution. | Price reporting agency (Platts reports) |
| Quotations committee deliberation (LME, 2018a) | LME Closing price published as a string of prices for different maturities | London Metal Exchange (copper closing price) |
| Price based on an extensive market survey (Rauch, 1999) | Reference price published in a trade journal without much additional information | Trade journal (Metal Bulletin) |
| Price based on a limited number of transactions (Hayenga, 2001) | Reference price stems from a thinly traded commodity exchange. | Commodity exchange (National Cheese Exchange) |

| CRP determination mechanism | CRP form | Issuer (Example) |
|---|---|---|
| Price determined by deliberations of a monopoly or cooperative oligopoly (Radetzki, 2013; Smart & Harrison, 2003) | Posted, or catalogue price, often accompanied by meeting minutes or an explanation why a particular price level was set. | International organization (OPEC in the 70s) |
| Buyer price guidance (Radetzki, 2013) | Posted or catalogue price | Company or Governmental body (central selling organization for diamonds controlled by De Beers) |
| Large producers and consumers negotiated prices, serving as guidance for the rest of the market (Sukagawa, 2014) | Published champion prices with additional comments | Professional associations (Pacific coast thermic coal) |
| Price based on proprietary market analysis and interpretation (Zsidisin and Hartley, 2012) | Reference price contained in market intelligence reports or forecasts | Market intelligence companies (ISH market reports) |
| Bilateral negotiation between the buyer and the seller (Roeber, 1996) | Published bilateral negotiation outcomes, often accompanied by background comments | Trade journals (Rare Earth) |
| Aggregated statistical data | Published in statistical surveys | Statistical office (a wide range of commodities) |
| Consensus price accommodating the interests of various stakeholders (Caliskan, 2007) | Published in the final report | The permanent working group (cotton price forecast) |
| Administrative transfer price (Radetzki, 2013) | Not published to the general public | Multinational companies (downstream semi-products) |

**Table 57: Continuum of CRP determination mechanisms**

**CRP's role in Price discovery**

The price discovery process is, by definition, uncertain because buyers and sellers do not have perfect information and trade on their interpretation of market fundamentals (Schroeder & Ward, 2000). CRP contribute to price discovery by informing market participants about the prevailing price level, by serving as the basis for bilateral negotiation through which the realization price is agreed (Caliskan, 2007), and by providing the basis for pricing heterogenous commodities (Hudson, Ethridge and Segarra, 1998).

The relationship between the realization price and CRP is not unidirectional because the CRP influences the realization price. At the same time, the realization prices observed on the market affect the CRP. This mutual influence is evident at the London Metal Exchange (LME), which produces several CRP prices: Continuous stream of quotes, LME Official price, LME closing price (seeFigure 21).

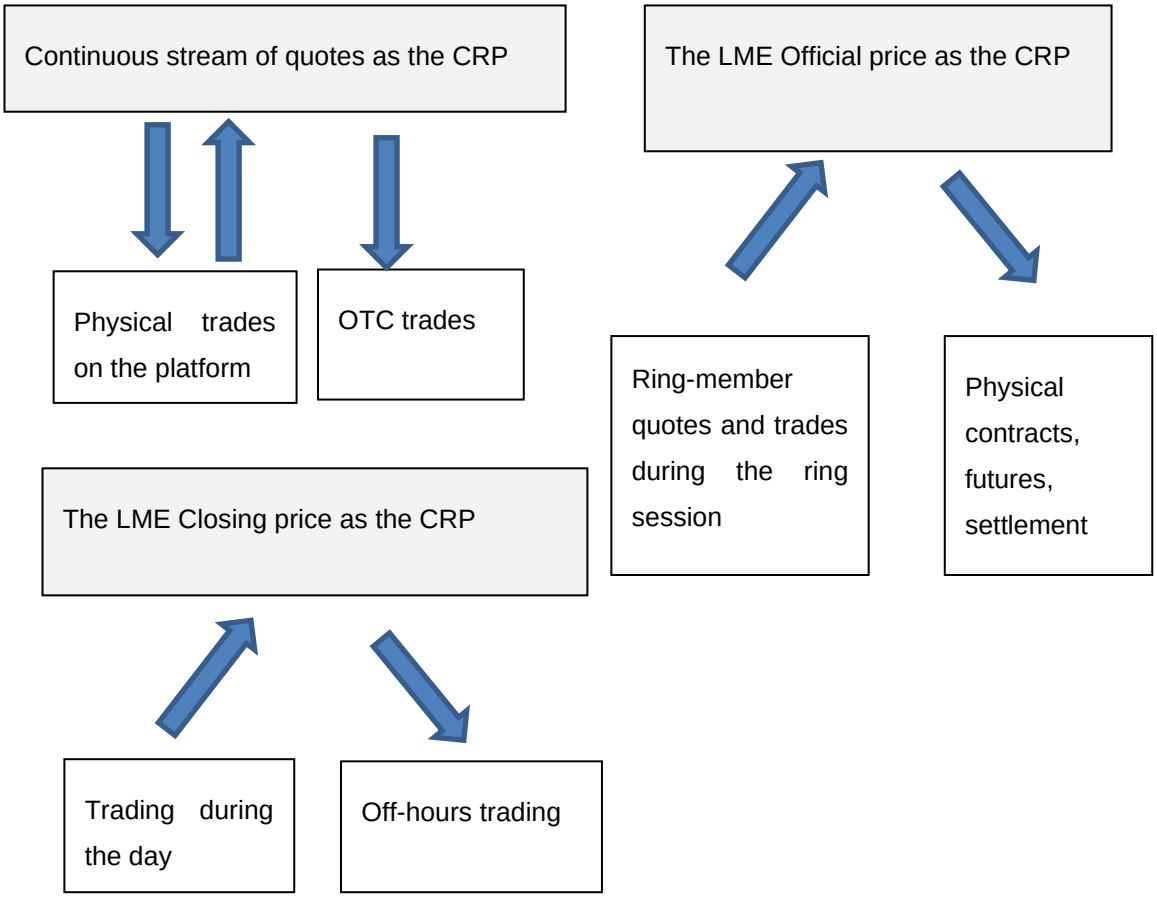


**Figure 21: Mutual influence between CRP and realization price. Source: Author.**

Firstly, the continuous stream of quotes emanating from the trading floor forms the CRP that indicates the price level at which market participants are willing to trade. Market participants use the CRP as the basis for OTC transactions. At the same time, the CRP is shaped by the actual trades realized through the commodity exchange platform. Secondly, the LME official price emanates from a five-minute trading session reserved for the ring members and represents the last quote of the ring session. Once the LME official price is published on the LME pages, it becomes the global CRP for physical contracts and futures settlement and shapes the subsequent trading. Finally, the LME

closing price is established by the LME quotations committee based on the day's trading and influences the off-hours trading.[3]

Cotton trading on the Turkish commodity exchange complements the previous illustrative example by showing how a layered complex of CRP informs the realization price and how the physical trading activities shape CRP. Hence, based on actual trading, different issuers form several interlinked CRP at particular moments, at different places, for various purposes: (1) The pit price, or the "rehearsal price," is created directly by the traders during the 10-minute window in the commodity exchange grand hall. It does not have a codified value, yet it is "real" for market participants who leverage it as a CRP for the post-pit trading, which goes on for another 45 minutes on the commodity exchange premises. (2) After this period of frenetic trading, the closing price is formed based on the actual trading through the deliberation of committee members. This CRP price appears in price reporting agencies' reports, is distributed to traders worldwide, and serves as CRP for bilateral trading. (3) Finally, the permanent working group meets regularly and creates yet another "market price" through negotiation based on the expected offer, demand, and production costs (Caliskan, 2007).

### A.1.4 Information source

The existence of CRP is not considered a criticality factor by Mayer and Gleich (2015), but as a variable that summarizes the interplay of all criticality factors into a single piece of information: "the most 'readily available and reliable' measure for future resource availability" (p. 60). As a matter of fact, most customers use CRP primarily for information and analysis purposes (Smith, 2013). For example, construction indices are instrumental for preparing budgets and estimates,

[3] The explanation is based on author's own experience and private conversations with professional aluminium traders.

studying the price variation and its impact on the total construction cost, or forecasting short-term price evolution (Eurostat OECD, 2009). From this perspective, CRP can be considered a platform for gathering, sharing, and trading private information (Rauterberg and Verstein, 2013) about the prevailing market price (Caliskan, 2009), the market value of the relevant trades (OFGEM, 2013), or the trading context, such as the level of stocks available in LME warehouses (Enke, Geigenmüller and Leischnig, 2012).

In particular, futures markets reduce information asymmetry for less informed market participants (Duffie, Dworczak and Zhu, 2017), convey valuable information about the market fundaments to a large audience (Cinquegrana, 2008), and enable production and capacity planning because the forward price curve reflects current expectations of future spot prices (Kang and Mahajan, 2006).

### A.1.5 Value holdings

CRP provide a way for valuing holdings of financial institutions and trade inventories (Aspris et al., 2017; Millo, 2007), calculating tax obligations (IEA et al.,2011), and mark-to-market and financial settlement of physical trades as well as forward or option contracts (Duffie, Dworczak and Zhu, 2017). Similarly, financial indices and benchmarks, a close CRP relative, are also used to calculate the mutual fund net asset value, secondary equity offerings and pricing mergers and acquisitions (Davies, 2020), or to determine the replacement values for insurance purposes (Eurostat OECD, 2009).

### A.1.6 Contract reference

Market participants leverage multiple forward contract structures to serve their needs (Kang and Mahajan, 2006). Depending on the forward contract type,

CRP assumes different roles: (1) It serves as the basis for negotiating the realization price at the contract signature in fixed price contracts. (2) Deferred price contracts use CRP as a reference for determining future realization prices. (3) Minimum price contracts compare the guaranteed minimum price with the CRP and choose the higher one as the realization price. Finally, (4) reference-price forward contracts use the CRP as a reference for determining the realization price at the moment of delivery (Kang and Mahajan, 2006).

However, increased market volatility made the highly inflexible, long-term, fixed-price contracts impractical in many industries. Instead, market participants now prefer flexible forward contracts with a price adjustment formula/price escalator (Li, 2010). For example, when the steel industry faced steep raw material volatility, it complemented the stable base price, typically negotiated annually, with a scrap and alloy surcharge escalator to transfer price increases to customers (Mulhall and Bryson, 2013).

Price formulas leverage CRP as a specific ex-ante contract term and let the CRP provider determine the commodity's transaction value. Parties only have to agree on the price adjustment process regarding frequency, CRP choice, or adjustment triggers (Gaudenzi et al., 2018). Needless to say, such an arrangement greatly facilitates efficient coordination in long-term contracts because it avoids costly contract renegotiation whenever the market price changes. Additionally, it curbs opportunism related to abandoning the contract and turning to the open market following a favourable price change (Rauterberg and Verstein, 2013). Furthermore, an in-depth exploration of formula pricing in five different industries suggests that formula prices lower internal transaction costs (TC) and free the market participants from repeat negotiations. Finally, formula pricing is attractive to small players because it reduces bargaining disparities against the large and better-informed market participants (Hayenga and Schrader, 1980).

Logically, CRP serving as the contract reference must be precisely defined because each CRP may take many forms, e.g., "(a) the high price; (b) the low price; (c) the average of the high price and the low price; (d) the closing price;

(e) the opening price; (f) the bid price; (g) the asked price; (h) the average of the bid price and the asked price; (i) the settlement price; (j) the official settlement price; (k) the official price; (l) the morning fixing; (m) the afternoon fixing; (n) the spot price; or (o) any other price specified in the applicable Final Terms" (Bank of America, 2011:117). Therefore, ISDA (2019) provides a long list of CRP suitable for derivative contracts to avoid misunderstandings.

Despite their advantages for market participants, formula prices have also been criticized for not contributing to price determination. By their very nature, they remain invisible to the market, may significantly reduce the overall market liquidity (Schroeder & Ward, 2000) and subsequently reduce CRP's ability to reflect prevailing market prices.

Interestingly, while more than 100 bn. worth of products is now managed through index-based pricing in the USA (Deloitte, 2016), only a fraction of existing CRP is used in long-term contracts, and even less to settle derivative contracts (Smith, 2013). Unfortunately, the extant literature does not explain this puzzling phenomenon.

# Intuitive and interpretive review of CRP measured attributes

This section reports findings of the intuitive and interpretive review of CRP measured attributes. Firstly, the intuitive approach reviews the extant and practitioner literatures to distil any relevant CRP measured attributes, provisionally organize them following Wang & Strong´s (1996) taxonomy, and finally establishes a provisional CRP transparency attribute taxonomy stemming from the intuitive approach. Subsequently, CRP deficiencies are identified from the literature, organized along the Rauterberg & Verstein´s (2013) taxonomy of RP, and the expanded taxonomy of CRP deficiencies is presented. Finally, the interpretive approach to CRP transparency attributes establishes the link between the CRP functions (outlined in Chapter 4) and CRP deficiencies, and considers suitable corrective measures which will subsequently converted into the relevant CRP transparency attributes.

## A.2 Intuitive approach to CRP transparency attributes

An intuitive approach to exploring the CRP transparency attributes identifies attributes that are the most critical for the phenomenon of study (Ge and Helfert, 2006) based on a critical literature review, the experience of researchers (Wang & Strong, 1996), and their understanding of the key CRP transparency attributes (Ge and Helfert, 2006).

The relevant literature search revealed that the research is scattered with limited cross-referencing. Contributions concentrate in periods with important structural changes of CRP or increased commodity markets volatility. The first period corresponds to the oil crisis in the 70s and the steep increase of commodity prices and scholars were primarily concerned with CRP dissemination and accessibility (e.g., De Montbrial, 1975; Schachter, 1975). The second period reflects the deregulation of many commodity markets (e.g., Roeber, 1996;

Figuerola-Ferretti and Gilbert, 2005). The third period is situated in the aftermath of the global financial crisis and scholars and practitioners express concerns about CRP accuracy, timeliness, accessibility, methodology and vulnerability to manipulation (e.g., Valiante and Egenhofer, 2013; Veerman *et al.*, 2016). Regulators are also active and focus particularly on CRP methodology (e.g., IEA *et al.*, 2011; IOSCO, 2013, 2015). However, the interest in CRP and their measured attributes seems to wane after 2017 with occasional research calling for better CRP accessibility (e.g., Belay and Ayalew, 2020) or highlighting the CRP vulnerability to manipulation (e.g., Putniņš, 2020).

### A.2.1 Provisional classification lens

A critical reading of the extant and practitioner literature dedicated to CRP reveals multiple occurrences of phenomena that may be classified as CRP transparency attributes but are not identified as such and often remain implicit. Hence, a robust analytical tool is required to extract, reduce, and analyze a long-list of CRP transparency attributes.

Wang & Strong's (1996) seminal taxonomy of information quality attributes was selected because, as posited by Schnackenberg & Tomlinson (2014), information quality is central to CRP transparency. The taxonomy stems from a long list of 118 information attributes, some of which appear in the CRP literature as well. Furthermore, compared to rival taxonomies (e.g., Michener & Bersch, 2013, Schnackenberg & Tomlinson, 2014, Lee et al., 2002), it provides the most complete yet concise grouping of attributes (see Table 58 for comparison). Finally, the attributes are well-defined and can be adapted to CRP transparency requirements.

| Michener & Bersch, 2013 | Schnackenberg & Tomlinson, 2014 | Wang & Strong, 1996 | Lee et al., 2002 |
|---|---|---|---|
| Visibility | Disclosure | Accessibility | Accessibility,<br>Security,<br>Timeliness |
| Inferability | Clarity | Representational | Concise and consistent representation,<br>Ease of operation,<br>Interpretability,<br>Relevancy,<br>Reputation,<br>Understandability |
| | Accuracy | Intrinsic | Believability<br>Free of error<br>Objectivity |
| - | - | Contextual | Completeness |

**Table 58: Candidate CPR transparency taxonomies**

## A.2.2 The long list of CRP transparency attributes

This section first classifies the long list of CRP transparency attributes derived from the literature along Wang and Strong's (1996) taxonomy which establishes four broad groups of information quality attributes: (1) *intrinsic attributes* provide valuable information in their own right, such as accuracy or reliability, (2) *contextual attributes* bring additional information about the context, such as timeliness, completeness, or appropriate amount, (3) *representational attributes* relate to understandability, form, clarity, and representation consistency, and (4) *accessibility attributes* stand for the ease of access and availability of information.

Table 59 compiled by the author based on the coding scheme, summarizes the long list of CRP attributes and suggests that *accessibility* and *intrinsic transparency* are the most frequent attributes. *Contextual* attributes occupy the middle ground, and *representational* factors are only rarely mentioned.

| **Reference:** | **Accessibility** | **Representa-tional** | **Intrinsic** | **Contextual** |
|---|---|---|---|---|
| (Schachter, 1975) | Dissemination | | | |
| (De Montbrial, 1975) | Accessibility | | | |
| (Hayenga and Schrader, 1980) | | | Accuracy, Robust methodology | |
| (Bloomfield and O'Hara, 1999) | Trade and quote disclosure, Timeliness | | | |

| Reference: | Accessibility | Representa-tional | Intrinsic | Contextual |
|---|---|---|---|---|
| (Roeber, 1996) | Accessibility, Availability of information | | | |
| (Ward and Choi, 1998) | | | Accuracy of reported cash market prices | |
| (Azzam, 2003) | Timely, information becomes available | | Accurate, Reliable | |
| (Figuerola-Ferretti and Gilbert, 2005) | Place of publication, Equal access | | Reliable, Source of information, Serve as common reference | Degree of information content |
| (Gupta, 2005) | | | Robust methodology | |
| (Cinquegrana, 2008) | Disclosure | Standardized | Reliability | Completeness |
| (Eurostat OECD, 2009) | Accessibility | | Accuracy of prices | Key elements of pricing policy |
| (Li, 2010) | Freely available, Timely | | Accurate | Precisely defined commodity |
| (European Commission, 2011) | Disclosure | | Robust methodology | |
| (Fattouh, 2011) | Open access, Regular publication | | Accurate, Reached through a transparent process | Transparency about prices, Open interest, and Traded volume |
| (IEA *et al.*, 2011) | | Collecting, Collating, Editing and Disseminating information | Test credibility of trades, Reliability of price assessment process | |

| Reference: | Accessibility | Representa-tional | Intrinsic | Contextual |
|---|---|---|---|---|
| (Koontz and Ward, 2011) | Timely | | Accurate | Provide regional reporting |
| (European Commission, 2011) | Disclosure through food price monitoring tool | | Regulatory framework | Information on market fundamentals |
| | | | | |
| (Valiante and Egenhofer, 2013) | Publicly available, Accessible in real-time | | Serve as benchmark<br>Transparency of methodology | Provide granular data |
| (Duffie, Dworczak and Zhu, 2017) | Improve the information available | | | Existence of benchmarks/post trade reporting |
| (Economist, 2014) | Accessible | Standardized | Transparent methodology, | |
| (Official Journal, 2016) | Disclosure | | Robust methodology | |
| (EU, 2016) | Accessibility, Dissemination, Timely | Different types and forms of information | Accurate and reliable | |
| (Favada and Pepke, 2014) | Accessibility, Timely | Standardized, Comparable | | |
| (Hernandez *et al.*, 2017) | Accessibility of price tickers | | | |
| (Ahlers, Broll and Eckwert, 2013) | | | Reliable | Informativeness on determinants of price movements |

| Reference: | Accessibility | Representa-tional | Intrinsic | Contextual |
|---|---|---|---|---|
| (IOSCO, 2013) | Disclosure of contract terms and conditions,<br>Timely,<br>Publicly available | | Price assessment process, | Report more widely pre-trade and post-trade information |
| (OFGEM, 2013) | | | Strong governance and transparent methodologies | |
| (Radetzki, 2013) | Ease of Access, Frequency of price publishing | | Impartial,<br>Price discovery mechanism quality | Report future prices and expiries |
| (Rauterberg and Verstein, 2013) | | Tradability and consistency | Accuracy | Incorporate and reflect trade information |
| (Stewart, 2013) | Visibility,<br>Accessibility | | Set of bureaucratic procedures | Context of trades,<br>Interpretation of the market |
| (Maxwell, 2015) | Price information regularly quoted, Readily reported, | | Price discovery mechanism quality | |
| (IOSCO, 2015) | Disclosure | | Robust methodology | |
| (Verstein, 2015) | Disclosure | | Robust,<br>Published,<br>Mechanistic methodology | |
| (Veerman *et al.*, 2016) | Availability of market information to participants,<br>Timely, | Disseminated in duly aggregated form,<br>Easy to use format | Reliable and credible reference | Mediate complete market information |
| (Johnson, 2017)<br><br>(Mixon, Onur and Riggs, 2018) | Dissemination<br><br>Disclosure of trading positions | Comparable | Accuracy,<br>Methodology | |

| Reference: | Accessibility | Representa-tional | Intrinsic | Contextual |
|---|---|---|---|---|
| (Belay and Ayalew, 2020)<br><br>(Putniņš, 2020) | Accessibility | | Accuracy,<br>Reliability,<br>Methodology | |

**Table 59: Long-list of CRP transparency attributes classified according to Wang and Strong's (1996) taxonomy**

Table 60 provides an alphabetical, aggregated list of all CRP transparency attributes. Despite a very large number of codes, many are semantically very close or outright overlapping and a possibility to reduce them into a few meaningful categories.

| Aggregated list of provisional labels |
|---|
| Accessibility |
| Accessibility of price tickers |
| Accessible in real-time |
| Accuracy |
| Accuracy of prices |
| Accuracy of reported cash market prices |
| Accurate and reliable |
| Availability of information |
| Availability of market information to participants, |
| Collecting, Collating, Editing and Disseminating information |
| Comparable |
| Completeness |
| Context of trades, Interpretation of the market |
| Degree of information content |
| Different types and forms of information |
| Disclosure |
| Disclosure of contract terms and conditions, |
| Disclosure through food price monitoring tool |
| Disseminated in duly aggregated form, |
| Dissemination |

| |
|---|
| Easy to use format |
| Equal access |
| Existence of benchmarks/post trade reporting |
| Freely available, |
| Frequency of price publishing |
| Impartial, |
| Improve the information available |
| Incorporate and reflect trade information |
| Information on market fundamentals |
| Informativeness on determinants of price movements |
| Key elements of pricing policy |
| Mediate complete market information |
| Mechanistic methodology |
| Methodology |
| Open access, |
| Place of publication, |
| Precisely defined commodity |
| Price assessment process, |
| Price discovery mechanism quality |
| Price information regularly quoted, |
| Provide granular data |
| Provide regional reporting |
| Publicly available, |
| Published, |
| Readily reported, |
| Reached through a transparent process |
| Regular publication |
| Regulatory framework |
| Reliability |
| Reliability of price assessment process |
| Reliable and credible reference |
| Report future prices and expiries |
| Report more widely pre-trade and post-trade information |
| Robust methodology |
| Serve as benchmark |
| Serve as common reference |
| Set of bureaucratic procedures |
| Source of information, |
| Standardized |
| Strong governance and transparent methodologies |
| Test credibility of trades, |
| Timely |

| |
|---|
| Timely, information becomes available |
| Tradability and consistency |
| Trade and quote disclosure, |
| Transparency about prices, Open interest, and Traded volume |
| Transparency of methodology |
| Transparent methodology, |
| Visibility, |

**Table 60: Aggregated CRP transparency attributes in alphabetical order**

A finer-grained semantic analysis confirmed the relevance of the contextual and representational categories but also revealed significant semantic differences within the Intrinsic CRP transparency category. Hence, it was split into two distinct categories labeled *accuracy* and *methodology*. Similarly, *accessibility* proved too broad and ambiguous and was divided into *accessibility* and *timeliness*. Finally, a provisional taxonomy of six distinct CRP transparency attributes was established: methodology, accuracy, contextual transparency, timeliness, accessibility, and representational transparency (see Table 61).

| **Original taxonomy**<br><br>(Wang and Strong, 1996) | **Provisional CRP transparency taxonomy: Intuitive approach** |
|---|---|
| Intrinsic | Methodology |
| | Accuracy |
| Contextual | Contextual |
| Accessibility | Timeliness |
| | Accessibility |
| Representational | Representational |

**Table 61: Provisional CRP transparency attribute taxonomy stemming from the intuitive approach**

## A.3 CRP deficiencies

The effective fulfilment of CRP functions highlighted in the previous sections is contingent upon CRP's ability to map and represent the market's state correctly. Unfortunately, extant and practitioner literature suggest that CRP witness numerous deficiencies understood as non-conformity between the direct market observation and observation mediated by the CRP.

This section, therefore, explores CRP weaknesses indicative of the different levels of CRP contingency and thus helps conceptualize the CRP construct and determine its measured attributes. In particular, three generic deficiencies—incomplete representation, ambiguous representation, and meaningless states—common to all information systems (Wand and Wang, 1996) will be explored through Rauterberg & Verstein´s (2013) taxonomy of RP deficiencies: *malproduction*, understood as low index quality; *manipulation*, defined as active misuse; and *underproduction*, conceptualized as the index absence.

### A.3.1 Malproduction

Malproduction is defined as low CRP quality, owing to which the index is not fit for the intended use. Unlike CRP manipulation, malproduction is not intentional (Rauterberg & Verstein, 2013). Instead, it stems primarily from flawed methodology, methodology change, CRP inaccuracy, basis risk, trade-offs in CRP design, and lagged incorporation of new information.

### A.3.2 Flawed methodology

Flawed price discovery and reporting methodology are the major sources of incomplete market representation. In particular, CRP covered by price reporting agencies (PRA) are vulnerable to flawed methodology because they are “merely estimates based on incomplete information from unregulated, illiquid markets … [and] rely at best on a seasoned reporte''s ability to interpret what his sources tell him about bids, offers and deals, and at’worst on a gullible greenhorn's guesswork” (Economist, 2014). Digging deeper, PRA methodologies suffer from two key weaknesses: *selective reporting*, when the market data is submitted to PRA on a voluntary basis, and *opacity and variations in assessment methodologies* in terms of data considered, assessment windows, and application of judgment (IEA et al., 2011). For example, the cotton CRP was found to lack robust internal procedures to assure statistical accuracy. Furthermore, it was largely influenced by the informant sample and biased by those who chose to provide the market data (Hudson, Ethridge and Segarra, 1998).

Regulators are well aware of this problem, and ISDA (2019) urges market participants to carefully check the CRP discovery methodology and pay particular attention to the origin and nature of the collected data, computational procedures, conflicts of interest, degree of information disclosure, and regulatory oversight. Similarly, widespread dissatisfaction with livestock and meat reporting reliability resulted in mandatory price reporting in the USA (Koontz & Ward, 2011). Finally, the EU directive on benchmark indices in financial instrument contracts (EU, 2016) represents an important step in regulating CRP and reducing methodological issues.

### A.3.3 Change of methodology

Following examples document that CRP methodology adapts to context evolution: Some adjustments are relatively minor, for example, the London Gold Fix changed from a teleconference held by a handful of large banks to a one-

minute e-auction, or the LBMA Silver price discovery moved under the auspices of CME Group and Thomson Reuters (Perkins and Mortby, 2015). However, other methodologies underwent a fundamental qualitative change and momentarily disrupted the market. For example, following the North Sea production decline, additional grades were progressively added to the original ICE Brent benchmark to maintain liquidity and protect the CRP from squeezes and distortions. Even though these significant product specification changes impacted prices and, subsequently, all contracts related to this benchmark, most transitions were smooth and without legal risks for the existing contracts (Perkins and Mortby, 2015). However, the addition of the Buzzard field with a higher sulfur content into the ICE Brent CRP momentarily paralyzed the market and forced Platts, a price reporting agency, to introduce a quality de-escalator off the CRP standard value (Fattouh, 2011).

The Principles for Price Reporting Agencies by IEA et al. (2011) recognize market vulnerability to CRP methodology change and insist that all methodological changes must be announced with sufficient notice and consider stakeholders´ comments. Furthermore, PRA should regularly review the ongoing methodology relevance and make the necessary adjustments.

### A.3.4 CRP Inaccuracy

Market participants regularly complain about CRP (in)accuracy (e.g., Economist, 2014; IOSCO, 2013; Maynard, 1997; Wachenheim & DeVuyst, 2001), and scholarly research provides ample evidence to substantiate these concerns. For example, a study of formula pricing in five different commodity markets reveals that some markets lack a generally accepted and accurate CRP that could serve as a basis for formula prices (Hayenga and Schrader, 1980). Furthermore, market insiders argue that commodity benchmark prices are wrong 27% of the time (Nguyen and Arnsdorf, 2013), and only 20% of respondents believe that CRP are entirely fit for the purpose (Clyde & Co LLP, 2014).

Inaccurate CRP have severe implications for companies and even whole industries. For example, reporting inaccuracy of the Daily Urner Barry CRP in the range of one cent per dozen eggs results in a 1 million USD change in industry revenue (Maynard, 1997). Furthermore, inaccurate CRP in business contracts decouple companies from the physical market (Hayenga and Schrader, 1980), which may hamper their overall competitiveness.

The CRP (in)accuracy was even subject to WTO arbitration. The Central American states argued that Sopisco News could not be considered an accurate benchmark of “actual prices” as only a tiny fraction of the newsletter was dedicated to price estimates and Sopisco News added a disclaimer on all its prices. Furthermore, the plaintiffs argued that “actual prices” were only price quotes “that did not reflect as accurately as possible the actual selling prices of bananas” (WTO, 2005:15).

The European Communities (EC), on the other hand, argued that Sopisco News was widely used by the market as well as by international organizations and that CRP accuracy was vital for its viability as a commercial, subscription-based service. EC conceded that Sopisco News prices were not necessarily actual market prices. Nevertheless, they were an accurate representation of these prices. In their final judgment, the arbitrator accepted this argumentation.

However, CRP accuracy concerns are not reserved uniquely for CRP generated by PRA. Market participants are also worried about the ability of thinly traded markets to mediate accurate CRP. The so-called “thin market problem” triggers high volatility during unanticipated supply and demand shocks, allows manipulation through strategic trading, and leads to systematic departure from the economic equilibrium price (Adjemian et al., 2016). Consequently, the CRP has become unrepresentative of the actual market. The problem is further exacerbated by the information asymmetry when CRP generated by commodity exchanges inform the OTC price discovery while OTC prices feed little information back (UNCTAD, 2011).

Hayenga & Schrader (1980) support the thinning market concerns and identify a direct relationship between the propagation of formula pricing and the

decreasing volume of negotiated trading. This trend leads to inaccurate CRP and requires regular bilateral negotiations to discover the “true” price (Vercammen, 2012). In particular, cattle and hog markets substantiate these fears: as the thinly traded spot market becomes a mere residual market for lower-quality livestock, the ensuing CRP biases the higher-quality livestock contracts whose realization price is pegged to the CRP. Hence, better-regulated and more liquid CRP, such as live-cattle futures, should be preferred to avoid the thinning market problem (Schroeder & Mintert, 2010).

Considering all these weaknesses, it is logical that CRP emanating from the thin markets are judged non-representative of the underlying market and subsequently ignored in the physical market, as documented by a study of the Indian wheat futures market (Ghosh, 2010).

However, the case against the thin markets is not as clear-cut as it might seem from the previous discussion. Adämmer, Bohl, & Gross (2016) apply three econometric methods to evaluate the relative contribution of thinly traded futures contracts for hog and piglet to price discovery and conclude that even thinly traded markets with several dozen transactions per week facilitate efficient price discovery and provide reliable price information.

The ‘intended use’ perspective of CRP (Rauterberg and Verstein, 2013) may explain why both the critics and proponents of thinly traded markets are correct. On the one hand, market participants who need immediate information about the exact spot price prevailing on the physical market will worry about high spreads and vulnerability to manipulation. In contrast, their peers, who use the CRP as an information source for long-term decisions, may consider the same CRP highly informative and accurate.

The same logic holds for the input price construction indices, which are too inaccurate for escalator clauses because they only focus on the evolution of wages and material costs and ignore other essential cost factors such as productivity gains or market sentiment (Eurostat OECD, 2009). However, these indices may not have been conceived for price escalation formulas in the first place. Perhaps, they were designed as a source of helpful business information,

and the breadth of coverage was preferred to CRP accuracy. From this perspective, these CRP mediate reasonably accurate price levels without aspiring to represent actual realization prices.

In summary, in terms of accuracy, CRP may be deficient in three ways: as an inaccurate representation of the real-world they represent, as inaccurate for the intended use, or both.

### A.3.5 Basis risk

In an ideal world, the spot and futures prices are perfectly correlated. However, this is rarely the case due to the variability of storage costs and convenience yields (Cinquegrana, 2008), different development in the physical market and the futures exchanges, or even market manipulation or shortage of supply (Kang and Mahajan, 2006). Basis risk, therefore, represents a specific type of CRP deficiency defined as the difference between the spot/ producer price and futures prices. The basis risk reduces the informativeness of the CRP and the effectiveness of hedging (Mohan, 2007) and may even increase the total commodity risk (Shi, 2004). Furthermore, basis risk may be triggered by the difference between the quantity hedged and the standardized futures contract or by the difference between the physical commodity specification and the standardized futures (Shi, 2004).

### A.3.6 Trade-offs

Information quality literature highlights numerous trade-offs between information quality attributes: security versus accessibility, timeliness vs. accuracy, reliability vs. timeliness, the amount of information vs. comprehensibility, and conciseness vs. the amount of information (Eppler and Wittig, 2000). Similar trade-offs were documented with CRP as well. For example, Platts preferred tradability to accuracy when they decided to include more oil grades into the Brent benchmark to improve its liquidity. This particular trade-off

was helpful to users who used the index as the source of information but damaged users who used it for investment purposes while seeking accuracy (Rauterberg and Verstein, 2013).

CRP users should also consider trade-offs implicit in the CRP value-add hierarchy highlighted by Johnson (2017) that make CRP (un)suitable for some CRP functions: *Information CRP* have the lowest standing and focus on mediating the market news and analysis in the textual form. *Information and Data CRP* occupy the middle ground and provide the general price data and context. Finally, *CRP as Benchmark* provide market participants with transaction data and can be used for physical trades, derivative contracts settlement, and referenced outside their specific market or region (Johnson, 2017).

### A.3.7 Lagged CRP

The need for timely and accurate information grows with the trading volume and the number of participants (Li, 2010). A CRP is considered lagged if its publication frequency is lower than the frequency with which the prices are set or the frequency of transactions on physical markets (Veerman et al., 2016). There is evidence that market participants, all things equal, always prefer more timely price updates. For instance, real-time aluminum prices issued by the LME quickly ousted both the trade journals reporting and producer prices, whose frequency and flexibility could not match the organized commodity exchanges (Figuerola-Ferretti and Gilbert, 2005; Radetzki, 2013). Yet, CRP differ substantially in conveying new information about prevailing market prices. For example, ICIS, a leading PRA, publishes its different CRP monthly, weekly, or daily. In addition, ICIS offers 24-hour coverage of breaking news that affects markets, prices, or business decisions (ICIS, 2020).

Most practitioners call for timely CRP disclosure (IOSCO, 2013; UNCTAD, 2011; Veerman et al., 2016) because lagged CRP lead to CRP inaccuracy and unreliability and have profound implications for business practice. In contrast, some market participants argue that less frequent CRP updates, such as

quarterly producer prices, increase price stability (Radetzki, 2013). For instance, the European steel industry opposed the introduction of the spot market for fear that it would significantly increase volatility (Blas, 2010). However, this case seems exceptional because lagged CRP are particularly impractical during turbulent market periods. For example, during the 2008 financial crisis, the leading iron ore producers, who practiced fixed prices determined by annual champion negotiation (Sukagawa, 2014), were underbid by new entrants. They were, therefore, forced to revise their strategy and pushed for the spot-based CRP to protect their markets (Radetzki, 2013).

### A.3.8 Manipulation

CRP manipulation materializes through two, often interlinked, mechanisms: manipulation and collusion (Rauterberg and Verstein, 2013; Verstein, 2015). It is expected to always exist due to economic frictions, liquidity considerations, information asymmetries, and trading strategies (Pirrong, 2017).

### A.3.9 CRP Manipulation

LIBOR manipulation, which caused massive damage to millions of people, shifted the traditional focus from manipulating the realization price towards the reference price manipulation, which is easier and more effective because it grants influence on the whole market (Verstein, 2015).

In the simplest terms, CRP manipulation seeks to distort prices (Pirrong, 2017). It is defined as “deliberate intervention into index´s input, methodology or output to serve manipulator´s interests at the expense of other users…” (Rauterberg & Verstein, 2013:31). It typically materializes through false or misleading signals about supply and demand, attempts to set the price at an artificial level, a fictitious trade, deception, contrivance, or the dissemination of misleading information (EU, 2011).

Previous sections documented that CRP come into being through different mechanisms and may therefore differ in their vulnerability to manipulation. Five influencing factors seem particularly salient: (1) the *quality of the benchmark process control*, (2) the *data source,* where indices such as LIBOR, which draw on private data, are more vulnerable to manipulation than indices such as the S&P 500, which draw on publicly available data; (3) *revenue potential* because CRP discredit would kill the revenue stream for the issuer and thus provides a strong disincentive to manipulate; (4) *conflict of interests*, when the CRP issuer is also a CRP consumer; (5) *policy considerations,* when the CRP issued by public authorities may be manipulated for policy reasons (Rauterberg and Verstein, 2013).

Many customers and industry insiders believe CRP are systematically manipulated (e.g., Sitko & Jayne, 2012). This distrust may be rooted in a poor understanding of the commodity markets and fuelled by those harmed by the publicly available prices (Perdue, 1987). In addition, sellers are naturally incentivized to bias CRP upwards and grant selective discounts because the ensuing equilibrium lies above the marginal costs, and the buyers without bargaining power get a worse deal (Raskovich, 2007).

Empirical evidence of widespread CRP manipulation may seem overwhelming. For example, 124 instances of commodity market manipulation were observed between 1867 and 1921 (Pirrong, 1995). CRP manipulation is facilitated by three factors: domain, participant, and liquidity concentration (Verstein, 2015).

Thanks to **Domain Concentration**, it suffices to manipulate only a small portion of the data set considered in the benchmark creation. Such manipulation can be achieved by failing to report a trade, fabricating the trading data, or deliberately choosing to include or exclude trades within or outside the index window. For instance, a trader attempted to manipulate the CRP emanating from the pit trading by ‘buying his own cotton’ (Caliskan, 2007); hog market buyers only trade after the benchmark price has been set to avoid that their contractual formula price increases (Schroeder & Ward, 2000); rubber sellers artificially

increase the ask price in anticipation of cyclical orders (Accenture, 2015); intermediaries, whose performance is judged against the CRP, opportunistically time their trades to impact the CRP (Baldauf, Frei and Mollner, 2019); the closing price tinkering through last-second pre-scheduled orders (Muniesa, 2007); strategies known as “painting the tape” where managers purchase securities they already hold to inflate the end-of-quarter CRP and subsequently their relative performance, or “bang the close” which abuses the closing price-setting methodology, and finally, “pinning” which seeks to create a closing CRP equal to the option strike price at expiry and thus make the option worthless (Davies, 2020).

**Participant concentration** covers all instances when a few market participants dominate the trading considered by the benchmark. For example, the leading market players engaged in downward price manipulation in the National Cheese Exchange by selling at a loss to extract lower prices from their formula-based long-term contracts (Mueller, Marion and Sial, 1997). Similarly, privileged access to benchmark value granted a 10-basis point advantage to the informed traders (Caminschi and Heaney, 2014). Finally, the rubber market suffers from manipulating the production data, e.g., underestimating the production amount, exaggerating the weather events, or delaying data publication (Accenture, 2015) .

Finally, **Liquidity concentration** emerges whenever there is a paucity of trades and a single, selectively reported price biases the CRP. This phenomenon is exacerbated in thinly traded markets, which were already discussed in previous sections.

Despite this evidence, not all CRP are manipulated. Notably, the investigation into oil benchmarks did not find any evidence of manipulation. It concluded that price differences between PRA are minimal and triggered different data collection methodologies (IEA *et al.*, 2011). Despite this positive outcome, the report recommended improvements to increase confidence in benchmarks which were accepted and implemented by leading PRA (IOSCO, 2015).

### A.3.10 CRP Collusion

CRP collusion is a deliberate and secret attempt to influence the CRP level through explicit or implicit communication or conscious parallelism among competitors (Harrington, 2017). While “normal” collusion is generally assessed against a competitive benchmark such as CRP (Motta, 2004), it is challenging for market participants and regulators to notice the CRP collusion because there is no appropriate reference point.[4]

Cartels and price collusion are relatively frequent in commodity trading. For example, the European Commission fined steel reinforcement bar manufacturers for coordinating sales prices in a price-fixing cartel between 1989 and July 2000 (Official Journal, 2006). Similarly, synthetic rubber producers were punished for regularly discussing prices and coordinating price increases (Official Journal, 2009). Other commodity collusion cases concerned monochloroacetic acid, choline chloride, raw tobacco, or organic peroxide to cite just a few (EU, 2020).

*Explicit collusion* involves situations when companies exchange assurances to pursue common activities (Kovacic, 1993). For example, the European Commission fined three large ethylene buyers for rigging the monthly contract price that serves as industry CRP for individual price negotiations and price formulas (Official Journal, 2021). Similarly, foam producers were fined for rigging the CRP and passing over the raw material price increases to customers between 2005 and 2010 (Official Journal, 2014).

*Implicit or Tacit collusion* materializes through indirect communication when one company announces a course of action and relies on others to do the same (Page, 2006). For instance, leading producers of isocyanates and polyol allegedly fixed prices between 1999-2003 (Tadena & Cameron, 2013). Similarly, advance price announcements, such as the OPEC price guidance, may help suppliers coordinate their pricing policy (Raskovich, 2007) and raise concerns about a cooperative oligopoly (Boshoff, Frübing and Hüschelrath, 2018). Finally, Danish

[4] The discussion about the appropriate tools for CRP collusion detection is beyond the scope of this thesis.

mandatory reporting for ready-mixed concrete is a well-known example of misusing CRP as a price coordination tool to increase the sales price (Albæk, Møllgaard and Overgaard, 1997).

Finally, *Conscious parallelism* is typical for concentrated industries where companies share monopolistic power and set prices at a profit-maximizing level. Such a strategy may be lawful as long as there is no communication between firms (Harrington, 2017). However, the temptation to collude is high. For example, the European Commission fined the stainless steel producers for imposing a general price increase mechanism called the “alloy surcharge” (Official Journal, 2007). Since then, ironicially, the scrap and alloy surcharges have imposed themselves in price revision formulas in the steel trading market (e.g., Mulhall & Bryson, 2013).

### A.3.11 Underproduction

A close reading of the extant literature suggests several reasons for index underproduction, conceptualized as the absence of CRP (Rauterberg and Verstein, 2013) due to its inexistence (Roeber, 1996), non-acceptance (Jamora and von Cramon-Taubadel, 2017), temporary non-issuance (Maxwell, 2015), or the fact of being discontinued (Accenture, 2015). Furthermore, CRP may be or become geographically or grade-wise irrelevant, become obsolescent, or too rigid (Hudson, Ethridge and Segarra, 1998; Larson, Varangis and Yabuki, 1998).

### A.3.12 CRP Absence

Inexistent CRP are typical for “primitive” and inefficient commodity markets where traders incessantly look for word-of-mouth information (Roeber, 1996). The absence of CRP makes the price discovery process extremely tedious as each market player has to discover their specific contractual price without CRP guidance. This leads to a wide range of price levels at a given moment (Radetzki, 2013). Furthermore, CRP absence renders the price discovery process

vulnerable to manipulation (Adjemian et al., 2016) and increases the role of asymmetric information (Radetzki, 2013). Fortunately, the total absence of CRP is rare because markets cannot handle large volumes of trading without CRP, and PRA step in to provide a CRP as soon as they see a business opportunity (Roeber, 1996).

Interestingly, some commodities may suffer from too many CRP. For example, a proliferation of rice CRP harms effective comparison and trading between regions, and Thai *5% brokens*, a good candidate for the world rice price, lacks general acceptance (Jamora and von Cramon-Taubadel, 2017). Similarly, gas trading was simultaneously pegged on two CRP: energy commodity exchanges and oil price indices (Reverdy, 2007). This dichotomy hampered the institutionalization of trading practices. Only the progressive fading of the oil-indexed mechanism in recent years (Zhang, Shi and Shi, 2018) has allowed the CRP of different European trading hubs to converge towards the law of one price, where all consumers pay the same price adjusted for transaction and transmission costs (Bastianin, Galeotti and Polo, 2019).

Instances when a CRP is temporarily not issued fundamentally disrupt the price discovery process. For example, the lithium market relied on a trustworthy and readily available producer list price which informed bilateral contracts until the early 2000s. However, the entry of new producers who fought aggressively for market share ousted the CRP. Instead, producers would only announce annual prices in the form of percentage change, and any “official” price indications were subject to hard negotiation and secret discounts. The situation stabilized only in the 2010s when CRP became available and reliable again, thanks to the arrival of price reporting agencies (Maxwell, 2015).

Some commodities then face the prospect of permanent CRP disappearance. For instance, insiders worry about natural rubber futures traded at the Singapore Exchange, which serve as CRP to tire producers (Accenture, 2015). To prevent uncontrolled CRP disappearance, the EU passed benchmark regulation with special rules applicable to critical CRP should the issuer wish to discontinue them (Official Journal, 2016).

However, these fears may be excessive because empirical evidence on the gravity of discontinued reference prices is inconclusive. For example, the minimum lending rate disuse in 1981 had only a marginal impact on the market, and the transition to a new reference occurred seamlessly and without revisions to existing contracts (Perkins and Mortby, 2015).

Similarly, even poorly managed CRP discontinuity did not significantly disrupt the market: Eurofer, the European Steel Association which represents large steel manufacturers and national steel federations, issued its widely followed scrap price indices for information purposes only, yet insiders leveraged these CRP in their steel price revision formulas, e.g., “The uniform scrap surcharge formula agreed on 3 October 2003 was ‘Eurofer index minus the offset 68’…” (European Commission, 2016). Then Eurofer unexpectedly “closed indefinitely” all CRP in March 2016, triggering panic and feverish activity across the market. As most steel contracts are reviewed monthly or quarterly, market participants only had a few weeks to identify and agree on alternatives. For example, the BDSV3 was considered because it witnessed an almost perfect correlation with the Eurofer CRP, enjoyed an excellent issuer reputation, had transparent methodology, and was already widely disseminated (ArcelorMittal, 2016).

### A.3.13 CRP Irrelevance

A CRP may be or become irrelevant due to geographic representativeness, local availability, or grade. Naturally, the informed market participants will ignore irrelevant CRP, but their irrelevance may not be known to everybody and may subsequently trigger wrong economic decisions (Hudson, Ethridge and Segarra, 1998). For example, cotton has eight distinguishing features determining its final price (Caliskan, 2007). These quality differentials are priced-in as premiums of discounts against the official cash cotton price. Unfortunately, the differentials CRP fail to accurately represent the market level and movement (Hudson, Ethridge and Brown, 1996; Hudson, Ethridge and Segarra, 1998). Subsequently, textile mills should not rely solely on them when considering quality trade-offs to maximize profit.

The problem with local CRP availability/irrelevance is salient in developing countries where farmers cannot leverage CRP traded on major commodity exchanges to hedge their commodity price exposure (Larson, Varangis and Yabuki, 1998). Therefore, scholars suggested local CRP adaptation, eliminating the foreign exchange and basis risk and making hedging much more efficient (Mohan, 2007). Similarly, construction CRP should not be considered a reliable basis for automatic escalators because regional differences in the critical cost factors heavily impact their relevance (Eurostat OECD, 2009).

### A.3.14 Section summary

This section identified multiple CRP deficiencies that prevent CRP from fulfilling their functions (see taxonomy in Table 62). The ensuing taxonomy is richer than Wand & Wang's (1996) overview of information system deficiencies and Rauterberg & Verstein's (2013) study of financial index deficiencies. It is also fine-tuned to the CRP construct and reveals that CRP vulnerability is highly differentiated: some CRP suffer from flawed methodology, others may be lagged or irrelevant to a business problem. In addition, there are different levels of CRP deficiencies, e.g., a CRP price may be moderately or significantly lagged, or potentially or effectively manipulated. These findings are important for conceptualizing the CRP contingency levels and their measured attributes and will be revisited during the interpretive analysis of CRP contingency attributes.

| Rauterberg & Verstein's (2013) / Wand & Wang's (1996) | Expanded taxonomy of CRP deficiencies |
|---|---|
| **Malproduction**<br>Incomplete representation | Flawed Methodology |
| | Methodology Change |
| | Inaccuracy |
| | Basis risk |
| | Trade-offs |
| | Lagged |
| **Manipulation**<br>Ambiguous representation | Manipulation |
| | Collusion |
| **Underproduction**<br>Meaningless states | Absence |
| | Irrelevance |

**Table 62: Expanded taxonomy of CRP deficiencies following Wand and Wang, (1996), Rauterberg and Verstein (2013)**

### A.3.15 Interpretive approach to CRP transparency attributes

This section establishes the link between the CRP functions, outlined in Section 4.1.1., and CRP deficiencies, outlined in Section 4.2., and considers suitable corrective measures which will subsequently serve as the basis for distilling the relevant CRP transparency attributes. In contrast to the previous section, where the CRP transparency attributes were extracted from the literature, the CRP transparency attributes are inferred from CRP deficiencies and corrective measures. Table 63 summarizes the whole process which follows recommendations by Stvilia, Gasser, Twidale, & Smith (2007) and Wand & Wang (1996).

Firstly, the CRP deficiencies were identified based on the detailed analysis of CRP functions. Subsequently, the suitable corrective measures were identified in the literature. Finally, provisional CRP attributes were inferred from these corrective measures and regrouped into six broad categories labelled: (1) methodology, (2) information content, (3) timeliness, (4) accessibility, (5) understandability, and (6) accuracy.

When CRP transparency attributes derived from the interpretive approach semantically and terminologically overlapped with the CRP transparency attributes identified through the intuitive approach, the same labels were used. In contrast, different provisional labels were selected for two CRP transparency attributes: CRP “information content” is a better description of observed deficiencies than the “contextual attribute;” similarly, CRP “understandability” seems more to the point than the “representational” CRP transparency attribute label. So far, there is no empirical reason to prefer any of these terms, and their suitability will be explored in the following section.

| Observed CRP deficiency | | Corrective action | Inferred CRP transparency attribute |
|---|---|---|---|
| **Malpro-duction** | Flawed Methodology | Improve CRP methodology (IEA *et al.*, 2011; IOSCO, 2013, 2015) | Methodology |
| | Change of methodology | Improve CRP methodology (IEA *et al.*, 2011; IOSCO, 2013, 2015) | Methodology |
| | Inaccuracy | Select CRP fit for purpose (Rauterberg and Verstein, 2013)<br>Modify the price discovery methodology (Aspris, Foley and O'Neill, 2020)<br>Improve timeliness (Veerman *et al.*, 2016)<br>Increase information content (Cinquegrana, 2008; Veerman *et al.*, 2016)<br>Increase CRP accuracy (Koontz and Ward, 2011) | Methodology<br>Information content Timeliness<br>Accuracy |
| | Basis risk | Modify CRP properties (Rauterberg and Verstein, 2013)<br>Improve the correlation between the physical and futures markets (Shi, 2004) | Methodology<br>Accuracy |

| Observed CRP deficiency | | Corrective action | Inferred CRP transparency attribute |
|---|---|---|---|
| | Trade-offs | Highlight inherent trade-offs (Rauterberg and Verstein, 2013)<br>Modify CRP properties (Rauterberg and Verstein, 2013) | Methodology |
| | Lagged | Increase publication frequency (Radetzki, 2013) | Timeliness |
| **Manipu-lation** | Manipulation | Modify the price discovery process (Aspris, Foley and O'Neill, 2020)<br>Improve regulation (Cinquegrana, 2008) | Methodology |
| | Collusion | Modify the price discovery process (Aspris, Foley and O'Neill, 2020)<br>Improve regulation (Cinquegrana, 2008) | Methodology |
| **Under-produc-tion** | Absence | Create a CRP (Cinquegrana, 2008)<br>Make CRP accessible (Cinquegrana, 2008)<br>Replace with alternative (Zsidisin and Hartley, 2012) | Accessibility |
| | Irrelevance | Complement or update with relevant information (Valiante and Egenhofer, 2013)<br>Change publication frequency (Figuerola-Ferretti and Gilbert, 2005) | Information content<br>Understandability<br>Timeliness |

**Table 63: CRP transparency attributes inferred through the interpretive approach**

# Expert opinion about suitable CRP transparency attributes labels

This section summarizes insights from expert interviews concerning suitable CRP transparency labels.

## A.4 Methodology

**CRP transparency as methodology** was the most disputed label, and several alternative terms were put forward (see Table 64 for quotations). Unfortunately, the terms “quality” and “relevance” are too generic and applicable to all other CRP transparency attributes. “Source transparency” may be too reductionist because it only covers the quality of the data source but not the subsequent price discovery and reporting process. Similarly, “regulation” is potentially misleading because it would favor CRP issued by the government, official bodies, or regulated CRP irrespective of the oversight quality. In contrast, “price discovery quality” summarizes the main methodological challenge and is a suitable candidate for the CRP transparency label.

“Price discovery quality” also seems suitable, if not wordy. The word quality is not problematic here because it may denote a continuum of quality states. Similarly, “governance” or “compliance” seem acceptable because they capture the essence of the CRP transparency attribute: the overall quality of the CRP price discovery process. At the same time, all three terms are already widely used and may bear specific and misleading connotations for some users.

Finally, experts recommended adding a qualificative attribute that indicates what the methodology represents, e.g., “index methodology” or “robust methodology.” However, the former is potentially confusing because not all CRP

are indices. The latter then contains a strongly positive connotation which might complicate its subsequent operationalization. Hence, “methodology” and “price discovery quality” were shortlisted.

| | |
|---|---|
| Methodology | “This attribute is about methodology, so the word should be in the label.”<br><br>“Index methodology.”<br><br>“The simplest label is *good methodology*.”<br><br>“Liquidity and regulation are the prerequisites for a robust price. But I do like the term *regulation*. *Liquidity* is unclear.”<br><br>“Price discovery quality.”<br><br>“Definitely not *robustness*, maybe *methodology*, [but] I would label it *price discovery*. Or even better, *the quality of price discovery*.”<br><br>“We speak about the issuer quality, so why not *governance* or *compliance*? Both terms mean that somebody guarantees the reference price quality.”<br><br>“I sort of like *relevance* because *the price discovery process* may be relevant or not—the precise maths with approximate numbers.” |

**Table 64: CRP transparency as methodology–- illustrative quotations**

## A.5 Accuracy

There was a consensus concerning **CRP transparency as accuracy** (see Table 65 for quotations), especially if *precision* is considered equivalent to *accuracy*. The term was deemed relevant and easy to understand. *Objectivity* and *reliability* were suggested as suitable alternatives. However, both words convey a slightly different meaning that might confuse the users: While an accurate CRP emphasizes the "quality of being correct of precise" (Oxford dictionary, 2021), objective or reliable CRP relate more to the way the CRP was discovered and thus to methodology. Hence, none of the terms was shortlisted.

| | |
|---|---|
| Accuracy | "I prefer you called it directly *accuracy*."<br><br>"When we say *accuracy*, we actually mean the quality of the forecast."<br><br>"When I hear *intrinsic*, I do not know what that means. But when I read through the *accuracy attributes*, it is clear that *accuracy* [is the proper term]."<br><br>"For me, *reliable* and *accurate* are synonyms."<br><br>"The meaning is clear, and I would settle for *accuracy*."<br><br>"You should say *accuracy* because if you go to commodity exchanges, the difference between the reference price and reality disappears."<br><br>"I understand the term *accuracy*… [but] *objectivity* would not be bad [either]."<br><br>"No problem with *accuracy*. … I'd call it the *level of objectivity*.<br><br>"I think *objective* or *simple*. … But with *simple*, no one understands the meaning, so I settle for *objective*. |

**Table 65: CRP transparency as accuracy–- illustrative quotations**

## A.6 Contextual transparency

As for the **contextual CRP transparency attribute**, the label was judged understandable but perhaps somewhat restrictive and misleading because it does not encompass all facets of the price information, such as the range of regional or futures prices. Instead, the labels “completeness” or “availability of information” were suggested. Both terms have several advantages. Firstly, they cover both contextual and price information. Secondly, they allow for different degrees of completeness, availability, or content, which is convenient for subsequent operationalization. Thirdly, they imply that users should look for a whole range of information when assessing the level of CRP transparency. Fourth, neither term contains the word “transparency,” which is already included in the “CRP transparency” construct.

Alternatively, the term “price drivers” was mentioned, but it seems too reductionist, focusing only on one contextual factor. Hence, the terms “completeness” and “availability of information” were shortlisted and complemented with the term “information content,” which stems from the interpretive approach (see Table 66 for quotations).

| | |
|---|---|
| Contextual | "[the term *contextual*] suggests giving information about the business context. I like it."<br><br>"Now, I agree that [the term] *completeness* suggests both the price and the context, while *context* leaves the price aside. … Perhaps [*completeness*] is more precise."<br><br>"I do not see the difference [between *completeness* and *contextual*]. Both are self-explanatory."<br><br>*Availability of information* would be my recommendation."<br><br>"I will go for *complex* because the reference price goes from simple to complex, which describes the behavior of the whole market."<br><br>"*Contextual transparency* is perfectly understandable."<br><br>"I like *completeness*."<br><br>"It is information about the price drivers and other factors. … [The term] *price drivers* describes this aspect well." |

**Table 66: CRP transparency as contextual transparency–- illustrative quotations**

## A.7 Timeliness

Even though the informant brief contained several alternatives, the terms "timeliness" and "frequency" prevailed. The two terms are interrelated and partly overlapping: *timeliness* refers to the "occurrence at a favourable or useful time" (Oxford dictionary, 2021), suggesting that the schedule of updates is commodity and context-specific. *Frequency* then denotes "the rate of occurrence over a period of time" (Oxford dictionary, 2021), highlighting the fact that CRP are published with different periodicities, which subsequently impacts the timeliness.

However, accepting the subjective and contextual nature of timeliness, it becomes challenging to operationalize it across CRP. In contrast, the term *frequency* may be ambiguous without a specifying attribute such as “publication frequency.” Finally, the proposed term “regularity” does not capture the essence of the CRP attribute and does not inform the user about the frequency nor timeliness of updates. Hence, the terms “timeliness,” “frequency,” and “publication frequency” were shortlisted (see Table 67 for quotations).

| | |
|---|---|
| Timeliness | “The *[publication] frequency* is more suitable.“<br>“In my opinion, *frequency* is the most important attribute.“<br>“*Timely* sounds good.”<br>“Frequency of publication.”<br>“We should highlight the fact that the reference price is published regularly. … [The term] *regularity* comes to mind.” |

**Table 67: CRP transparency as timeliness–- illustrative quotations**

## A.8 Accessibility

**Accessibility.** Experts considered the term suitable, easy to understand, and capturing the essence of the CRP transparency attribute (see Table 68 for illustrative quotations). The alternative label “ease of access” is semantically neutral and can be considered synonymous with “accessibility.” While it does not bring any additional insight or greater precision, it was shortlisted for further scrutiny. On the contrary, the proposed label “transparent access” is potentially confusing because this paper already uses the term “transparency” in a different meaning.

| | |
|---|---|
| Accessibility | "*Accessibility*- fine with me."<br>"It should be *ease of access*."<br>"*Transparent access*, maybe." |

**Table 68: CRP transparency as accessibility–- illustrative quotations**

## A.9 Representational transparency

The term **representational CRP transparency** proved confusing, yet most respondents did not come up with an alternative label except for "appropriate format" or "standardized format." While easy to understand, "standardized format" may be somewhat reductionist because it does not carry the notion of clarity, it was shortlisted for further scrutiny.

| | |
|---|---|
| Representational | "I do not really understand what this label means. When I read the explanation, I sort of understand what you want to say. But there must be a better label."<br>"No, [the label] does not make sense to me."<br>"You have to explain [me] what exactly you mean. … I see, but I do not know. Perhaps *appropriate format*?"<br>"*Standardized format* simplifies the sense-making process." |

**Table 69: CRP transparency as representational transparency–- illustrative quotations**

## A.10 Acceptability

The label **acceptability** was considered straightforward and easy to understand, and there were no alternative proposals (see Table 70 for illustrative quotations).

| | |
|---|---|
| Acceptability | “Clear. Nothing to add here.”<br><br>“Everyone understands what this [term] means.” |

**Table 70: CRP transparency as acceptability–- illustrative quotations**

# Conceptualization of CRP transparency attributes

This section conceptualizes CRP transparency attributes identified through a combination of intuitive, interpretive, and empirical approaches.

## A.11 Accuracy

Scholars emphasize the importance of 'accurate' (Koontz & Ward, 2011), 'impartial' (Radetzki, 2013), 'reliable' (Cinquegrana, 2008), or 'objective' (Maxwell, 2015) CRP. They consider poor CRP accuracy a significant obstacle (e.g., Economist, 2014; Hayenga & Schrader, 1980; Nguyen & Arnsdorf, 2013) which hampers effective CRP use as a benchmark (Valiante and Egenhofer, 2013), common reference (Figuerola-Ferretti & Gilbert, 2005), or credible reference (Veerman et al., 2016). Similarly, practitioners view CRP accuracy as the most fundamental CRP transparency attribute, e.g., *"without accuracy, the benchmark is useless,"* and consider it equivalent to "objective value," "unbiased benchmark," "regionally accurate reference," or "benchmark to beat." Yet, it is not trivial to define CRP accuracy as it encompasses four facets (See Table 71 for additional illustrative quotations):

(1) "Intrinsic CRP accuracy" is understood as the objective difference between the representation of the real world and the real world. Hence, it explores how accurately the CRP mediates the quotes/realization prices to market participants (e.g., Adjemian et al., 2016; Adjemian, Saitone, & Sexton, 2016; Maynard, 1997; WTO, 2005).

(2) "Subjective CRP accuracy" is conceptualized as a consumer's subjective judgment of fitness for use and examines whether the CRP is accurate enough for the intended purpose (e.g., Eurostat OECD, 2009; Rauterberg & Verstein, 2013). For example Expert 4 notes:

> “We do not need accurate reference prices but representative CRP. For example, the statistical office publishes an average petrol price- an accurate number. But you will never achieve this number because you only buy on the highway. So, the central reference price has to be accurate but does not need to be accurate for my specific business context.”

(3) “Structural CRP accuracy” explores the difference between the CRP specification and the purchased commodity specification, region, or market structure and may render even highly accurate CRP meaningless. For example, PM responsible for steel procurement in energy sector observed that the steel trader bluntly refused his request for using a CRP:

> “The supplier tells me—this [reference] price is only valid in Germany and for large accounts. End of the story.”

(4) Finally, “CRP accuracy consistency” explores whether the CRP accuracy level is maintained over time because any variation has an important impact on CRP business use. For example, PM responsible for chemicals observed that some CRP witness inconsistent accuracy levels and formulated implications for CPM practices:

> “[when delivery situation stabilized and market prices started to decrease dramatically], major producers continued to report high selling prices which contradicted the real market. [Subsequently,] the benchmark became so inaccurate that we were losing hundreds of thousands of euro every month [due to the CRP-based price escalator]. [So] we told the supplier that this could not go on. We maintained the contracted volumes but renegotiated [the price] based on the market prices. … We cannot trust this index as the basis for contracts [anymore].”

At the same time, CRP accuracy should not be overemphasized as CRP issuers may trade it off for other legitimate reasons, such as CRP consistency or timeliness (Rauterberg and Verstein, 2013).

Considering the prominence of CRP accuracy, it may be surprising that no specific measures were identified in the literature to improve CRP accuracy. Instead, scholars consider CRP accuracy improvement a consequence of enhanced methodology (e.g., Hudson et al., 1998), information content (e.g., Bloomfield & O'Hara, 1999), timeliness (e.g., Wachenheim & DeVuyst, 2001), selection of CRP fit for purpose (Rauterberg & Verstein, 2013), or governance, accessibility to underlying market data, and reliability of information (Azzam, 2003; Valiante and Egenhofer, 2013; EU, 2016c). However, the contingent nature of CRP Accuracy is difficult to defend:

- Methodological robustness of the price discovery mechanisms does not necessarily correlate with CRP accuracy, e.g., posted prices by a monopoly producer may be opaque in terms of the price-setting mechanism but highly accurate as a reflection of prevailing market prices (e.g., Radetzki, 2013).
- Publication frequency does not correlate with CRP accuracy, e.g., the continuous stream of CRP may be noisy and hence a less reliable reflection of fundamental value (Putniņš, 2013).

In summary, CRP accuracy belongs among the key CRP transparency attributes because (1) it is considered critical for the CRP usefulness by scholars and practitioners, (2) there are significant differences between CRP accuracy levels with serious implications for business practice, (3) CRP accuracy is clearly distinct from other CRP transparency attributes. Hence, CRP accuracy will be included among the definitive CRP transparency attributes.

*Intrinsic accuracy:*

“The reference price must be unbiased and objective.”

“essential … how [the CRP] reflects the market reality.”

“Objective CRP reflects the market, and you must be sure that CRP reflects the physical transaction. So, LME published an accurate CRP because it is not calculated from a statistical sample.”

“I agree with *accuracy* [as an important CRP transparency attribute]. Say you have an index with 65% accuracy. You can trust it because it reflects the market.”

“I would like the CRP to tell me where the market price is so that I can be slightly below this price. This is what every buyer wants- to have a competitive advantage.”

“Accuracy is key. It means that the reference price is of good quality and error-free.”

*Subjective accuracy:*

“It does not have to be perfectly accurate as long as both sides agree to use this number in their contract. … [And] you will check that [the CRP] follows the market evolution and make your independent assessment of CRP accuracy.”

*Structural accuracy:*

“Regional accuracy is key. For example, we signed contracts based on an Australian coal index because Australian coal was cheap. But then there was an earthquake in Australia. The prices in our region remained the same, but our contractual prices skyrocketed because we selected the wrong index.”

*Accuracy consistency:*

“[Price reporter] always talks to the same people including me. Buyers always decrease the price, seller inflate it. They make an average and come up with a good price.”

**Table 71: illustrative quotations from the practitioner interviews for CRP transparency as accuracy**

## A.12 Methodology

CRP Methodology is conceptualized as a detailed description of the price discovery process and the data sources (IEA et al., 2011). Scholars identify the methodological robustness of the price discovery process, reporting methodology, and governance as the key CRP transparency attributes (e.g., Valiante, & Egenhofer, 2013; IEA et al., 2011).

Robust CRP methodology leverages multiple and reliable sources of information and publishes the price discovery methodology (IEA *et al.*, 2011; IOSCO, 2013, 2015). However, the risk of CRP manipulation cannot be ruled out, and some CRP are considered more vulnerable to manipulation than others (Rauterberg and Verstein, 2013; Verstein, 2015). In particular, the opaque side of the continua of commodity price discovery mechanisms (e.g., Humphreys, 2010; Radetzki, 2013; Strauss, 1992; Maxwell, 2015), such as private and opaque pricing by vertically integrated companies, tend to be more vulnerable than public and transparent pricing generated by leading PRA or commodity exchanges.

Purchasing managers consider CRP methodology fundamental in assessing the CRP transparency. They should, therefore, check the quality of CRP methodology before accepting a CRP. They should focus on the issuer's identity, methodological clarity, data sources, vulnerability to manipulation, auditability, and regulatory oversight. However, this is rarely the case due to limited buyer capacity and skills. Instead, buyers rely solely on the CRP and the issuer's reputation. For example, Expert 9 highlights practical problems related to CRP methodology assessment:

> "Sure, [methodology] is fundamental. [But] buyers never consider methodology quality because they do not have the capacity to address this issue. You need an in-house expert to tell if the LME steel price discovery is good or bad."

CRP methodology must evolve along with the changing market context; otherwise, the CRP becomes irrelevant. For example, Fattouh (2011) shows that

the Brent CRP methodology evolved by adding new grades to maintain the benchmark's liquidity. Similarly, IOSCO (2015) reports that leading PRA implemented the recommended methodological improvements. However, Expert 6. considers any CRP methodology change potentially disruptive:

> "I remember when we were badly impacted by a steel index switch from leading to lagged. … We had to renegotiate the contract [clause] with our customer [pegged to this CRP]. … We actually found out about the change completely by chance - when the prices jumped and differed from the ones we had negotiated with our suppliers. We started looking into why, and only then did we notice that the methodology had changed. … Honestly, no buyer has the time to keep track of [methodology changes]. We either figure it out by accident like we did back then, or a supplier or customer tells us."

There is broad agreement about the necessity to increase the integrity and transparency of CRP methodology (European Commission, 2011). A rare survey demonstrated that only one-third of respondents were satisfied with the current quality of CRP methodologies (Amenc and Ducoulombier, 2014). Unfortunately, there is little consensus about the way to achieve this objective: over 50% of respondents believe that EU regulation of benchmarks and indices is necessary, while 28% consider it excessive (Amenc and Ducoulombier, 2014). Furthermore, some market participants denounce the subjectivity of the price assessment process and call for a purely mechanistic approach, while others emphasize the inherently subjective nature of CRP assessment, where some level of judgment will always be warranted (c). In particular, Fleming (2015) supports the subjectivity argument arguing that most CRP suffer from a low number of transactions, market participants are not interested in broadly representative assessments, and inter-product spreads are high. He concludes that judgment is fundamental in selecting and changing the CRP assessment attributes, dealing with anomalous data or manipulative attempts, and determining the typical transaction price range.

The research into CRP Methodology improvement is vast, and scholars suggest three broad approaches to improving the CRP Methodology quality: (a) market pressure and self-regulation, (b) independent institutional rules, and (c) government regulation. Each has potential strengths and weaknesses:

**(a) Market pressure and self-regulation** are enacted through the market forces, which represent a strong disincentive to CRP manipulation or malproduction because they decrease the attractivity of the index and are likely to seriously hamper any revenue stream emanating from the CRP (Rauterberg and Verstein, 2013).

Self-regulation may be ineffective for public and by-product indices that are less responsive to profit-based or coercive measures because they do not generate revenue (Rauterberg and Verstein, 2013). However, this does not necessarily mean that government regulation is the only possible corrective action. Instead, strengthening intellectual property rights to CRP would generate a stable revenue stream for the CRP issuers and motivate them to improve and maintain high CRP quality (Rauterberg and Verstein, 2013).

In contrast, commodity exchanges, an important CRP issuer, are thought to have sufficient incentives and capabilities to deal with manipulation themselves (Pirrong, 1995). For example, Aspris, Foley, & O'Neill (2020) argue that commodity exchanges can improve transparency, reduce leakage, transaction costs, and volatility by changing the closing price determination mechanism from opaque to electronic. However, this measure did not increase platinum and palladium price discovery quality, perhaps due to the low liquidity of these indices (Aspris, Foley and O'Neill, 2020).

Furthermore, Pirrong (1995) challenges the laissez-faire approach and calls for government action. He argues that commodity exchanges are not motivated to deal with manipulation due to customer inertia and exchange impartiality concerns. Furthermore, fully automatized and formulaic CRP discovery mechanisms become vulnerable to manipulators who know precisely how to twist the trade or the submitted data to bias the CRP (Verstein, 2015). Indeed, a

determined trader can always find ways to abuse even the most sophisticated closing mechanisms (Cordi, Foley and Putniņš, 2015).

The price reporting agencies also advocate self-regulation through detailed and binding codes of conduct open to public scrutiny (e.g., ICIS, 2021), collaboration with independent auditors (e.g., SteelBenchmarker, 2017), or voluntary adoption of recommendations by independent supervisory bodies (e.g., Argus Media, 2019). Furthermore, CRP issuers could further improve CRP transparency if allowed to include non-transactional data, such as the perceptions of market participants, in the CRP formation process. Yet, it would also make the CRP issuers vulnerable to accusations of CRP tinkering (Verstein, 2015).

**(b) Independent institutional rules**. The principles for the quality and integrity of PRA methodologies formulated by IOSCO are the prime example of independent institutional rules that CRP issuers widely adopted for all commodities, including energy, metals, chemicals, and fertilizers (Fleming, 2015). The principles cover all aspects of the CRP formation process: (a) data collection and acceptance, minimum data amount, the use of an assessor's judgment, (b) detailed methodology disclosure, clear guidelines for managing changes to methodologies, conflict of interest avoidance, complaints handling, (c) cooperation with regulatory authorities, and the appointment of an external auditor responsible for reviewing the methodology compliance (IOSCO, 2013, 2015).

The follow-up report on the principles implementation documents that the key PRA align their management and operational policies with the principles regarding IT, documentation, compliance, training, methodology, and scope of application. It also states that CRP consumers recognize the benefits of the principles and do not encounter any unintended negative consequences (IOSCO, 2015). Finally, the report dissipates the fears of a lower volume of submissions and subsequent deterioration of the assessment process quality following the stricter methodological rules, which some scholars feared (e.g., Stewart, 2013).

**(c) Government regulation**. The fear that commodity markets would become disconnected from their fundaments following the massive arrival of financial

investors and speculators (e.g., Arezki, Lederman, & Zhao, 2014) prompted traditional market participants to actively lobby for limiting the size of open positions held by financial investors, force traders to disclose positions above a given threshold, ban the proprietary trading by financial institutions involved in hedging on behalf of their clients, and prohibit traders from taking financial positions in markets that they could influence through their market power (UNCTAD, 2011). These voices became particularly audible following the extreme commodity price hikes and volatility observed in the late 2000s. For example, the 2010 G20 Seoul meeting mandated IOSCO to produce a report on oil PRA (G20, 2011), which resulted in the principles discussed in the previous subsection. Furthermore, despite the evidence that the financialization of commodity markets biases prices is, at best, inconclusive (De Meo, 2013), the Commodity Futures and Trade Commission ceded to pressure and imposed position limits for financial commodity derivatives on 28 commodities (Arezki, Lederman, & Zhao, 2014).

In addition, the 2012 Libor manipulation scandal triggered several regulatory initiatives, such as the European Union Regulation on Wholesale Energy Market Integrity and Transparency (REMIT), the regulation on indices used as benchmarks in financial instruments and financial contracts, and the Market Abuse Regulation (see Amenc & Ducoulombier (2014) for a comprehensive overview, which is out of the scope of this paper).

Not surprisingly, regulatory measures have been subject to harsh critique. Firstly, scholars are sceptical that governments can develop universally valid CRP methodologies. Perhaps the elusive nature of one-size-fits-all regulation is best reflected in the three subsequent IOSCO reports, which gradually weakened the required level of PRA methodological transparency (Amenc and Ducoulombier, 2014). Similarly, Rauterberg & Verstein (2013) analyze six regulatory Libor mechanisms and show that each measure is vulnerable to manipulation.

Secondly, coercive regulatory measures may not be efficient for the by-product indices because wrongful behaviour is difficult to prove. Also, even if

proven, the punishment of the violators may be too costly (Rauterberg and Verstein, 2013). This somewhat depressing statement is backed by empirical evidence demonstrating that commodity market manipulation may be practically unprosecutable (e.g., Pirrong, 2010).

Thirdly, draconic regulation and immediate data disclosure may deter CRP providers and informants (Verstein, 2015) and encourage regulatory migration (UNCTAD, 2011). Excessive regulation may also harm market transparency because market participants may refuse to disclose their trades and share opinions about the market dynamics (Stewart, 2013). Furthermore, even mandatory data submission may be harmful because it makes cartels easier to form and ignores the fact that some trades are legitimately private and internal to company strategy (Verstein, 2015).

In summary, CRP methodology constitutes a fundamental CRP transparency attribute for several reasons: (1) CRP methodology is key for evaluating a CRP contingency and fit-for-use. (2) CRP methodology is clearly structurally distinct from all other CRP transparency attributes. One expert suggested that methodology and accuracy were intimately related and should be merged into a single CRP transparency attribute. It is contended that sound methodology is a pre-condition for CRP objectivity, freedom from error, and accuracy. However, others clearly distinguished them as two different CRP transparency attributes. (3) There are several distinct levels of CRP methodology with significant impact on business practice.

*Methodology importance:*

"The methodology is fundamental for every CRP. I must know a detailed description of the reference price and the data sources."

"[Methodology] is critical, similar to the number of stars when you grade investment funds."

"Methodology is essential for internal justification. The reference price is transparent because the statistics office publishes it, and no one will say it has been manipulated. But it is sometimes misused to justify wrong decisions."

*Methodology assessment:*

"Methodology as issuer authority. For example, LME is an authority for non-ferrous metals, and our final customers are willing to accept it [as the contract reference]."

"Methodology and robustness is a single facet. The methodology must be clear if I want to check the price discovery quality. The third facet- whether the reference price is regulated or not."

"[Methodology is] important … I do not trust CRP created by producers because they can manipulate them … [On the contrary,] the London commodity exchange is difficult to challenge because it is a well-known CRP based on the trading and accepted by everyone. And the same holds for oil because the prices are public and based on trades."

"Managers use reference prices and do not even consider the methodology. [However,] to defend my decision internally, I need to understand the underlying principles and must be able to explain the methodology in simple terms."

"The reference price [issuer] must publish the price discovery methodology and be auditable. More auditable, less vulnerable to manipulation."

"Methodology informs you about the possible usage of the reference price- is it a helicopter view of the local price, or is it a benchmark to be used in contracts?"

"Robustness is essential, especially if you start using a reference price. You should investigate who makes the CRP and what data they base it on. Sometimes this information is difficult to get hold of."

*Methodology change:*

- *Not observed besides the quotation mentioned in the text.*

**Table 72: illustrative quotations for CRP transparency as methodology.**

## A.13 Completeness

CRP completeness is understood as the depth and breadth of information mediated by the CRP (Wang and Strong, 1996; Madhavan, 2000; Lee *et al.*, 2002; Stewart, 2013). Thus, CRP completeness brings additional information about the commodity, the market, and the trading context and assists market participants during the sense-making and decision-making processes.

CRP completeness cannot be considered in isolation but always within the context of the task at hand (Wang & Strong, 1996); therefore, the optimum information content is always contextual (Lee *et al.*, 2002), i.e., market, participant, and business case specific. For example, a hedger will be interested in the pre-trade information but may not care for the comprehensive harvest forecast because he may assume that this information has already been included in the futures price. In contrast, farmers may seek the fundamental analysis data, while real-time futures quotes are less relevant outside the hedging window.

Scholars label CRP completeness as the “completeness” or “reliable information on important determinants of price movements” (Ahlers et al., 2013:1) and cite a wide range of contextual information sources: the commodity, demand, supply, inventory, pre- and post-trade data, open interest, trading volumes, regional reports, weather, international market conditions, government interventions, traders’ interpretations of the market, elements of pricing policy, future prices and expiries (Cinquegrana, 2008; Fattouh, 2011; Koontz & Ward, 2011; Li, 2010; Madhavan, 2000; Stewart, 2013; Hewitt, 2003; Radetzki, 2013).

CRP completeness plays a vital role in respondent accounts that emphasize the richness of data that the CRP mediates, e.g., prices for different grades and regions, the level of detail of background information, the availability of the forward price curve, trade information, or alternative/additional data sources.

There is an overwhelming consensus that the “more information, the better,” in terms of the (1) depth and (2) breadth of information. Respondents appreciate

comprehensive market data even if they do not study or leverage it for their decisions. Instead, they may use it to make sense of the market, gain confidence in the decision, and justify one´s actions internally. PM responsible for wood and chemicals notes that less informed buyers will find comprehensive information mediated by the CRP helpful and informative:

> "If you buy the commodity intensively, nothing will surprise you [in the CRP report]. But if you buy it only occasionally, the report will help you understand the quotes and negotiate the price."

Nevertheless, buyers should be warned against information overload because additional information may be irrelevant, already known, or even misleading or dated.

In contrast, Stewart (2013) challenges the "more-is-better-consensus" and argues that disclosing the mass of auditable data, mandatory reporting, oversight procedures, and penalties may harm horizontal and vertical transparency. As for the former, too much disclosure may discourage market participants from sharing and reporting sensitive trade data and may entice them to trade outside the trade window. Regarding the latter, too much regulation may discourage traders from conversing with the market about the market moves, commenting on the deals, or sharing the market sentiment, which would significantly weaken market informativeness. However, this concern remained isolated and did not resonate with the practitioners. On the contrary, extant literature suggests several measures to improve CRP completeness further:

- Poor data quality may stem from data dispersion and processing difficulty, as illustrated by Thornsbury, Davis, & Minton (2003), who document that 13 different agencies provide 50 official citrus reports just in Florida. Hence, better coordination, aggregation, and standardization could immediately improve CRP completeness.
- Market participants or regulators may pressure the CRP issuers to improve the definition and standardization of the input market data and start publishing data about the areas under plantation, harvests, available stocks, short-term

demand and supply, position-taking, or categories of market participants (Cinquegrana, 2008; UNCTAD, 2011; Veerman *et al.*, 2016). Additionally, CRP issuers may consider disclosing more detailed pre-trade and post-trade information (Madhavan, 1996) as well as any other relevant data likely to curb information asymmetries and prohibitive monitoring costs (Valiante and Egenhofer, 2013).

- Finally, the invisible hand of the market may resolve the CRP absence. Unlike Rauterberg & Verstein (2013), who argue that the market mechanism is of limited utility for underproduction because one cannot punish a CRP into existence, there is evidence that PRA step in and start producing CRP whenever they see the commercial benefit (Roeber, 1996).

In summary, there is strong support for including CRP completeness in the final list of CRP transparency attributes. (1) Both extant literature and practitioners agree that CRP completeness is fundamental to understanding and using the CRP (see Table 73 for illustrative quotes). (2) The extant literature suggests that there are different levels of CRP completeness with differing and significant impacts on business practice (Madhavan, 2000). (3) While some respondents argued that CRP completeness overlapped with CRP accuracy, e.g., futures prices or regional prices, others maintained a clear distinction between the two CRP transparency attributes because contextual transparency primarily contains comments, analyses, and trading information. Hence, the attributes are complementary rather than overlapping, and CRP completeness provides the necessary context to understand the CRP and leverage it internally and externally. PM responsible for electricity and gas procurement emphasizes the importance of contextual information:

> "It is imperative to know precisely what is going on on the market and why the reference price is what it is."

Considering all these arguments, CRP completeness was included among the key CRP transparency attributes.

*Importance of completeness:*

"For buyers, it is essential to have information about traders' identities. If the reference price moves, you want to know whether it was a big transaction. I am not using this level of detail, but if I were a big buyer, I would like to see why the reference price changed, and based on what trade."

"Without contextual transparency, I cannot defend the price-internally nor externally. It gives the cost drivers, market situation, commodity availability. It is an important source of business information."

"It is like splitting hairs. I understand the difference but would merge [contextual transparency] with accuracy for simplicity reasons."

"Contextual transparency is the same as accuracy, right? If you provide the Central European prices, then the [commodity reference] price must also be accurate for the region."

*Contextual completeness:*

"[Important, but] the level of detail depends on the receiver. Sometimes CRP provides too much information to handle for a lambda buyer or plant manager."

"We get the print-screen of the CRP from our supplier, which is sufficient. But the commodity buyer needs the full report with all information to make sense of the price."

"It is important because it gives me the necessary background information. On the other hand, I do not think it is relevant on a tiny detail level. For example, I do not need to know a miner's salary. [When] the reference price gives me more information than I need. … [then] my costs to analyze the index exceed the benefits."

"I would include contextual transparency. … You can easily measure it – the information is there or not – it suffices to look at the report and see if there is just a CRP without any comment."

**Table 73: illustrative quotations for CRP transparency as completeness**

## A.14 Accessibility

Perhaps the first call for CRP transparency as “accessibility” was observed in the 1974 UN General assembly, where the French Foreign Minister called for a world economic monitoring center. This institution would increase market transparency by “recording prices and publishing a weighted mean price as a reference known and agreed by all, for every commodity in world trade” (Schachter, 1975:109). Hence, CRP accessibility was originally understood as “CRP existence.”

Today the meaning of CRP accessibility shifted towards the amount and quality of shared information received in a timely manner (e.g., Wang & Strong, 1996; Lee et al., 2002). However, this definition comprises physical and temporal accessibility, which may not always correlate. Furthermore, the temporal aspect is covered by the CRP Publication frequency. Hence, CRP accessibility is understood more narrowly as CRP availability to market participants (Cinquegrana, 2008; Valiante and Egenhofer, 2013; Veerman *et al.*, 2016).

The notion of physical availability is substantiated by many synonyms observed in CRP literature, e.g., “availability” of relevant market information to all market participants (Veerman *et al.*, 2016), “disclosure” (Valiante and Egenhofer, 2013; Maxwell, 2015), “dissemination” (IEA *et al.*, 2011), “visibility” (Stewart, 2013), or “equal access” (Figuerola-Ferretti & Gilbert, 2005).

Some CRP are accessible for free, e.g., a simple registration is sufficient to gain access to some CRP issued by the LME. Yet, most CRP are subscription-based. Practitioners prefer CRP that are publicly and freely available; however, the paid-for access is not considered a significant obstacle and does not determine the decision to use a CRP. Low-volume commodities represent the only exception, as buyers are reluctant to take a costly subscription for just a few transactions per year. Instead, they bypass the subscription fee through informal CRP sharing or a print-screen of the relevant CRP. PM responsible for a wide range of commodities provides a pragmatic justification for this behavior:

> "It depends on the business case. You do not want to subscribe to a reference price just because you buy a few hundred tons. You would end up paying 1,000 or 5,000 euro for hundreds of reference prices. The fee may actually cost more than the resulting price change! So instead, you ask the supplier to make you a print-screen of the report. Of course, there must be a minimum level of trust. I tell them: if you want a price escalation formula, you must share the report with us. You can amortize the cost over many customers. Let's be clear, the reference price value is great. Especially if you consider that without a reference price, you would have a hard time agreeing with the supplier and have senior managers haggle several weeks over a few cents."

Despite the broad consensus that accessible CRP increases market efficiency (Rauterberg & Verstein, 2013), empirical operationalization of CRP accessibility is missing, perhaps due to the difficulty of defining CRP accessibility criteria (Feltkamp and Musialski, 2013). Even the comprehensive EU regulation on benchmarks does not cover this issue, focusing only on the accessibility of methodologies and complaint handling (Official Journal, 2016). Notwithstanding, several CRP accessibility improvement measures can be inferred from the literature:

(1) Replace subscription/mark-to-market based CRP by public, free of charge CRP, and publish all research and collected data funded with public money (Veerman *et al.*, 2016)
(2) Impose mandatory price reporting (Veerman *et al.*, 2016) equally accessible to all market players (Wachenheim and DeVuyst, 2001)
(3) Require market operators to make continuously available the pre-trade and post-trade data during regular trading hours (Feltkamp and Musialski, 2013)
(4) Terminate discriminatory practices by making the CRP available to all stakeholders at the same time (De Almeida, 2020)

(5) Leverage market interconnectedness, IT technologies, and electronic trading platforms to improve CRP accessibility (Valiante and Egenhofer, 2013)
(6) Foster CRP accessibility not only on the futures markets but also on the physical commodity markets (European Commission, 2011)
(7) Make CRP locally available by creating regional derivative exchanges (Larson, Varangis and Yabuki, 1998) and offer futures and OTC transactions in local currency (Mohan, 2007)
(8) CRP issued by public authorities could fill the gap where CRP are missing and provide an alternative to for-profit and by-product indices (Rauterberg and Verstein, 2013). Along the same lines, Cinquegrana (2008) recommends the establishment of an international commodity agency, which could centralize and take responsibility for collecting and consolidating information on all internationally traded commodities. On the downside, Public CRP would also render CRP vulnerable to political influence, trigger legitimacy concerns, and put immense pressure on governments to create effective oversight mechanisms (Rauterberg and Verstein, 2013).

In summary, there are several strong arguments against including CRP accessibility among the definitive CRP transparency attributes. Firstly, all CRP are now easily accessible on the internet, and poor accessibility is regarded as a warning sign that there is something wrong with the CRP. Secondly, the subscription fee is not a CRP accessibility criterion: companies simply pay or find a way around if they need the CRP. Thirdly, regulators do not consider CRP accessibility important enough to legislate. Fourthly, the CRP Accessibility improvement measures equally relate to other CRP transparency attributes, e.g., CRP methodology, completeness, or accuracy. Finally, practitioners do not view CRP accessibility as a CRP transparency feature and recommend dropping it (see Table 74 for illustrative quotations).

| |
|---|
| *Calls for inclusion:* |
| “I would only mention a widely used index in the contract.“ |
| *Calls against inclusion:* |
| “All these [commodity reference] prices are publicly available free of charge or subscription-based.” |
| “Compared to others, it is less important.” |
| “From my perspective, not relevant.” |
| “I do not care if it is paid or free, as long as the data is of good quality. Whenever somebody sent me something for free, it lacked details, no background comment, and the data out of context. If it is for free, then somebody else pays, and there is something behind it.” |
| *Circumvent subscription:* |
| “It’s pay to play. If you trade commodities, you have to get access to information. We subscribe to all possible reports and business intelligence. …. I disagree [that you have to subscribe]. Suppliers will update you with every time the price increases, and you always find the way to get the information you need.” |

**Table 74: illustrative quotations for CRP transparency as accessibility**

## A.15 Publication frequency

Publication frequency is frequently mentioned in the scholarly and practitioner literatures (e.g., Azzam, 2003; Valiante, & Egenhofer, 2013; Bloomfield & O’Hara, 1999; Fattouh, 2011; Koontz & Ward, 2011; Radetzki, 2013b; Veerman et al., 2016) and ranges from *immediately* for some metals (Radetzki, 2013), *once a day* for cotton (Caliskan, 2007), through quarterly updates for timber (Favada and Pepke, 2014) to *once a year* for some commodities covered by the US geological survey.

CRP publication frequency is very similar to timeliness, defined as real-time information (e.g., Azzam, 2003; Valiante, & Egenhofer, 2013; Koontz & Ward, 2011), which is particularly salient for large, liquid markets with many market participants (Li, 2010). However, unlike publication frequency, which is easy to operationalize, timeliness remains vague. For example, the London Stock Exchange attempted to quantify the timeliness of trade disclosure: it first imposed immediate trade disclosure before modifying it to 24 hours based on traders' complaints. Finally, it settled on 90 minutes for any trade exceeding the standard market size by an order of three (Gemmill, 1996). The practical difficulty with defining timeliness is also palpable in recent CRP regulations. For example, the principles require PRA to set criteria for the timeliness of data submissions (IOSCO, 2013) but do not specify how to establish the optimum time span. Likewise, the Wholesale Energy Market Integrity and Transparency Regulation (REMIT), which requires effective and timely information disclosure, does not specify what "timely" means, with the notable exception of insider information which has to be published before the trade (Feltkamp and Musialski, 2013).

The relentless progress and dominance of commodity exchanges with real-time CRP (Radetzki, 2013b) suggest that market participants always prefer CRP with higher publication frequency. However, the reality may be more nuanced, and the distinction should be made between "absolute publication frequency" and "meaningful publication frequency." The former assumes that any improvement in publication frequency is beneficial for the market participants. This is well documented by Figuerola-Ferretti & Gilbert (2005), who show that aluminum producer prices, trade journals reporting, and organized commodity exchanges coexisted for some time. As quarterly producer prices and price assessments by trade journals were getting out of touch with the actual market fundamentals and could not reflect dramatic price swings during periods of instability, they were progressively replaced by the real-time prices generated by commodity exchanges. Similarly, PM responsible for steel procurement emphasizes how the low frequency of steel CRP updates resulted in systematically lagged CRP and hampered effective trading:

> "The situation on the market is such that steel prices change daily. So a monthly report or even a weekly one is useless. You have to pick up the phone and ask the supplier what the prices are and make the decision because tomorrow the price will be different again. But nobody publishes such information because it is not feasible for steel. There is no exchange like electricity where you can see the spot prices. It is not in the steel mills' interest."

In contrast, "meaningful CRP publication frequency" accounts for the fact that frequently updated CRP may be considerably noisier and consequently less reliable measures of the fundamental value (Putniņš, 2013). Furthermore, real-time CRP publication frequency may only add stress and provide little value compared to official daily settlements or closing prices. Therefore, the tendency towards more frequent CRP reporting is not universal, and the optimum frequency remains commodity-specific. The importance of meaningful CRP publication frequency is confirmed by a PM in a large processing company responsible for a wide portfolio of commodities:

> "I need real-time updates of the electricity [CRP but] I am ok with monthly chemical [CRP] updates because we negotiate on a monthly or quarterly basis."

In addition, a lower frequency of updates may constitute a tradeoff where CRP accessibility or completeness are preferred. For example, the European energy exchanges operate a parallel system where the daily or slightly lagged price is free, while online platforms with a continuous stream of CRP are subscription-based. PM in a tier 2 automotive company seems happy with this arrangement because it gives him a choice:

> "[In my current company,] I am fine with delayed [energy] prices for observing the market evolution. … [But] some companies invest in real-time access because they believe it gives them an advantage."

Similarly, a daily livestock price update is of value to producers who decide when and where to sell their livestock. On the other hand, intermediate and long-term decisions about breeding and investment do not require daily prices (Wachenheim and DeVuyst, 2001). Different frequencies for different uses are also reflected in mineral industry surveys that appear monthly, quarterly, or at other regular intervals and are termed “timely” (U.S. Geological Survey, 2020:2).

Finally, infrequent and lagged CRP updates may also be the source of competitive advantage for well-informed buyers. For example, PM working for a diversified holding emphasizes the commercial potential of asymmetric information:

> “If everybody gets the price change information through the CRP, [you maintain zero competitive advantage]. But if you design a better mechanism, which gives you the [information] lead ahead of the market, you gain a competitive advantage. … [For example] if you know that there is an outage and the report is due next week, you have precious time to buy on stock at the current price and secure deliveries.”

The arguments for meaningful CRP publication frequency assume that higher CRP publication frequency is detrimental to CRP other CRP transparency attributes. Yet, some daily reports witness exemplary CRP completeness, e.g., Platts Coal Report, or great CRP accuracy, e.g., real-time quotes on the power exchange. Similarly, it is argued that some market participants do not need high CRP publication frequency. Therefore, one might view high CRP publication frequency as an option. Hence, if CRP publication frequency does not harm other CRP transparency attributes and if it gives more options to market participants, absolute CRP publication frequency is a superior conceptualization of CRP publication frequency.

Considering the importance of CRP publication frequency, only a few simplistic corrective measures were found in the literature: the introduction of digital trading formats (Banker et al., 2011), increase in CRP publication frequency (Radetzki, 2013b), change in price discovery mechanism (Figuerola-

Ferretti and Gilbert, 2005), or complement CRP with continuous coverage of breaking news (ICIS, 2020). In addition, no corrective measure was found to determine and fix the “meaningful CRP Publication frequency.”

In summary, there are strong arguments for including CRP publication frequency among the key CRP transparency attributes. Firstly, CRP publication frequency is a distinguishing factor for CRP choice and performance. Secondly, extant literature identified several levels of CRP publication frequency and documented its impact on business practice (e.g., Figuerola-Ferretti & Gilbert, 2005; Radetzki, 2013b). Finally, experts agreed that CRP publication frequency is a fundamental and differentiating CRP transparency feature and recommended including it among the definitive CRP transparency attributes (see Table 75 for illustrative quotations).

*Publication frequency importance:*

“The frequency of publication is 100% important—it informs me about the market movement. If you do not have this information, you do not know if you should review the price.“

“Definitely important…Timeliness is a function of market price changes. You need a frequency that guarantees that you get the information without delay.“

*Absolute publication frequency:*

“Pragmatically, infrequent CRP publication gives a competitive advantage to big buyers because they know that something has happened before the rest of the pack. But so does the real-time CRP because they have time to follow it and react.”

“To work with a reference price, you must know how often it is published. It differs depending on the commodity. For oil, once a year is not enough. … But I can imagine that you accept a lagged reference price if you get free access because the paid-for, super timely data is not necessary for your particular needs.”

*Meaningful publication frequency:*

“As for the frequency, I will not recalculate the oil prices daily just because I can.

| |
|---|
| The business case determines the suitable frequency of reference price publication – each commodity has its dynamics.” |
| “Timeliness is important if the commodity is your top procurement category. But for minor categories, continuous prices are overkill. It suffices to set up an escalator clause and look at the reference price from time to time.“ |
| “The frequency of publication importance depends on your contract. If you have a semi-annual escalator clause, you do not care about daily reference price publication and whether the CRP moved by 1%. What matters is a long-term average. That is why many firms switched to longer fixations – frequent CRP publication triggers too much useless volatility.“ |
| “Look, this CRP is published twice a year. For us, it is sufficient, and we could do even with an annual update. But our suppliers would prefer hourly updates because the actual market moves daily.” |
| “The [publication] frequency is important but in reality, we negotiate these prices monthly and only look at the report when the negotiation is up.“ |

**Table 75: illustrative quotations for CRP publication frequency**

## A.16 Representational transparency

*Representational CRP transparency* relates to the format and meaning of the data and is defined as the consistent representation, ease of understanding, and interpretability of the received information (Wang and Strong, 1996). Hence, it has two facets:

(1) Format clarity highlights the simplicity and good understandability of the CRP calculation formula, an indication of the regional prices, the type of trades covered, or the visual futures curve (Wang and Strong, 1996; Lee *et al.*, 2002).

(2) Format consistency and the fact that the meaning of data is obvious (Wang and Strong, 1996; Lee *et al.*, 2002) becomes salient when the CRP issuer decides to change the currency, unit of measure, benchmark

specification or stops covering some regions. For example, Expert 9 highlights the danger of format changes:

> "You know, you normally skim the [CRP] report and move on. But this time, the price was bizarre, too low. So you look closer and see that they moved from short to metric tons. I was lucky to note that. Otherwise, I would have submitted a wrong forecast to controlling department."

While format changes are rare, they may disrupt the industry and trigger a widespread renegotiation of formulas, e.g., the Brent composition change which temporarily paralyzed the market (Fattouh, 2011).

Scholars agree that CRP understandability is essential for making sense of CRP and highlight the usefulness of information "standardization" (Cinquegrana, 2008), "consistency" (Rauterberg and Verstein, 2013), "comparability" (Favada and Pepke, 2014), "dissemination of the collected data in duly aggregated form" (Veerman *et al.*, 2016). They argue that all these measures facilitate the smooth transfer of meaning as well as "representativeness, relevance, and appropriateness [of information] for its intended use" (EU, 2016:5) and, subsequently, easy processing and interpretation of information.

Despite its relevance, the literature provides only very generic advice about how to improve CRP representational transparency:

- Foster standardized formats and specifications (Dahl and Matson, 1998; De Almeida, 2020)
- Design easy-to-use formats and internet-based applications (Veerman *et al.*, 2016) because complex layouts may contain too much information and be incomprehensible to market participants (Galitz, 2007)
- Include clear and complete descriptions of the variables (Thornsbury, Davis and Minton, 2003)

This relative lack of concern is coherent with practitioners who waived this CRP transparency attribute as undistinctive. For example, Expert 3 makes a case for dropping representational CRP transparency:

> "But the form is not a [CRP] distinctive criterion … You see a number, range, or graph and know how to decipher it. [Perhaps,] when you see it for the first time, you have to think, but it becomes a routine after a time. [So] the reference prices do not differ in the quality of representation."

Furthermore, practitioners prefer the CRP representation consistency even if they have to make internal adjustments for their actual business needs, e.g., Expert 2 is not disturbed by a different currency:

> "LME is in USD per tonne, and I trade in EUR per kilo. I am used to making the conversion and do not need anyone to publish the euro prices."

In summary, there are several reasons why representational CRP transparency should be dropped from the final list of CRP transparency attributes: Firstly, as Expert 1 emphasizes:

> "unintelligible or unusable CRP would not survive … There is a natural selection- only those indices that are simple and easy to understand survived."

Secondly, CRP are intended for professionals with extensive commodity knowledge in terms of CRP scope, terminology, units, currency, etc. Hence, even a lower quality representation may be acceptable as long as CRP and the accompanying reports provide high consistency of representation in terms of format and data clarity. Thirdly, practitioners do not view CRP representation as a distinctive CRP feature that would determine the choice of CRP (see Table 76 for illustrative quotations). Finally, while CRP must not cross the line between a simplified CRP representation and excessive aggregation that hampers accuracy and misses essential details, this requirement is attributable to CRP methodology and accuracy.

| *Representational transparency importance:* |
|---|

“We can drop this one.”

“I would drop the format and merge it with *robustness*.”

“It is important. But it is not a differentiating criterion. I have never had problems—when you see a graph showing the range, you understand the CRP.”

*Format clarity:*

“I prefer details that I aggregate myself. I have a big problem with aggregation done by somebody else because I do not know the coefficients used. I once asked the issuer and found out that they used random coefficients.”

“If the report were unintelligible and unusable for practice, it would not survive.”

“Most buyers have never seen the full CRP report [because] central buyers copy the number into the commodity monitor and send it out. That includes me.”

“I will not subscribe to a report just because it is nice. The chemical report format has been the same for 20 years when you received it by fax, and it does not matter. You just have to copy the price to an excel sheet for analysis.”

“Definitely, the understandability of the report is important so that I understand everything at a glance. And the comment should be standardized as well … Anyway, you have to adjust the reference price to your context, contracts, and management reports.”

“Oh, I see. I think that nobody cares [about the format] as long as you can export the data to form a curve and see the key information at a glance.”

*Format consistency:*

“Standardization is important. You must be sure you compare apples to apples.”

**Table 76: illustrative quotations for CRP representational transparency**

## A.17 Acceptability

In addition to CRP transparency attributes already identified through intuitive and interpretive approaches, the interviews revealed a new CRP transparency attribute coined **CRP acceptability**, which has two facets (see Table 77 for illustrative quotes):

(1) "General acceptability" of the CRP relates to the overall market and its recognition as the CRP. For example, PM in a mining company uses general acceptability as a proxy for CRP quality:

> "When we buy a low-volume product with an important commodity share, we just ask the supplier if there is a recognized benchmark on which we can peg the contract."

Generally accepted CRP are more likely to be approved internally and buyers can use them strategically to justify the unfavorable price movement, as documented by a PM in aeronautical sector:

> "[respected CRP] is easy to sell internally. You say that the ICIS set the [reference] price at this level, and nobody would challenge you. [CRP] is like an official stamp that you cannot do anything about [the price increase]."

However, General CRP acceptability assessment criteria are vague, and buyers mostly seek external validation of the CRP acceptability with other market participants or market institutions, implying that CRP acceptability may not be a CRP transparency attribute in its own right. Furthermore, PM in the construction sector suggests that peer CRP acceptance is more important than general acceptance:

> "The supplier was advocating a benchmark. [But] I found that a construction material producer issues it [which makes it biased] and developers would not use it, only the public sector. [So] I told the supplier to forget it and come up with something official like the Statistical Office."

(2) "Mutual acceptability" of the CRP as a relevant benchmark for the business transaction highlights the fact that business contracts are based on the contractual freedom of the business partners and that both sides need to agree on the CRP. This process may be relatively straightforward if parties do not have a preference and/or there is a dominant CRP. For example, CRP issued by the London Metal Exchange enjoy the status of undisputed CRP. But PM responsible for steel in a consumer goods company demonstrates that the negotiation may also turn quite complicated if each side prefers a particular CRP and is unwilling to cede ground:

> "Our supplier wanted to push a commodity escalator clause in the contract but failed because we could never agree on the relevant steel benchmark and the base price. … [We want a reference that] covers the whole European market, they want a local benchmark issued by their [steel] supplier, which is not acceptable. [So] we keep negotiating on a case-by-case basis."

Turning to the extant literature, it becomes obvious that CRP acceptability stems from CRP methodology, accuracy, or publication frequency. For example, IEA et al. (2011) argue that market participants are more likely to accept and have confidence in methodologically sound CRP. Similarly, Radetzki (2013) demonstrates that aluminum market participants stopped using CRP issued by the leading producers not because they considered them biased but because these CRP became lagged and inaccurate compared to CRP issued by commodity exchanges. CRP acceptability as a dependent variable of other CRP transparency attributes was also highlighted by Expert 5:

> “For me, it is the same as methodology. [Because] if the methodology is good, you have high acceptability—by businessmen and your management.”

In summary, two important arguments call against the inclusion of CRP acceptability among the key CRP transparency attributes: (1) it is a result of other CRP transparency attributes, (2) practitioners do not consider it a fundamental CRP transparency feature and recommend merging it with CRP methodology or accuracy. Therefore, CRP acceptability was dropped.

*General CRP acceptability:*

"Because everyone uses a CRP, it does not mean it is good. It may have been used in the past and is now used without thinking."

"The fact that I accept [a CRP] depends on how accurate it is and how confident I am that the price is objective."

"We seek a widely accepted, objective, third-party index to which we can peg the commodity portion of the product."

"If someone respected says that this is a good reference … [or if] I know that a prestigious company uses [this CRP]."

*Mutual CRP acceptability:*

"We had this issue [of acceptability] with the scrap index. To convince the customer, we had to break the index down and show them that it represented the trend and was issued by a reputable issuer."

"Any contract is the result of the free will of the contracting parties. The advantage of the reference price is that it cannot be influenced. So it keeps the contract balanced. … [But] whether you accept a CRP and include it into the contract is subjective. Same for the other party."

*Inclusion of CRP acceptability:*

"Acceptability is the result of a transparent CRP. I would not include it as an attribute."

**Table 77: illustrative quotations for CRP acceptability**

# Commodity reference price transparency attribute definition, operationalization and related findings

This section reports detailed findings from the semi-structured interviews and documentary evidence analysis. Each section follows the same format: the CRP transparency attribute is defines, operationalized, assessed and the related findings are reported.

## A.18 CRP transparency accuracy attribute

### Definition

Extant literature highlights differences in CRP efficiency to accurately aggregate and disseminate the market price and the expectations of market participants (e.g., Roeber, 1996; Figuerola-Ferretti & Gilbert, 2005; Radetzki, 2013; Maxwell, 2015). The previous chapter suggested that CRP accuracy is a multi-faceted construct where all facets converge toward the notion of conformity between the CRP and the actual prices. Building on these findings and acknowledging that there is no commonly accepted definition of accuracy (Wand and Wang, 1996), CRP transparency accuracy is defined as *conformity to the actual or potential transaction prices.*

Including actual and potential transaction prices is important because actual transaction prices inform market participants about the executed transactions, while potential transaction prices are oriented toward the future. In addition, the word “conformity” implies a continuum ranging from *unreliable/biased CRP* to

*highly accurate CRP* that equal the transaction price or quote at which market participants are willing to trade.

### Operationalisation

The five distinct CRP accuracy transparency levels stem from a thematic analysis of interviews. Table 78 summarizes typical labels that the respondents used to characterize the individual levels of CRP accuracy, the subsequent operationalisation of each level, and its standardization on a zero to four scale. Table 79 provides illustrative quotes for each CRP accuracy level.

| CRP transparency level | Labels characteristic of the CRP accuracy level | Operationalisation of CRP accuracy level / Standardization on a 0 to 4 scale |
|---|---|---|
| **Black Hole** | Nonexistent, not established, not issued, not aware of, no benchmark price | The CRP is nonexistent.<br>0 points |
| **Opaque** | Unreliable, more or less ignored, rough information, wishful thinking, absolutely irrelevant | The CRP is perceived as arbitrary and does not reflect the actual market level or transaction prices. It may be biased or irrelevant to the buyer's region or grade.<br>1 point |
| **Translucent** | Sometimes uncoupled, plus-minus a percentage, reflects the trend, adjusted by one's market power, helicopter view of the overall market, statistics of the past, not included into the price formula, negotiable, some correlation with the real price, only average price, weighted average, a reliable reflection of the [market] | The CRP provides a high-level and aggregated view of the market price or trend, yet significant adjustments are needed to discover the transaction price. |

| CRP transparency level | Labels characteristic of the CRP accuracy level | Operationalisation of CRP accuracy level / Standardization on a 0 to 4 scale |
|---|---|---|
| | price, adequate way to check prices, not so transparent, accepted because no better alternative, lower price for higher volumes | 2 points |
| **Transparent** | A small discount off the CRP, represents the market, an objective indication of the actual market, significantly correlated, exact correspondence, actual price stems from the CRP, only a tiny difference, single price, verified, negotiate around the CRP, suitable for contract, official price, well-known reference, a benchmark, standard reference for trading, follow the index, high-quality reference price, price setting benchmark | The CRP mediates prevailing market prices, and actual transactions happen around the reference price with standardised and justified adjustments for the grade, quantity, distance, etc.<br><br>3 points |
| **Dazzle** | Direct reference for large contracts, stemming from the commodity exchange, the valid price for all transactions, known and official, reference price-based contract, print-screen of the CRP, charge the exact [reference] price, CRP plus fixed premium, precisely what one sees on the | CRP is the transaction price or quote and is used at face value in transactions. |

| CRP transparency level | Labels characteristic of the CRP accuracy level | Operationalisation of CRP accuracy level / Standardization on a 0 to 4 scale |
|---|---|---|
| | commodity exchange, actual quote, online access to market, real-time trades, real market price, adjusted for payment terms, no difference with reality, the price seen on the exchange | 4 points |

**Table 78: CRP transparency as accuracy attribute operationalization**

| CRP Accuracy level | Illustrative quotes from interviews and documentary sources |
|---|---|
| **Black Hole** | "The supplier told us there is no CRP for the technical gases we buy, just the price formula based on electricity, fixed costs, transport, a storage fee, and profit."<br><br>"There is no CRP [for technical gases]; I would really like to have one."<br><br>"… it is necessary to include … [into long-term industrial gas] contracts formulae for changing the gas price charged. These formulae are based on indices of the wholesale price of power …" (Downie, 2007:53)<br><br>"There is no index [for industrial gases] where I could check the prices like copper on LME. Therefore, we established informal benchmarking with other big companies in the area." |
| **Opaque** | "This [posted CRP] is the price a lambda person can get when they need the concrete of a particular grade…You may study it and conclude, 'they increased the tariff year-on-year,' but it bears no resemblance to our actual price [emanating] from the tender."<br><br>"If we have a larger project, we will go and negotiate with the [concrete] supplier, and we negotiate a special price…But if I need just one cubic meter for a small order, I will buy it at the list price. … [And] there is an end-of-year bonus based on the total quantity."<br><br>"Estimating concrete prices is not an easy exercise, as many factors are involved in pricing concrete…You can get a rough estimate for your project using the above figures" (ConcreteNetwork, 2021). |
| **Translucent** | "[the chemical CRP report] publishes a [price] range, and I am always within it, but [the range] is too wide. I only use it for negotiation."<br><br>"I developed my own tools to calculate the actual [steel] premium because the [steel CRP] price [INCOTERMS] is Ex works and does not correspond to our exact chemical and mechanical specification nor the payment terms. But if I |

| CRP Accuracy level | Illustrative quotes from interviews and documentary sources |
|---|---|
| | juxtapose the two curves, the trend roughly corresponds. Sometimes, we are slightly better or worse depending on the steel mills' capacity—if they are sold out or fight for business."<br><br>"An arbitrator concludes that Sopisco news is a good indication of actual market prices for bananas." (WTO, 2005) |
| **Transparent** | "We negotiate a premium against the aluminium settlement price with the German supplier because the LME is known and official, and the settlement price is archived for 50 years on [LME] website. There is no discussion about the [CRP] accuracy."<br><br>"I buy at the exact LME price, [so] the price that you actually see [on the commodity exchange] at a given moment plus the broker's fee, which is an additional 1/16 of a percent. And then I pay a premium for transport costs and the seller's mark-up and finance costs if I pay for 30 days." |
| **Dazzling** | "We fix zinc on the LME at the exact spot price quoted the moment we place the order. We may agree with the supplier to wait a few days, and they follow the market for us and then call us when the price is right."<br><br>"In the United States, the marketplace generally prices aluminium as the London Metal Exchange (LME) price plus the "Midwest Premium." (Innace, 2018). |

**Table 79: Illustrative quotations for CRP accuracy levels**

### Practical application

Table 81 summarizes the CRP transparency as accuracy assessment for the sample CRP.

| CRP | CRP Transparency as Accuracy |
|---|---|
| Technical gas | 0 |
| Concrete: Cemex | 1 |
| Hydrochloric acid: ICIS | 1 |
| Natural rubber: World bank, TSR20 | 1 |
| Steel alloy surcharge: Moravia Steel | 1 |
| Steel: Internal report | 1 |
| Wood: Czech Stat. Office | 1 |
| Sulphuric Acid: Fertecon | 2 |
| Banana: Sopisco | 2 |
| Copper: Czech/Slovak cable industry | 2 |
| Carton paper: Euwid | 2 |
| Steel: Platts | 2 |
| Steel: MEPS | 2 |
| Steel: SteelBenchmarker | 2 |
| Diesel: Slovak Stat. Office. | 3 |
| Diesel: Platts | 3 |
| Methanol: ICIS | 3 |
| Natural Rubber: Shanghai futures exchange | 3 |
| Electric power: EEX Settlement price | 4 |
| Electric power: EEX best bid | 4 |
| Aluminium: the LME Official Price | 4 |
| Steam Coal: Argus | 4 |

**Table 80: CRP transparency as accuracy assessment**

Technical gasses with nonexistent CRP or CRP informed by occasional reports or highly aggregated statistical data were assessed as the Black Hole CRP Accuracy level.

Opaque and Translucent CRP Accuracy levels form an amalgam of CRP without obvious unifying features. They witness different price discovery mechanisms, such as the producer-posted price for concrete, standardised statistical data for wood or rubber, informed judgment for steel, chemicals, or banana, and actual quotes for ferrous metals. In addition, the number of grades varies from one for copper to multiple for steel.

Similarly, Dazzle and Transparent CRP accuracy levels are generated by different types of institutions: commodity exchanges, reputed PRA, or the statistics office. Hence, no rule of thumb based on the price discovery mechanism, issuer reputation, or the number of grades can be recommended for CRP Accuracy assessment.

Unlike the other CRP transparency attributes, which rely on documentary evidence, CRP accuracy is primarily assessed through practitioner interviews following a pre-established procedure (see Section 3.4.2.4. in Methods). The data reveals that respondents' assessments do not vary by more than one transparency level with Black Hole, Transparent, and Dazzle CRP accuracy levels. For example, the aluminium Official Price by the LME shows remarkable assessment coherence as Dazzle (see Table 81). Only one respondent suggests that the CRP is marginally different from actual transaction prices on the relevant German market.

| Respondent | Illustrative quote | Assessment (comment) |
|---|---|---|
| 1 | “We only negotiate a premium with supplier X because the LME CRP is known and official.” | Dazzle (4) |
| 2 | “You take the LME [price] average plus the conversion cost and calculate the purchase price.” | Dazzle (4) |
| 3 | “Aluminium sales are linked to the LME—forward buy, escalator, and spot prices. We can arrange any method our customer wants.” | Dazzle (4) |
| 4 | “I think it is fantastic to check the LME…The [sales] price only moves following the LME. | Dazzle (4) |
| 5 | Suppliers always include the relevant LME price level in their total price. I have to check the quoted LME price to compare apples to apples.” | Dazzle (4) |
| 6 | “I consider the LME reference [price] transparent for both sides—you can check the actual level, and it is easy to fix.” | Dazzle (4) |
| 7 | “I forgot to mention it. Our [aluminium] price is composed of LME and added value. We update prices quarterly based on the LME average price.” | Dazzle (4) |
| 8 | “As for X, we follow an internal market price assessment reflecting the German market [transactions], which may be slightly different from the LME because we are a big player.” | Transparent (3) |
| 9 | “I upload the LME values every month, calculate the last month’s average, and update the price…The commodity exchange is a data source for me.” | Dazzle (4) |
| 10 | “What I buy [as a central buyer] is the exact LME price you see on the exchange plus the broker’s fee, which is 1/16 of a percent.” | Dazzle (4) |
| 11 | The respondent uses a different index than the LME and cannot assess LME accuracy. | N/A |
| 12 | “We buy aluminium on the LME one-to-one. We follow the spot market. The LME is the basis, and we only discuss the premium, which depends on the supplier's offer. So the final price can deviate from the LME.” | Dazzle (4) |
| 13 | The respondent uses a different index than the LME and cannot assess LME accuracy. | N/A |

| Respondent | Illustrative quote | Assessment (comment) |
|---|---|---|
| 14 | "[The LME quotation] does not represent the actual market prices [at which people trade]. You must add processing and transport costs [to LME CRP to get the final transaction price] in your contract." | Dazzle (4) |

**Table 81: Aluminium Official Price assessment for accuracy**

In contrast, Opaque and Translucent CRP accuracy assessments vary by two levels. However, a finer-grained analysis suggests that these assessments are outliers that systematically stem from less informed buyers who typically overweigh the CRP accuracy level. A typical outlier assessment comes from buyers who procure the commodity in lower quantities and are responsible for many other purchase categories and therefore do not devote resources to an in-depth evaluation of the CRP accuracy. For example, a PM in a mining company who buys copper regularly in small quantities as a part of wire harnesses assesses the copper CRP issued by the Czech/Slovak cable industry as *highly accurate* and bases the escalator clauses on it:

> [Copper by the Czech/Slovak cable industry] is the official price, which is key [for including it in monthly escalator clauses]… [I would assess it as] very accurate … I was told the whole [local] industry used it. … We did not investigate how good it was or any alternatives. We sought a benchmark to compare our suppliers and a tool to see that our price did not go sideways.

In contrast, a large wire harness buyer from the automotive industry downplays the same CRP accuracy to Translucent:

> I know of [this CRP] existence but never used it. … It is irrelevant because [The CRP] differs from the LME [CRP for copper]. … I do not trade at these prices on the Czech market. … [But] if you look at the curve, it sort of follows the LME, [so] it is not

> completely off…though I would have to check the currency exchange more precisely [to determine the CRP accuracy level].

Furthermore, less informed buyers took over an already institutionalised CPM system where the CRP is leveraged in a certain way, e.g., a PM in a steel processing company operates two price discovery systems:

> In the long-term [Steel supply] contract, we update the base price with [the Steel alloy surcharge] evolution…[The supplier offers] the best quality steel [so] we want to be sure we get the quantity and have to accept [this CRP]… [However,] we negotiate the price [updates] with all other suppliers based on the [steel] market price [and not based on this CRP].

Finally, the outlier CRP accuracy assessment may reflect the customer pass-through mechanism, e.g., a PM responsible for carton packaging uses the CRP in an automatic price escalator because the company has agreed the same formula with the customer.. In practice, it works the other way round. The sales department agrees on the CRP escalator clause with the customer, and procurement mirrors it in the supply contract to eliminate the risk. Hence, the buyer does not know or care about how accurate the CRP is as long as it is accepted by both the supplier and the customer.

In summary, market participants interested in assessing CRP accuracy cannot rely on rules of thumb and should ignore less informed buyers' assessments. Alternatively, they might consider a larger sample and curate it through the procedure suggested by this research.

## A.19 CRP transparency completeness attribute

### Definition

Building on the previous chapter and the facets of CRP completeness, the CRP completeness attribute is defined as *the breadth and depth of market information disclosed to market participants*. The depth of information refers to the level of detail of pre-trade, trade, and post-trade activity that the market participants can observe in the form of quotes, prices, volumes, and trading parties' identities (Madhavan, 2000). The breadth of information reflects the extent to which the CRP addresses a commodity's temporal, volumetric, specification-related, or regional characteristics. The availability of such information dramatically simplifies the sense-making and decision-making processes and reduces the need for additional information searches. All things being equal, broad and deep CRP information helps market participants assess CRP accuracy and increases the choice of trading strategies.

### Operationalisation

The five levels of CRP completeness were operationalised through a thematic analysis of documentary evidence and were complemented with the practitioner interviews. Table 82 summarizes illustrative examples of each CRP transparency level, operationalizes them along the five levels of a geological metaphor, and standardizes them on a scale from 0 to 4.

| CRP transparency level | An illustrative example of CRP Completeness level | Operationalisation of CRP Completeness level /<br><br>Standardization on a 0 to 4 scale |
|---|---|---|
| Black Hole | Not found | The CRP does not exist.<br><br>0 points |
| Opaque | **Technical gases.** The US Geological Survey publishes CRP for helium. CRP is a single number for a given technical product specification. The CRP contains some very generic market information, e.g., statistics about production and consumption, import sources, government stockpile, trends, reserves, and substitutes. Still, other important information, such as terms, transaction size, regional context, or packaging & transport costs is missing: “the estimated price for private industry’s Grade-A helium was about $11 per cubic meter ($310 per thousand cubic feet) in 2022, with some producers posting surcharges to this price“ (U.S. Geological Survey, 2020: 86).<br><br>**Scrap and alloy surcharge.** A steel producer publishes monthly CRP for scrap and alloy surcharges for different products, alloys, and production processes. The underlying commodity specifications are classified under standard material number (W.Nr.), steel grade, | Single CRP price with limited background information regarding CRP specification, market structure, grade, region, or commercial terms, no transaction information, and no market and price interpretation.<br><br>1 point |

| CRP transparency level | An illustrative example of CRP Completeness level | Operationalisation of CRP Completeness level /<br><br>Standardization on a 0 to 4 scale |
|---|---|---|
| | and production process type. CRP shows only a single price in €/ton without additional transaction information. Historical prices are available five years back. No market background information. | |
| Translucent | **Chemicals report by a PRA.** The report publishes four European regional CRP and USA with low-high range and the CRP value 12 months ago, monthly price history is visualised on graph. Mentions US domestic quarterly contract price for chlorine. Specification described as technical grade only. High-level information about the market sentiment and generic information about concluded transactions. High-level information about crude oil.<br><br>**Steel report by a PRA**. Textual information about the price evolution of selected steel grades, principal steel and scrap grades assessed for four regions, price curves, product and grade specification, Incoterms and typical buyer size information. | Price range (low-high, spot/contract price), grades, regional prices, limited transaction information, and some market and price interpretation.<br><br>2 points |
| Transparent | **Steel report by a PRA.** The report with multiple CRP is published once a month. It provides detailed descriptive information about the market evolution regarding prices, market sentiment and expectations, available capacity, and stock. Trade information is given on an aggregated level, such as “French buyers agreed…” or “Service centres delayed…” | Wide range of prices (spot, forward, regional, grades), selected transaction information: bid/ask, transaction price, volume, transaction parties, extensive market, and price interpretation. |

| CRP transparency level | An illustrative example of CRP Completeness level | Operationalisation of CRP Completeness level /<br><br>Standardization on a 0 to 4 scale |
|---|---|---|
| | Basis price and product definition are explained in detail. High and low CRP are quoted for a wide range of steel products, grades, and regions. Six-month price history is provided. Steel purchasing indices covering different grades, areas, and sectors are provided, covering monthly or quarterly evolution.<br><br>Mid-term price forecasts are given as well. Prices are quoted in euro, pounds, and dollars for some grades. | 3 points |
| Dazzle | **Wholesale electricity.** European Energy Exchange issues CRP that contain: (1) temporal aspects such as spot, and futures with different maturities, (2) derivatives such as options and spreads, (3) regional prices, (4) trading information such as available quotes, number of contracts, exchange volume, open interest, (5) price history can be visualised on a graph.<br><br>The CRP is complemented by market analyses, newsletters, and trading recommendations published by market participants. | CRP reveals the full range of prices: spot, forward/futures, options, and different grades. Extensive transaction information: bid-ask, volumes, transaction parties. Availability of market and price interpretation.<br><br>4 points |

**Table 82: CRP transparency as completeness attribute operationalization**

## Practical application

Table 84 summarizes the CRP completeness assessment and documents that all five levels are represented in our sample of CRP.

| CRP | CRP Transparency as Completeness |
|---|---|
| Technical gas | 1 |
| Concrete: Cemex | 1 |
| Diesel: Slovak stat. office. | 1 |
| Natural rubber: World bank, TSR20 | 1 |
| Copper: Czech/Slovak cable industry | 1 |
| Steel alloy surcharge: Moravia Steel | 1 |
| Steel: Internal report | 1 |
| Wood: Czech Stat. Office | 1 |
| Banana: Sopisco | 2 |
| Hydrochloric acid: ICIS | 2 |
| Methanol: ICIS | 2 |
| Carton paper: Euwid | 2 |
| Steel: SteelBenchmarker | 2 |
| Electric power: EEX Settlement price | 2 |
| Sulphuric Acid: Fertecon | 3 |
| Aluminium: the LME Official Price | 3 |
| Steel: Platts | 3 |
| Diesel: Platts | 3 |
| Steel: MEPS | 3 |
| Electric power: EEX best bid | 4 |
| Natural Rubber: Shanghai futures exchange | 4 |
| Steam Coal: Argus | 4 |

**Table 83: CRP transparency as completeness**

The assessment of the sample of CRP was relatively straightforward. It sufficed to compare the data and information contained in the CRP and the adjoining report with the coding scheme. The findings were subsequently triangulated to increase confidence with the interviews where respondents assessed CRP completeness.

CRP transparency as completeness shapes the search for additional information, the interpretation process, and the range of CPM options available to purchasing managers (see Table 84 for illustrative quotes).

**The Black Hole CRP completeness level** was not identified in the sample. It is equivalent to the total absence of the CRP. Yet, even for technical gases, where respondents claimed a complete lack of CRP, some external CRP could be found, e.g., helium by the USGS Mineral commodity survey or argon CRP issued by the Czech statistical office. Hence, the perceived CRP inexistence means that the CRP is irrelevant to the market participant and cannot be used to inform business decisions. This was apparent in the follow-up interviews with technical gas buyers:

> Honestly, the American report does not help me buy helium in Slovakia. I mean, it is always interesting to know this information [about production and exporters], but helium is extracted from air, and the electricity cost is the key [price] driver" (a PM in a large chemical company).

> I know that the Czech Statistical Office publishes some [CRP of] technical gases. … [Our argon] contract is negotiated for a year. [So] was this price [in the report] negotiated 12 months ago or last month? In my case, it would be seven months old and completely disconnected from the market today… [I would not] use [this CRP] in a management report because they would challenge me [on the reliability of the data]" (a PM in a medium-sized steel processing and welding company).

Hence, the CRP nonexistence forces buyers to engage in private research and find out the information through informal conversations and bilateral negotiation as documented by a PM from the paper processing industry:

> Experience counts. [The buyer] has to know the suppliers, the [manufacturing] process…the price history…the competition, [and] assemble the whole picture… [Especially when] suppliers come with a price increase [request], you must check other sources, how much they paid.

| **CRP transparency level** | **Illustrative quotations from interviews on the CRP Completeness level** |
|---|---|
| **Black Hole** | "If you try, you will find some benchmark [even] for these special commodities. … At least the customs office will publish the value of imports [so] you can estimate the [transaction] price."<br><br>"We produce sustainable CO2 from a natural source and use it in our mineral water directly on site…OK, if I had to buy more from a supplier, I know our production costs and transport cost…[But] there is no external reference price [for this niche commodity]. |
| **Opaque** | "It would be interesting to have an independent benchmark for technical gases. [But] It is not in the producers' interest. If nobody knows what the prices are, they can divide the market and impose their prices." |

| CRP transparency level | Illustrative quotations from interviews on the CRP Completeness level |
|---|---|
| | “[You can see] the price [for different steel grades] but no information about its validity, why the price is what it is…Also no information about the cost drivers.” |
| **Translucent** | “You can buy the weekly report, you get the price and a few lines, or you purchase the monthly edition, which is in-depth but more expensive. But if you see only a number and do not see what is behind it, it will not encourage you to take action.”<br><br>"[ICIS Acid CRP] is a three-page report with prices in Europe and Asia, production information, gossip about the next quarter negotiation, and a lot of rubbish to justify the [subscription] price. … Over the years, you always read the same sentences like ‘it is too soon to negotiate the following quarter prices.’" |
| **Transparent** | “Even if the information is reliable and I can trust the price, I do not like just the number. I prefer [a CRP with] a comment attached, information about what is going on, some background explanation, an economic forecast, a recommendation for our reporting and managerial decision, and some backup data for our top management.” |
| **Dazzle** | “We can choose from different CRP [published] on the exchange in real-time [such as] sales prices, different maturities. This is important because price spreads vary over the trading day and with maturities. The most up-to-date information is subscription-based, where you can see real-time [CRP] movements and breaking news.” |

**Table 84: Illustrative quotations for CRP completeness levels**

**The Opaque CRP completeness level** mediates the price signal for selected grades without any background or trade information. A single price deprives buyers of additional trading options, e.g., arbitrage or a combination of different maturities. The CRP tends to be highly aggregated and forgoes important regional, volumetric, or temporal differences, which precludes a meaningful interpretation of the price signal. Hence, it does not come as a surprise that a PM in a high-tech engineering company complained about a niche chemical with opaque CRP completeness level:

> When you only see a [CRP] number without any analysis or background, you do not know how to react. I need to know if the deal was struck between big players or if this is just a spot transaction…Is there a facility breakdown and capacity problem [that accounts for the CRP increase]? Sometimes [the CRP change] is [triggered by] just paper business and not a physical transaction.

Despite this weakness, the Opaque CRP completeness level is sufficient for three types of business problems. Firstly, well-informed a PM in a multinational, wood processing company needs an aggregate "official" number for specific purposes:

> We do not want to disclose our wood purchase prices in our public documents. Instead, we take the statistical office [CRP] and argue that this is our wood price evolution.

Secondly, a PM in a steel processing company who characterizes himself as a "small buyer" has to accept the CRP from the dominant producer:

> The steel mill imposes this CRP into the contract, and we have to accept it if we want [to secure] the long-term deliveries.

Thirdly, opaque CRP completeness may be acceptable for buyers for whom the commodity represents a small share of the total spend and who leverage the

CRP as an official benchmark during the tender, e.g., a PM in gas storage business states:

> Petrol is [an unimportant] C-commodity. We compare the prices of the Diesel [CRP] from the statistical office at the sourcing time with our fuel card provider [price level].

The **Translucent CRP completeness level** may seem somewhat imbalanced as some reported information is broad and deep, while the rest is not communicated. For example, the SteelBenchmarker provides steel CRP for many grades and regions, such as *hot rolled band (5mm thick x 1200-1500mm wide)* for the West Europe Market, valid for mid-sized buyers procuring between 500 and 2,000 metric tons of commodity-grade products. However, while the range of products covered is broad, the CRP does not provide any comment or background information about transactions, complicating the sense-making process. It also does not say whether and how CRP evolved within the observation period, even though it might provide an important clue to market participants about the market dynamics. Finally, the CRP is based on an average that eliminates outliers. However, the outliers are not quoted, even though they might be of interest to some market participants as the signal of the “big-ticket,” “residual,” or “emergency purchase market” dynamics. Market participants, therefore, complement the CRP with the private search, e.g., a PM in a medium-size steel processing company:

> [SteelBenchmarker] gives me information about the market trend set by the steel mills…[But] we buy from resellers [so] we are delayed by a month compared to [SteelBenchmarker], which reports what steel mills are doing. . . . [When CRP evolves] I pick-up the phone and check whether suppliers already follow the trend or have some old stock I can buy. . . . [Subsequently,] I prepare the report for top managers [about] what prices I expect for the next month.

Buyers show an understanding of the insufficient Translucent CRP completeness when the CRP covers a commodity with multiple grades. For

example, a PM in a major steel forging company views it as the issuer's strategic choice and a trade-off between the CRP completeness and other CRP attributes:

> [SteelBenchmarker] cannot cover all steel grades [and] doesn't provide detailed [market] information. . . . [Instead,] they quickly collect prices and publish them. . . . [The CRP issuer] expects that buyers are deep in the steel business and know what is happening on the market. . . . [Buyers only] want to see the price [impact].

The **Transparent CRP completeness level** combines the price data with extensive trade and market information, editorial comment, analysis of the cost drivers, transaction information, and even price forecasts. The CRP is also complemented with online resources, analyst videos, or even real-time social media updates. However, most buyers do not leverage these resources:

> They have to justify the fee. You feel you get a lot of information for your money, but in reality, you already know all that information if you are a competent buyer (a PM in the automotive sector).

Hence, Transparent CRP completeness only becomes salient during emergencies:

> In normal times, I skim the [MEPS] report when it arrives and only look at the prices. Only when there are capacity and pricing issues, I study the information carefully (a PM in a large steel processing company).

In addition, a PM from the aeronautic industry admits that the information contained in the CRP may be used selectively and strategically:

> We use [the report information] to push our proposals [to management]. It has the aura of official information and gives weight to our proposals.

Transparent CRP completeness offers additional trading opportunities to buyers, such as the facility for cheap and efficient hedging, streamlines the forward price negotiations, allows flexible purchase timing, and eliminates some risk:

> We leverage different [commodity reference] prices as a risk management tool. We combine the spot with futures with different maturity. We used to have the take-or-pay clause for the non-consumed volumes. [But] today, you just sell your excess volumes on the spot market [and thus avoid the take-or-pay risk] (a PM from the beverage industry).

> Nickel is an important stainless steel cost factor. I always follow the [futures CRP] curve evolution because it gives me a good idea about where the [stainless steel] prices are heading. I know steel mills fix their [nickel] contracts three months in advance. . . . [So] if the forward curve aims downwards, I can expect lower [stainless] steel prices in the next quarters (a PM in a medium air-conditioning producing company).

The **Dazzle CRP completeness level** is populated with CRP providing exceptional depth and breadth of information. The Steam Coal Argus CRP meets the highest criteria in both regards: it informs multiple CRP specifications and regions, historical prices for major spot markets, forward price curves, in-depth market coverage, trade information and announcements, output market situation, and shipping costs. Similarly, electric power-best bid CRP issued by EEX excels in the quantity of data provided: the real-time bid value and quantity offered for trade, bids for different maturities and regions, the bid/ask spread, day high and low, history of transactions and traded volumes, information about other power products such as auction results or options. Complementary resources in the form of press releases provide additional information, such as installed capacity, non-usability updates, or price volatility. The commodity exchange also publishes alerts about critical market changes and disruptions. Finally, numerous power

traders and generators issue complementary newsletters and analyses that interpret the market movements and formulate trading recommendations.

However, Dazzle CRP completeness triggers unexpected risks and downsides. Firstly, sophisticated CPM strategies require experienced and highly qualified buyers because their implementation is not without costly errors stemming from inexperience with market volatility management, misapplied hedging and input/output dissonance, speculative positions, counterparty risk ignorance, inconsiderate volume commitments, or unsuitable procurement strategy:

> When I took over the [energy] category, my predecessor would train and supervise me for six months. I would discuss every important decision with him for another year. Initially, I thought it was a stretch, but I agree in hindsight (a PM in a wood processing company).
>
> [Risky CPM practices are] the safest way to bankrupt your company. Buyers do not understand that they are playing with fire. . . . [Companies] need strict commodity [trading] policies and controlling (a PM from the aeronautic sector).
>
> When [steel] prices fluctuated a lot, everybody was interested in hedging. . . . One bank offered the possibility to hedge Polish construction steel through the Turkish steel exchange [CRP futures], but no customer goes for it- it is expensive, and everybody is afraid (a PM from construction sector).

Secondly, Dazzle CRP completeness may lead to information overload and even decision paralysis:

> I am frustrated. I see the [Financial] director with an [electricity] buy proposal because I have a strategy to buy in small tranches. [But unfortunately,] electricity became [the director's] hobby- he reads all the reports and follows the [commodity exchange] prices. He always asks me, 'what are the reasons for not waiting

> a few more days?' I have no good answer. So we wait and wait. . . . Since [my last proposal], prices have increased by 3 euros. But we still do not buy! Now we wait for the price to go down (a PM in a large steel processing company).

Acknowledging that Dazzle CRP completeness triggers too much information and requires sophisticated management, companies collaborate with specialised consultants who assist them in the sense-making process or even manage their purchase decisions. For example, a PM from the automotive industry "outsourced" the sense-making to an external partner:

> [In the past,] the director would take a coffee with the [monopoly electricity] supplier, complain about the prices and that was it. An hour, a year. . . . [Today,] I do not have time nor capacity to follow the commodity. We [therefore] subscribed to the daily CRP report, which leverages the fundamental and technical analysis and formulates a buy/hold/sell recommendation. [The report issuer] convinced me that their advice was better than passive [procurement] strategies. I admit that I do not read [the daily three pages report] in full. Just the recommendation [in one sentence] at the bottom and the market trend colour [green for buy, orange for hold, red for sell].

This trend toward CPM expertise outsourcing was not observed with other CRP completeness levels.

## A.20 CRP transparency publication frequency attribute

### Definition

The previous chapter highlighted the difference between CRP timeliness and publication frequency. Furthermore, a distinction between “absolute” and “meaningful” CRP publication frequency was made. Notwithstanding the strong arguments for meaningful CRP Publication frequency, the concept of absolute CRP publication frequency prevailed because, all things equal, more frequent CRP publication frequency is beneficiary for market participants who can decide whether they leverage it or not. Therefore, CRP transparency as publication frequency is defined *as the commodity reference price publication frequency*.

### Operationalisation

To operationalize CRP publication frequency, the extant literature was reviewed, and a continuum of CRP was created, which ranges from continuous updates for commodity exchanges (Figuerola-Ferretti & Gilbert, 2005) through daily CRP issued by PRA (Caliskan, 2007), weekly CRP published in trade journals (Figuerola-Ferretti & Gilbert, 2005), quarterly/monthly CRP issued by dominant producers or buyers (Radetzki, 2013), to years for annual surveys, occasional industry studies, or annual champion price negotiation (Li 2010). Subsequently, the continuum was triangulated with typical CRP publication frequencies and interviews to determine the meaningful cut-off points. Table 85 describes each CRP publication frequency level and provides illustrative quotes from the interviews.

| CRP transparency level | Illustrative examples of CRP publication frequency | Operationalisation of CRP publication frequency level /<br><br>Standardization on a 0 to 4 scale |
|---|---|---|
| Black Hole | "[Commodities with nonexistent CRP] are the arena for the best buyers [where] they can leverage their skills and beat the market. . . . Their job is not to follow the market but to do something about it and negotiate with suppliers."<br><br>"Such CRP are getting rarer. Buyers want more frequent information and are willing to pay for it. Even XXX CRP is now updated at least quarterly."<br><br>"We would buy the [annual] study for our budgeting and price forecasting purposes. . . . [Annual publication frequency] is sufficient for our purposes." | Not published at all, published irregularly, or annually.<br><br>0 points |
| Opaque | "On a time axis, the journal has a closing date, and if information comes a day later, it is not included [into the CRP]."<br><br>"[The CRP issuer] publishes a monthly report … [it would be good to have more] frequent updates when the market goes crazy. . . . I called the steel mill on Monday, but the price was completely | Published regularly but less frequently (quarterly, monthly).<br><br>1 point |

| CRP transparency level | Illustrative examples of CRP publication frequency | Operationalisation of CRP publication frequency level / Standardization on a 0 to 4 scale |
|---|---|---|
| | different on Wednesday. [So] you would have to update the report at least twice a week, which is unfeasible." | |
| Translucent | "The sulphuric acid markets are covered weekly by ICIS in the World Sulphuric Acid Weekly report and the Asia Pacific Report. . . . Most of the time, I only look at it at month´s end when we negotiate the price."<br><br>„[The CRP] is published weekly, so it is a bit more frequent [than the competing CRP], [but the CRP] is often unreliable and suffers from a smaller team of reporters." | Published regularly and frequently (bi-weekly, weekly).<br><br>2 points |
| Transparent | "The [official] price on the LME is updated every day. . . . You can immediately see when buyers enter the market and push the price up."<br><br>"We tried the spot CRP, but it did not bring any additional benefits. [So] we went back to the daily settlement price reference." | Published very frequently (daily).<br><br>3 points |
| Dazzle | "Electricity prices must be released in real-time because they fluctuate up and down." | Published continuously.<br><br>4 points |

**Table 85: CRP transparency as publication frequency attribute operationalization**

### Practical application

Documentary evidence was leveraged to assess the CRP publication frequency transparency attribute (see Table 87 for assessment). Interviews reveal that CRP issuers progressively settle on a CRP publication frequency that fits the CRP consumer requirements, and market participants accept these frequencies as an immutable fact.

| CRP | CRP Transparency as Publication frequency |
|---|---|
| Concrete: Cemex | 0 |
| Technical gas | 0 |
| Natural rubber: World bank, TSR20 | 1 |
| Steel alloy surcharge: Moravia Steel | 1 |
| Steel: Internal report | 1 |
| Wood: Czech Stat. Office | 1 |
| Steel: MEPS | 1 |
| Banana: Sopisco | 2 |
| Diesel: Slovak Stat. Office | 2 |
| Sulphuric Acid: Fertecon | 2 |
| Hydrochloric acid: ICIS | 2 |
| Methanol: ICIS | 2 |
| Copper: Czech/Slovak cable industry | 2 |
| Carton paper: Euwid | 2 |
| Steel: Platts | 2 |
| Steel: SteelBenchmarker | 2 |
| Diesel: Platts | 3 |
| Electric power: EEX Settlement price | 3 |
| Aluminium: the LME Official Price | 3 |
| Steam Coal: Argus | 3 |
| Electric power: EEX best bid | 4 |
| Natural Rubber: Shanghai futures exchange | 4 |

**Table 86: CRP transparency as publication frequency assessment**

The analysis of the CRP publication impact analysis revealed a qualitative chasm between the lower and higher levels of CRP publication frequency. Lower CRP publication frequencies tend to be the lagging indicators of past trading and trends. In contrast, higher CRP publication frequencies provide leading CRP and a forward-looking perspective. Translucent CRP publication frequency with a mix of lagging and leading information forms a middle ground. However, market participants value more the leading inputs because they represent “the true market and not just the statistics.” For example, a PM from the automotive industry highlights the decrease of CRP informativeness when it reduced publication frequency and moved from quotes to past transactions:

> Our contract was linked to a German index which published a three-month rolling forecast. But last year they started to update CRP only when they received actual transactions, so it became less frequent and more statistical. We asked our customer to switch away from this CRP because the statistics are worthless [for commodity procurement]. We need a forward-looking CRP.

The **Black Hole publication frequency** concerns two CRP in the sample. Market participants consider them lagged and irrelevant and only good for fulfilling the compliance requirements:

> The big producers [of concrete] must issue a price list with volume discounts which they show the competition authority. They issue it once a year and then file it, just in case. But [the CRP] does not really reflect actual prices (a PM from the construction sector).

Black Hole CRP publication frequency highlights the CRP function as an anchor and information source. Buyers complain that the absence of CRP is always advantageous for the seller who enjoys an asymmetric information advantage, as buyers do not have an easily accessible CRP. The information asymmetry seems particularly tangible with “small” buyers who do not have the leverage to test the market. Also, even large buyers often leave the market observation to chance:

The **Opaque CRP publication frequency** covers CRP issued by public institutions such as the World Bank or the Czech Statistical Office. Their low frequency of updates makes them unsuitable for price discovery. Still, they can serve as a snapshot of the past price evolution, a price level shared with external shareholders to conceal the real price:

> I use the CRP in customer presentations—it is auditable, and I do not want to reveal our real [transaction] prices (a PM in a wood processing company).

In addition, the Opaque CRP publication frequency transparency level is occupied by three steel benchmarks whose publication frequency reflects the industry needs because steel mills and scrap traders publish their selling prices once per month, and, in extension, most transactions among market participants are typically negotiated monthly. However, due to the relatively long period between updates, the CRP is always somewhat delayed:

> The [MEPS] report is published every month and has a closing date. Anything that comes afterward does not exist. As we are permanently active on the market, it never happened that the report was ahead of us, that we would have missed a trend. But there is nothing better [than the MEPS] (a PM in a large steel forging company).

The lag is particularly pronounced during turbulent periods and renders the report temporarily useless. A PM in a multinational consumer goods company voices concerns with a steel CRP:

> Normally, we negotiate the [steel] price the last week of the month. But when the market is disrupted, I inquire about prices every week and even every day. And the supplier says: ‘I have this price from the steel mill, and it is valid only today,’ and you have to decide. . . . Yes, you can forget the steel index. It may tell you the [CRP issuer] expectations [but] the market does what it wants.

Despite these concerns, the CRP publication frequency is not adjusted even during exceptionally turbulent periods. Consequently, the CRP gets temporarily ignored by knowledgeable buyers:

> It’s not that the report was factually wrong [during the 2007-08 turbulence]. But it was too delayed in a period when you had to react quickly to new announcements. In phone discussions, suppliers challenged our MEPS-based arguments arguing that the market already follows a different logic (a PM in a multinational consumer goods company).

The CRP issuer's effort to keep up with the market evolution and price in sudden turbulences may then lead to absurd situations when the CRP publication is delayed by several weeks and disrupts the price discovery. One respondent said:

> The quarterly [chemical] CRP should be published on the first week of the quarter. But in turbulent times, the negotiations drag. Most buyers and sellers are afraid to commit. We have to wait for the report because this is what we have in our contracts. The negotiation may go well into the first month, and [contract] prices must be adjusted retroactively (a PM responsible for chemicals and resins).

However, structurally misaligned CRP publication frequency may be dangerous for CRP issuers. Extant literature documents that a CRP with higher publication frequency may disrupt an incumbent CRP if a higher publication frequency better addresses the new market reality, e.g., the success of aluminium CRP issued by commodity exchanges versus the producer and trade journals issued CRP (Figuerola-Ferretti & Gilbert, 2005; Radetzki, 2013).

**Translucent CRP publication frequency** covers a heterogeneous group of commodities such as bananas, chemicals, or carton paper. This CRP publication frequency transparency level supports the argument that the optimum publication frequency may be industry and company-specific (Veerman et al., 2016). For example, the weekly publication frequency of many chemicals is considered a good fit for industry information needs and trading patterns as it provides up-to-date information about prevailing prices, available capacity changes, and market sentiment. Still, it does not overload buyers with irrelevant information during "… calm periods, when nothing really happens [on the market], and it only takes a minute to skim the report" (a PM in a wood processing company).

Translucent and Opaque CRP publication frequencies sometimes coexist in the same CRP report but cover different markets and serve different needs. A PM in a wood processing company explains:

> …distinguish between the long-term contract with fixed volumes and the residual quantities negotiated on the spot. The long-term contract follows the quarterly CRP called the contract price [published quarterly by ICIS]. The remaining deliveries are negotiated as spot plus/minus something. . . . The last week of the month price is [the most] relevant [one] . . . [I] only skim the intermediate weeks for some big news.

Buyers locked in a long-term contract typically use the monthly or quarterly CRP contract price to update the long-term contract prices. Consequently, they usually skim the weekly reports for some big news and only scrutinize the first edition of the month, which serves as the basis for negotiation, while "the rest is published just to justify the subscription fees." Hence, a weekly publication frequency may seem almost too frequent for some PMs:

> … once a week is fine [for the carton paper CRP]. I read through it for big news and input the price into my database. . . . Once a quarter, we calculate the average and adjust the [purchase] price if the barrier is broken (a PM responsible for paper and plastic packaging).

In contrast, respondents active on the spot market complain that the weekly report forgoes important short-term opportunities and has to be complemented with the individual search. A PM responsible for large volumes of chemicals voices this concern:

> In the commodity market, the supply and demand are long-term balanced. . . . If a major supplier outage happens, there is no spare capacity to fill the gap. . . . The sooner you find out, the better because you can pick up the phone and steal the material from competitors. . . . When the information is finally published [in the CRP report], it is already too late, and the material has been sold out.

**Transparent CRP publication frequency** equals daily CRP updates. CRP are often determined and published at exact, predetermined time slots, e.g., 12.30 to 13.25 for the LME settlement price (LME, 2018b). Such predictability facilitates trading because buyers do not have to follow the whole trading day but only check the daily CRP to get an idea of the market evolution and make relevant business decisions.

However, sudden market turbulence may disrupt the market, make the Transparent CRP lagged and irrelevant, and force market participants towards Dazzle CRP publication frequency. For example, a large energy purchaser explained how the electricity and gas market volatility in 2022 paralysed settlement price-based trading. Instead, sellers insisted on the best-bid quotes and guaranteed prices only for a few minutes:

> We organised preliminary market consultations [with gas and electricity suppliers]. Suppliers were clear that they traded only the spot market or best-ask futures. The offer's validity was five minutes. Otherwise, they would take a premium of 20 to 50 euros [per megawatt hour] . . . . In the end, they agreed to 15 minutes [quote validity without upcharge].

Finally, real-time **Dazzle CRP publication frequency** is required by market participants engaged in daily trading:

> The finance department takes over [the actual purchases] and monitors the CRP continuously to spot the right timing. . . . When I analyse the trends, I want to build my curve from multiple data points (a PM in the beverage sector).

However, most buyers consider Dazzle CRP publication frequency a double edge sword leading to information overload, requiring constant market monitoring, and putting them under immense pressure to react immediately:

> Our supplier sends us [a price] update whenever something happens [on the commodity exchange]. Three times [a day] on a quiet day, but during the Fukushima crisis, I received an update every hour. . . . [During my buying window] I am glued to the screen and wait for the [CRP] to go a tick lower because every ten cents down make roughly ten thousand euro savings per megawatt [hour] (a PM responsible for electricity procurement in a steel processing company).

Furthermore, several PM observe that internal approval processes are not adapted to the Dazzling CRP publication frequency, which requires instant decisions and confirmations:

> When I want to buy electricity, I need approval from my manager and the financial director. Then I agree on the price valid for 15 minutes [with the trader], get the signatures, fax it, and the deal is finally done. It's more adrenaline than anything else (a PM responsible for energy procurement in petrochemical sector).

> The deals are closed over the phone, and the paperwork follows a few days later. The supplier sends the trade confirmation, the plant manager signs it, I scan it, and I send it back to the supplier. [The signature] does not change anything because the deal was concluded when I said 'buy' over the phone. But our controlling

> insists on this formal approval loop (a PM responsible for energy procurement in a wood processing company).

Hence, considering the short-lived nature of Dazzle CRP and internal administrative issues, some PM prefer daily Transparent CRP publication frequency:

> Over 12 months, we compared the settlement price to our real-time [aluminium] purchases and found that [real-time CRP] did not bring any savings. We just spent significantly more time on fixing the price (a PM responsible for energy procurement in a high-tech manufacturing company).

## A.21 CRP transparency methodology attribute

### Definition

Building on the Oxford Advanced Learner's Dictionary (Hornby, 2020), CRP methodology is defined as *a set of methods and principles used to determine the CRP*. Even though a methodological golden standard may be illusory (Rauterberg and Verstein, 2013), this thesis adheres to the set of recommendations formulated by IOSCO (2013) and considers a methodology robust if it is formalised, auditable, replicable and achieves a reference price that is free from internal or external distortion and representative of the market.

By *formalised*, the author understands any methodology issuers systematically follow to discover the CRP. Methodologies range from *proprietary* and judgemental to *completely open* and *mechanistic* (IEA et al., 2011). *Auditable* requires that the methodology is published and available for scrutiny/criticism and that improvement suggestions are taken into account through a formal process. *Replicable* means that anybody can follow the steps and arrive at the same results. Finally, being *Free from internal and external distortion and representative of the market* means that the issuer takes steps to ensure that the CRP is not manipulated.

### Operationalisation

The operationalisation of the individual CRP methodology attribute levels builds on (Radetzki, 2013b) and positions the transfer price as the Black Hole CRP methodology level. On the other extreme of the continuum, the Dazzle CRP methodology is embodied by commodity exchanges. Subsequently, the IEA et al. (2011) and IOSCO (2013, 2015) guidelines for robust CRP were studied and served as the basis for defining Opaque, Translucent, and Transparent CRP methodology levels. The provisional levels' operationalisations were triangulated with opinions on CRP methodology quality that emerged from interviews.

Table 87 operationalises the five levels of CRP methodology attribute and provides illustrative quotes.

| **CRP transparency level** | **Illustrative examples of CRP** | **Operationalisation of CRP Methodology / Standardization on a 0 to 4 scale** |
|---|---|---|
| Black Hole | Transfer prices: “Transfer pricing in commodity trading occurs when the producer/seller and the user/buyer are part of the same vertically integrated corporation. The prices in such trade are internal to the firm, and can be set at any level. They appear only in the accounts of the firm and are seldom published.“ (Radetzki, 2013: 266-267) | Not published, discretionary price setting, intentionally heavily biased.<br><br>0 points |
| Opaque | "Our editorial teams stay in close contact with industry players to report on the key developments in their sectors. We carefully check the information, add context and package the news in a compact format that provides concise coverage and analysis. . . . EUWID customers benefit from our insider knowledge of their industries and they can trust that our work is independent and based purely on journalistic criteria.” (EUWID, 2020) | Price discovery follows an existing, internal, not published procedure. Non-replicable.<br><br>1 point |

| CRP transparency level | Illustrative examples of CRP | Operationalisation of CRP Methodology / Standardization on a 0 to 4 scale |
|---|---|---|
| Translucent | ". . . if more than 50pc of the market data involved in arriving at a price assessment is sourced from a single party the supervising editor will engage in an analysis of the market data with the primary reporter to ensure that the quality and integrity of the assessment has not been affected. . . . Where available, we publish lists of deals in our reports that include price, basis, counterparty and volume information. The deal tables allow subscribers to cross check and verify the deals against the prices." (Argus Media, 2020: 2) | Price discovery follows a formal published procedure based primarily on judgment and is difficult to replicate. Explicit measures against manipulation.<br><br>2 points |
| Transparent | "The Unofficial Closing Prices are determined from trades made during the designated settlement period which is 16:50:00 – 16:59:59 hours UK local time. The Market Supervisor shall initially calculate settlement prices for all contracts in accordance with the settlement procedures below: | Price discovery follows a formal published procedure based on replicable or even mechanistic methodology. Robust measures against manipulation.<br><br>3 points |

| CRP transparency level | Illustrative examples of CRP | Operationalisation of CRP Methodology / Standardization on a 0 to 4 scale |
|---|---|---|
| | (a) Where trades are executed in the designated settlement period, the trade weighted average. . . . Fifteen minutes after their display on the ICE Platform of the Unofficial Settlement Prices, such prices become the Official Settlement Prices." (ICE, 2010: 16) | |
| Dazzle | LME: "The LME Official Price is the last bid and offer price quoted during the second Ring session and the LME Official Settlement Price is the last cash offer price." (LME, 2018b) | A particular transaction or quote stands for the reference price.<br>4 points |

**Table 87:CRP transparency as methodology attribute operationalization**

## Practical application

The classification of CRP into the five transparency levels is based primarily on the methodologies published by CRP issuers and was relatively straightforward (see Table 89 for CRP transparency as methodology assessment). The CRP assessment was complemented with interviews that explored the relevance of individual CRP methodology attribute levels.

| CRP | CRP Transparency as Methodology |
|---|---|
| Concrete: Cemex | 0 |
| Technical gas | 0 |
| Steel alloy surcharge: Moravia Steel | 0 |
| Banana: Sopisco | 1 |
| Natural rubber: World bank, TSR20 | 1 |
| Copper: Czech/Slovak cable industry | 1 |
| Carton paper: Euwid | 1 |
| Steel: Internal report | 1 |
| Sulphuric Acid: Fertecon | 2 |
| Hydrochloric acid: ICIS | 2 |
| Methanol: ICIS | 2 |
| Steel: Platts | 2 |
| Steel: MEPS | 2 |
| Steel: Steelbenchmarker | 2 |
| Diesel: Slovak stat. office. | 3 |
| Diesel: Platts | 3 |
| Electric power: EEX Settlement price | 3 |
| Steam Coal: Argus | 3 |
| Wood: Czech stat. Office | 3 |
| Electric power: EEX best bid | 4 |
| Natural Rubber: Shanghai futures exchange | 4 |
| Aluminium: LME official price | 4 |

**Table 88: CRP transparency as methodology assessment**

It should be noted that respondents show very limited knowledge of the CRP methodology and mostly rely on the rules of thumb, such as the CRP reputation, market acceptance, or issuer name. Especially, if the CRP has been institutionalised in the company, buyers continue using it without critical evaluation of its methodology.

The CRP methodology becomes salient only when it changes, its weakness is highlighted through an external event, or when the buyer directly participates in the CRP creation process and observes his/her own opportunistic behaviour to manipulate or bias the CRP.

Two qualitative “chasms” were identified throughout the geological metaphor continuum.

The first qualitative leap lies between the Black Hole and Opaque CRP methodology levels. It embodies the move from unpublished, discretionary, and potentially biased Black Hole CRP methodology to Opaque CRP methodology based on a procedure where some care was paid to the data collection, interpretation, and bias avoidance.

**Black Hole CRP methodology** may exist but is not shared with market participants. The fact that the CRP methodology remains undisclosed and is subject to discretionary changes represents a major risk of CRP discretionary updates. Purchasing managers therefore completely discount these CRP:

> [X] is the only supplier exporting the [commodity Y] into the USA. Hence, we investigated the statistical import data to estimate their [production] prices. We soon understood that these numbers were worth nothing. The supplier uses random transfer prices to sell to their local office, which then supplies and invoices local customers (a PM responsible for a niche commodity).

The justification for the existence and acceptance of the Black Hole CRP methodology is the producer’s dominant market position and the advantage it brings to the seller, who controls margin, price discovery, and automatic pass-

through of the cost driver fluctuation. Market participants are aware of the issuer's conflict of interest and are sceptical about CRP objectivity:

> I do not trust [the Moravia Steel alloy surcharge CRP] because it is artificially created and [the issuer's] motivation behind this CRP is clear … I do not buy into [this CRP] (a PM responsible for steel procurement in a steel processing company).

However, buyers may not have an alternative as challenging the *CRP* issuer has a minimal practical impact and they need the material*:*

> [when challenged] the sales guy shrugged and said that he had no control [over the CRP]. He explained that [the scrap and alloy surcharge CRP] reflected their internal costs … [What he really meant was] take it or leave it (a PM in a steel processing company).

Black Hole CRP methodologies have become the subject of scrutiny by public authorities. For example, a PM in a wood processing company explains that

> The tax office requires us to apply and justify the arm's length principle for [the commodity] sales to our [foreign] sister plants. They want to make sure that we do not optimize taxes by artificially high or low [selling] prices.

Yet, market participants are sceptical that this scrutiny increases CRP information value:

> It is natural to manipulate the [intracompany sales] price if you know that your customers will get access to [foreign trade data]. The easiest way [to hide true costs] is to set a high selling price and pay a portion back as an end-of-year bonus (a PM responsible for the high volume procurement of chemicals).

The **Opaque CRP methodology level** contains all CRP where the methodology exists, but the data collection and analysis procedure remains internal, and the CRP issuer only describes it in generic terms (see, for example,

the carton paper CRP by EUWID in Table 64). Opaque CRP methodology issuers may even highlight potential methodological weaknesses so that CRP consumers may judge whether the Opaque CRP methodology is fit for purpose. For example, Sopisco news publishes a lengthy disclaimer where it highlights that (1) the price information is obtained verbally from a number of sources, (2) the CRP stems from the spot prices, (3) the reported CRP may vary significantly from finally agreed prices, (4) there may be significant differences to CRP due to specific terms agreed between parties, and (5) the sales under the long-term contract which are generally lower than the spot are excluded from the sample, and (6) the issuer cannot guarantee CRP accuracy (see **Figure 22** for the exact quotation).

> "the information supplier is not supported by any official institution … price information is obtained verbally from market sources … reports prices offered by sellers to buyers which might then differ from the actual prices finally agreed between sellers and buyers depending also on volumes traded … cannot guarantee the accuracy … BUT THE PUBLISHER IS NOT RESPONSIBLE FOR ERRORS OR OMISSIONS CONTAINED [in the CRP report] … Due to the different modes of negotiations among the participants, prices published by Sopisco News-Nova Media Publishing Inc. could show significant differences according to the specific sale agreements as per Incoterms or other international regulations … refer to the spot prices of bananas sold each week and do not reflect prices for sales under contracts

**Figure 22: Sopisco news disclaimer. Source: https://sopisconews.com/disclaimer, accessed on 06.02.2021**

Interviews revealed that buyers have only a vague idea about the Opaque CRP methodology and trust the CRP issuer, typically an established market institution. They also assume the CRP issuers' independence and objectivity thanks to the CRP subscription fee. At the same time, market participants who are directly involved in the Opaque CRP methodology data collection process voice scepticism about the input data quality. For example, a PM responsible for chemicals admits that he deliberately delays the price information:

> [Price reporting agency] often calls me and inquires about [our wood transaction] prices. . . . [But] we wait four weeks before releasing any exact contract data. We agreed to this with our contractors because we do not want to influence our ongoing negotiations.

Furthermore, buyers may consciously bias the reported data:

> I lie to [reporters from the PRA] and downplay the price increase—to avoid a self-fulfilling prophecy and put pressure on prices. I may come up with a story that my prices increase only marginally, and then they will use my exact words to claim that the market is only slightly up (a PM responsible for wood procurement).

However, buyers also recognize that CRP issuers adopted procedures to minimize the bias and discover the balanced CRP level:

> The reporter calls several buyers and sellers to get the full picture. The report then says something like, 'A producer tried to increase the price, but buyers fiercely resisted, and the equilibrium settled around X.' This X is not my exact price but something that corresponds to market reality (a PM responsible for chemicals and resins).

The **Translucent CRP methodology** level is represented by chemical and steel CRP compiled by respected issuers. Translucent CRP methodologies are detailed, standardised, and contain information about the commodity features, commercial terms considered, data collection, data analysis, CRP publication

dates, a procedure for methodology change, and potential CRP methodological weaknesses. For example, SteelBenchmarker (1) first explains that they selected generic steel grades that market participants leverage to discover the base market price. (2) Subsequently, they outline the rules for the price input data submission and analysis, such as the total price, EXW, confidentiality, elimination of outliers, and publication date difference for subscribers and free service users. (3) Finally, particular care is devoted to measures assuring CRP robustness, such as a minimum sample of 25 inputs, no direct feedback to informants, a third-party computer calculation, and independent audits (SteelBenchmarker, 2022).

In addition, ICIS discloses the procedure for any CRP methodology changes and outlines potential CRP weaknesses. For example, they highlight the fact that the CRP excludes the probable but confidential commercial discounts agreed between parties: “It is common for discounts to be associated with announced contract prices, which are usually not common knowledge.” (ICIS, 2016:16)

Despite the detailed CRP methodology disclosure, some elements of the data collection and analysis process remain confidential, e.g., the Methanol CRP Methodology does not disclose the exact sample size and characteristics, nor the number and nature of outliers eliminated from the assessment. Similarly, the procedure for establishing Methanol’s final contract and spot price is described in generic terms without illustrative examples (ICIS, 2016). Furthermore, the procedure for establishing the CRP price in the absence of trades is judgmental: “[CRP is established] based on the majority market sentiment and the highest buying indications and the lowest selling indications” (ICIS, 2016:5), and impossible to replicate.

Buyers intuitively understand the Translucent CRP methodology:

> [Steel CRP by Platts] is collected by journalists who work for Platts. They have a contract with several suppliers and customers [from whom] they collect prices and average them. They collect prices from producers A-B-C-D and then issue a report. [The process] is similar to the German Statistical Office (a PM in a large multinational company).

They also understand potential weaknesses and a PM responsible for chemicals observes: “[So] buyers and sellers try to game the system by magnifying the increases or downplaying them.” However, only a few buyers studied the Translucent CRP methodology and followed its evolution. As soon as Translucent CRP becomes institutionalised in a company and as long as everything works as expected, nobody studies the CRP methodology or its evolution. The interest in Translucent CRP methodology resurfaces only with the arrival of structural breaks*:*

> Only when the methodology and data changes, then it is worth checking whether the CRP remains relevant (a PM responsible for rubber and niche resins).

Or when CPR covering the same commodity significantly differ in performance:

> By the end of the year, there was a difference between our CRP and CRP followed by the supplier. We searched for the root cause and concluded that the methodology of the supplier’s CRP is superior because they base their evaluation on actual trades and are forward-looking. [In contrast,] our CRP was based on the customs office data and was backward-looking (a PM responsible for rubber and niche resins).

**The Transparent CRP methodology** level comprises three CRP issuers: the statistical office, reputed PRA, and commodity exchanges that boast exemplary CRP methodologies. Transparent CRP methodology is rich, detailed, and replicable: if somebody used the same data and followed the methodology outlined, they would arrive at the same CRP. It also provides more robust measures against manipulation. However, while sharing these basic characteristics, CRP issuers adopt radically different methodological approaches.

The methodology for oil products issued by Platts remains judgmental and is based on a detailed methodology that outlines (1) exact data quality criteria following the market on close methodology which determines when and what data

is collected, prioritised and assessed, (2) the data collection and submission process including the time-window for submissions, required contractual terms, and practical examples to avoid misunderstanding, (3) detailed product specification, (4) data normalization method in terms of unit, currency, delivery date, (5) security and confidentiality measures to protect the data and informants, (6) assessment principles used to turn data into CRP such as differentials when the commodity trades with reference to a benchmark, loading and delivery schedule, or incorporation of contango or backwardation, accompanied with illustrative examples, (7) information about where and how editorial judgement is applied and how the adherence to standards is verified, (8) the complaints policy, and (9) even the methodology revision history (Platts, 2016).

In contrast, EEX, the power exchange, establishes a more mechanistic CRP by (1) defining the settlement price as an instrument for calculating each participant's variation margin, information purposes, and determination of premiums for options, (2) the settlement price determination method based on trades concluded and orders entered into the trading system during the settlement price time window, (3) the exact procedure and algorithm for calculating the theoretical price from which the settlement price is calculated after the market plausibility check, (4) the alternative procedures for determining the settlement price if no trades or orders are entered, (5) measures taken against the settlement price manipulation by checking prices from other sources and trades (EEX AG, 2023).

Finally, the Czech Statistical Office opts for a completely algorithmic approach to wood CRP by (1) outlining the historical price determination method and its weaknesses, (2) setting up a new method based on evaluating 35 types of wood, (3) disclosing the sample size of 60 respondents, (4) specifying that the prices collected are realization prices for the domestic market, (5) describing the aggregation method as simple arithmetic average of individual reported prices, and (6) setting December 2009 as the base level.

Transparent CRP methodologies are considered highly reliable and reputable. For example, a PM responsible for the fleet management appreciates CRP issued by Platts:

> [Plats oil] is a good independent source, easy to look up, respected. It provides a mark of objectivity. It shows that the [commodity reference] price is not fabricated. As a buyer, I work with objective data.

However, deeper investigation suggests that buyers have a relatively poor understanding of the actual CRP methodology. For example, a PM responsible for energy procurement believes that:

> [The EEX settlement price] is somewhat mysteriously calculated. It is something between the bid and ask values but not exactly in the middle. They also look at the last trades reported. And perhaps there are some other factors.

Instead, PMs rely on the institution's reputation and assume that reputable institutions generate high-quality CRP methodologies, e.g., Expert 2 observes that "Inflation is a good example of a high-quality index: it is transparent, published by the statistical office which makes sure that it was not manipulated." However, in the aftermath of the LIBOR scandal, one PM voiced doubt about the viability of this assumption:

> LIBOR was also considered crystal clear. Then we found out about the fraud, and the benchmark disappeared. How probable is it that the energy market CRP is also manipulated?

Finally, Transparent CRP methodologies are popular with the buyers because they are unlikely to be challenged by the management or business partners:

> If you buy at the EEX settlement price, it is transparent, you do not have to justify if [the CRP] is good or if you should have negotiated more. . . . In addition, you can buy at the settlement price till 09.00 the next day. [So] if

> you see that the pre-market price is increasing, you buy at the previous day [settlement price] (a PM responsible for energy procurement in the petrochemical industry).

**Dazzle CRP methodology** is reserved for commodity exchanges. It represents a radical qualitative departure from the other CRP methodologies because the CRP issuer does not directly intervene in the CRP price discovery outcome, and every data point, in the form of a continuous stream of quotes or actual transactions, becomes the CRP. Yet, it would be a mistake to conclude that the issuer is completely absent from the Dazzle CRP methodology because it defines the trading process and rules, decides what market information is disclosed, and shapes the CRP format.

The Dazzle CRP methodology issuers insist that CRP derives directly from trading. For example, the Official Price issued by the LME is a particular quote at which the LME Ring members are willing to trade. The CRP Methodology is of exceptional quality and defines (1) the term Official Price, (2) the prompt dates, typically cash, 3-month and three forward December prompts, (3) the exact procedure to determine the Official Price: “The LME Official Price is determined by the quotations Committee and represents the last bid and offer price quoted during the second Ring session” (LME, 2021), (4) possible CRP determination deviation through the Electronic determination, (4) CRP publication time: 12.30-13.25, and (5) the currency: primarily USD and also EUR, GBP, JPY (LME, 2018b).

Practitioners highly appreciate the level of Dazzle CRP methodology disclosure:

> The commodity exchange has some transparency rules. It is an official source based on official information. We know how they make the price and what data comes in (a PM in the automotive industry).

They also accept them as the undisputed benchmark, e.g., Expert 5 notes that “The LME is the LME. There is no discussion.” However, buyers do not study

the CRP methodology and contend with the general notion that Dazzle CRP result from the equilibrium of supply and demand, which they consider the fairest price discovery approach.