Forecasting commodities
– A study of methods, interests and perception

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Abstract

This study aims to investigate reasons for variation in accuracy between different forecast methods by studying the choice of methods, learning processes, biases and opinions within the firms using them; enabling us to provide recommendations of how to improve accuracy within each forecast method. Eleven Swedish and international companies that are regularly forecasting commodity price-levels have been interviewed. Since there is a cultural aspect to the development of forecast methods; the authors have chosen to conduct a qualitative study, using a semi-structured interview technique that enables us to illustrate company-specific determinants. The results show that choice of methods, learning processes, biases and opinions all have potentially substantial implications on the accuracy achieved. The phenomena’s individual implication on accuracy varies amongst method-group.

Keywords: Forecasting, method, interest, perception, accuracy, commodities, decision-making, decision making, knowledge creation, risk management, hedging, strategic purchasing, budgeting

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ABB
Atlas Copco
BNP Paribas
Boliden
Handelsbanken
NCC
Outokumpu
Scania
SNL
Swedbank
Swedish industrial firm (anonymously)
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1. Introduction

Forecasting has been used as a tool for predicting the future ever since ancient times. The first signs of written human forecasting can be traced back to 3000 BC when philosophical works, such as Upanishads, attempted to create guidelines for predicting future weather by observing cloud formations. (Das, 2013) As our knowledge of the surrounding world has evolved, so has the accuracy of forecasting. With changing times, new areas of forecasting have evolved.

Formal research of commodity forecasting, involving supply, demand and prices of agricultural products started in the beginning of the 20th century. This research soon expanded to involve mineral- and energy prices. Over time the methods evolved and researchers soon started applying statistical methods to price series, and the field of econometrics grew, which later on resulted in Dr. Granger being awarded the Nobel Prize in 2003. (Labys, 2005)

On the macro-economic level, the interest in commodity price-forecasting derives from its impact on core variables, such as inflation and output. The major commodity of interest in the macro-economic area has, since the 1970’s, been oil. This is because of the major impact oil-price shocks have had on the global economy during the last four decades, in combination with the fact that oil stands for about ten percent of the total world trade. (Carnot, et al., 2011) From a commodity point of view, oil-price is the driving factor of energy prices, which in turn increases production costs as the extraction of commodities, in general being energy-intensive. There are several other macro-economic indicators, such as estimated mineral extraction volumes and investments in infrastructure, also impacting the commodity-price levels. Recently, in March 2014, the price of copper climbed two percent after the notification that one of Chile’s major copper mines were about to shut down its production. Prices on zinc and aluminum were also augmented due to Russia’s intervention in Ukraine together with notifications of Chinese plans to boost economic growth through governmental intervention. (Dagens Industri, 2014)

From the perspective of an industrial firm, the commodities consists of a limited share of the total production cost, but due to its excessive increase during the last decade, as the speculation towards commodities has grew\(^1\) and the fact that resources of the globe become scarcer, the cost of commodities has increased in an unpredictably manner.

This has forced the industrial firms to consider solutions for monitoring the risk by forecasting the commodities or to active handling the risk by financial hedging or strategically purchase when the prices are estimated to increase. This development has in

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\(^1\) The development of speculation has been argued by Pichler et al. (2012) to have been triggered by a paper of Gorton and Rouwenhorst (2006) demonstrating that investors are able to reduce portfolio risk by diversifying into raw materials as the returns to these types of assets are negatively correlated to equity returns.
turn led to question the forecasting approach and methods, and the use of external forecasts produced by consultancies and banks versus in-house produced forecasts.

Some of these methods have been shown to systematically outperform others over time, leading to the conclusion that the choice of forecasting method is of utmost importance. An example of this is our pre-study, which will be further described in section 1.1, where a model that repetitively outperformed currently used methods by a Swedish industrial firm and the average of all international banks participants in Metal bulletins analyst price expectancy.

By comparing the methods used by investigated companies towards the analysis in the pre-study as well as theory upon forecasting the authors aim to evaluate the rationality of chosen methods, implications upon decision-making as well as the firms learning processes.

1.1. Problem formulation

In this section, the authors describe the problem identified through our pre-study of a large Swedish industrial firm during the fall of 2013.

The pre-study, which led to this thesis, had the aim of investigating the forecast procedure at one of the industrial firms included in this study, defined as Industry A in figure 1. It focused upon evaluating the accuracy of the firm’s forecasts and reviled contradictory practice compared to empirically proven best practice forecast model, Theta (Makridakis & Hibon, 2000). This is illustrated as an accuracy deviation between red and blue staple in figure 1, where the best fitted, quantitative time series, models results in a percentage error deviation shown as a blue bar in figure 1. As visible in figure 1, there is a significant accuracy deviation between best practice and methods used at the investigated company. These deviations increase over time and peaks at a time-horizon of around one year.

![Figure 1. Accuracy deviation](image-url)
Due to the insight of significant accuracy deviations between methods used at the investigated company and best practice, the study was broadened to include accuracy of forecasts performed by external partners, such as investment banks, published in Metal bulletins Analyst price expectations (Lewis, et al., 2006-2014; Metal Bulletin Research, 2011-2014). This is illustrated in the green bar in figure 1.

According to the assumption that the choice of method is explaining the difference in forecast accuracy, together with the fact that the choice of method is an insight into the learning process of the organization, it is reasonable to assume that companies that have poor learning processes will produce low accuracy commodity forecasts.

1.2. Purpose

The purpose of this study is to investigate reasons for variation in accuracy between different forecast methods by studying the choice of methods, learning processes, biases and opinions within the firms using them; enabling us to provide recommendations of how to improve accuracy within each forecast method.

1.3. Research questions

What role does the feature of firm operations play in the choice of commodity forecasting method?

In what ways do biases related to decision-making affect the accuracy of forecast methods at investigated companies?

Could the use of certain forecast methods, at investigated companies, be related to effective learning processes?

Is it possible to identify a best practice, when:

a. dividing methods into quantitative, qualitative and combined?

b. dividing the forecast horizon into long-, mid- and short term perspective?

1.4. Delimitations

This study will be limited to base-metals\(^2\) and to some extent ferrous\(^3\), all traded at the London Metal Exchange. Commodities that are lacking the turnover required for generating stable data will therefore be excluded. By stable data, the authors mean that commodities need to be traded at a certain volume in order to make the model statistically valid. The choice of limiting the scope of the study to metals is due to this commodity being investigated in the pre-study of this paper together with the fact that metals constitute a big

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\(^2\) Base-metals refers to the group of metals that oxidizes or corrodes relatively easily, such as aluminum, copper, lead, nickel and zinc

\(^3\) Ferrous refers to metals containing iron
part of commodities traded globally. Further, regarding the possibility of generalizing the findings of this study, the authors argue that findings related to learning processes and decision-making cannot be generalized without taking into consideration the cultural aspects of firms investigated. The generalization of remaining findings is further discussed in section 3.7.

1.5. Contribution

There seems to be a gap between theory and practice concerning the choice of method for commodity forecasting, relating to the deviations in accuracy presented in figure 1. By exploring this gap, the authors aim to give an indication of how forecasts are produced in practice and what measures could be implemented to enhance accuracy. Depending on our findings, from an academic point of view, this study could contribute to the discussion whether qualitative, quantitative or combined method is to prefer in a complex situation. As for practitioners, this study could bring value as guidance in evaluating and improving forecast methods.
2. Theoretical framework

2.1. Implications of human judgment on forecasting

The implications of human judgment have a wide applicability upon the forecasting process. The authors have chosen to focus upon decision-making due to its importance in the forecasting process. However, other aspects such as information analysis, information overload and risk management are included in appendix III for further reading.

2.1.1. Decision-making

When involving human judgment into forecasting, there are several potential implications that needs to be identified. In qualitative forecasting, the potential consequences of imperfections in human decision-making are clear as it is common knowledge that human decision-making is prone to error (Tversky & Kahneman, 1974). When quantitative models are utilized, the risk of flaws due to human biases are related to the assessment of the model itself in combination with the implication the human factor might have on the interpretation of results. In the following section, the authors will take a deeper look into these implications and the potential flaws they might cause on rationality in decision-making.

The human mind also tend to over-weight small probabilities while under-weighting large ones. This might result in skewed results when assessing a general model and is especially important when handling quantitative models as these are critically dependent on the probability distribution assumptions. (Kahneman & Tversky, 1973)

According to Bazerman et al. (2012), there are three major heuristics that could lead to potential biases. These are the availability heuristic, the representative heuristic and the confirmation heuristic. Shuping, Xiong and Zhenxin (2009), confirmed that these heuristics have implications on forecasting by looking at expected value of stock-prices. According to their study, the representative heuristic tends to create overreactions whilst the confirmation heuristic creates under-reactions on estimated stock-prices. There are however some critique against the conceptualization of heuristics. According to Gigerenzer and Planck (1996) the problem lies in them explaining too much and too little at the same time. Too little in a sense that people don’t know how and why heuristics work and too much because post hoc one of them can be used to explain almost any experimental result. As people don’t know how these heuristics work, Gigerenzer et al. (1996) argues that is likely that there will be little progress in this field of research as “judgments of probability or frequency are sometimes influenced by what is similar (representativeness), comes easily to mind (availability), and comes first (anchoring)” (Gigerenzer & Planck, 1996).

The availability heuristic refers to the inability of the human mind to “think representatively”. When asked about the frequencies of different events, our minds tend to overestimate the frequency of events that affect us emotionally. (Bazerman & Moore, 2012)

Biases referable to the availability heuristic:
Ease of recall explains the fact that people tend to overestimate the frequency of occurrences that are vivid. As an example, people are overestimating the likelihood of dying from guns and car accidents over the likelihood of dying as a consequence of tobacco-utilization and poor diet, even though the rational choice would be to think the other way around (Bazerman & Moore, 2012). This theory has been criticized in a number of studies. For example, Schwarz et al. (1991) states that studies attempting to illustrate the “subjectively experienced ease of recall also are likely to affect the amount of subjects´ recalled”. As a result, it is difficult to establish whether a result refers to a subject´s subjective experience of a biased sample size.

The representativeness heuristic

Biases referable to the representative heuristic:

Insensitivity to Base Rates refers to a human tendency of ignoring the base-rates in probability. People tend to get emotionally attached to some probabilities while either failing to understand or choosing to ignore underlying statistics. For example, many people choose not to create a prenuptial agreement although statistics suggest this as reasonable. This is due to people tending to look at divorces as something that “happens to others”. (Bazerman & Moore, 2012)

Insensitivity to sample size is explaining the human tendency of ignoring sample size when making estimations of probability. People tend to estimate the likelihood of an event as equally big no matter how big the sample size is. This reasoning is a logical flaw because the probability of an unlikely event occurring is much greater when the sample size is small. In the same way, when extracting information out of a greater sample size, the likelihood of extreme values is reduced. (Bazerman & Moore, 2012)

Regression to the mean refers to the inability of understanding that performance tend to regress towards the mean value over time. Extremely high and low values both tend move towards the average. For example, when estimating the future performance of base-ball players based on previous seasons performance, people tend to expect the individual performance of each player to be equal for the coming season. This estimation is likely to prove incorrect as extreme values tend to move towards the mean and average performances could move towards extremes. A more suitable strategy would be to predict the individual performance of all players at the average level of the team. (Bazerman & Moore, 2012)

The Conjunction Fallacy occurs as a consequence of the human tendency to make judgments that corresponds to a broader category within their minds. This thinking can be problematic as probabilities sometimes do not correspond to the mental pictures of the human judgment. As an example, people were asked to predict the profession of a young woman, Linda, based upon information of her background and education. The young woman had been active in the feminist movement and had studied philosophy at university. When asked whether she now worked as a bank teller or as a bank teller who is active in the feminist movement, most people thought the latest alternative to be the most probable. However, this reasoning is illogical as the broader definition is always more probable as option 1 in this
scenario also includes option 2. (Bazerman & Moore, 2012) Critique against this experiment, and the conjunction fallacy in general, was however raised by Gigerenzer (1994), stating that the Linda-experiment contained several flaws. At first, Gigerenzer argue that it is illogical to impose probability theory as a norm for a single event (estimation of Linda’s profession) as probability is about repeated events (Gigenrezer, 1994). Secondly, critique is raised due to the norm being applied in a way that is blind of content, meaning that there is an assumption that what counts as logical reasoning may not take into consideration context and content (Gigerenzer & Murray, 1987).

The confirmation heuristic refers to a desire to confirm our own believes. When presented with data that is in line with our beliefs, people tend to accept it without questioning its validity. When being presented to data that is not in line with our beliefs, people tend to ask ourselves whether they should believe the information at hand. Even when people come to the conclusion that the information at hand is valid, they still tend to ask their selves whether they must believe the information. This implies that the human mind chooses to ignore reason in order to avoid changing its preconceptions. Preconceptions, in this case, does not only refer to values but also to statistics. (Bazerman & Moore, 2012)

**Biases referable to the confirmation heuristic:**

The confirmation trap refers to the desire of searching for information that confirms what people already know, even though this is not always logical. In their ambition of confirming their own believes; they tend to disregard information that is important for making a logical decision. If, for example, the interviewer got a good impression of a candidate at a job interview, the probability of them disregarding negative references such as a past crime record is elevated. (Bazerman & Moore, 2012)

Anchoring makes people use whatever figure that comes to mind, however irrelevant, as a basis for estimations of uncertain predictions. In a study by Tversky and Kahneman (1973), respondents were tricked into using the result of a roulette wheel as basis for estimating the number of countries in Africa being members of the UN.

Overconfidence is closely related to the confirmation-heuristic and means that people are likely to look for information that confirms current believes, while ignoring contradictory information. As more information is retrieved, people tend to use the previous information gathered as an anchor. When new information is gathered, it is used to confirm our original beliefs. This leads to a vicious cycle of illogical self-confirmation. (Bazerman & Moore, 2012)

Hindsight and the curse of knowledge: The hindsight bias refers to the human tendency of overestimating what they knew before, by applying later gathered knowledge to a previous situation. This bias explains why people tend to be wice in retrospect. The curse of knowledge refers to the assumption that the mental map of others looks the same as our own. This leads to people often fails to give important information as the recipient is presumed to possess the same knowledge as the sender. This leads to miscommunication. (Bazerman & Moore, 2012)
2.2. Approaches to commodity forecasting

The approach to commodity forecasting could be described as the analysts underlying belief upon how the commodity market works and how to best describe its price fluctuations. It’s categorized into the two perspectives, the fundamental and the technical approach. The fundamental approach describes the commodity market as a rational function of supply and demand and focuses upon macro-economic indicators, storage levels, cost-structures in the mining business and political events. The technical approach describes the commodity market as a result of attitudes of investors towards a variety of economic, monetary, political, and psychological forces. These are too diversified to analyse in detail and are therefore focused upon trends and seasonal patterns in the price-series.

2.2.1. Fundamental approach

It’s human nature to find patterns where there are none and to find skill where luck is a more likely explanation. – William Bernstein, financial portfolio theorist

According to Miao and Elder (2012), there are relatively weak evidence of links between macro-economic announcements and commodity price levels. This supports the theory that commodity prices are tied to more long-term macro-economic indicators, such as output, consumption and investments (Kilian & Vega, 2010; Gargano & Timmermann, 2014). However, there are problems in adapting macro-economic indicators in a long-term perspective. Long term commodity price forecasting has, historically, showed to be problematic due to failure to determine the occurrence of unexpected events and the rate of change in macro-economic indicators (Rush & Page, 1979).

Another issue that has led researchers to question the market efficiency of commodity prices, and thus also fundamental analysis as method, is the implication financial speculation has on commodity price levels. Some studies have showed that the high volatility of commodity price-levels to a large extent is explainable by financial speculation. This could diminish the rationality of fundamental analysis as it assumes price-level efficiency. The implications of financial speculation on commodity price-levels are, however, inconclusive. In a study by De Meo (2013), financial speculation was shown to have a moderate effect on commodity price-levels (De Meo, 2013).

As previously mentioned, macro-economic indicators is best suited for longer periods (a year or more). Macro-economic indicators, however, needs to be adjusted in accordance with long term variables, such as current economic situation. Failure to adjust analyses accordingly will result in decreased accuracy. Studies have shown that fundamental analyses achieve its highest accuracy in times of economic recession and that prices are closely linked to the business cycle (Gargano & Timmermann, 2014).

In the long run, general indicators such as GDP-growth related to the accessible supply are commonly used. In this case, China is of major importance due to the size of the economy, high GDP growth and a GDP metal intensity of four times that of the developed economies (Groen & Pesenti, 2010). Economic development can also, in some cases, affect the supply of
commodities as this could provide better preconditions for metal-extraction. This could be observed in the economic development of Eastern Europe in the late 1990’s (Borensztein & Reinhart, 1994).

Additionally to the macro-economic indicators effect upon commodity prices, the inventory level has been shown to affect the base metals in the monthly perspective. The theory of storage, which originated from the agriculture markets, has recently been validated by Geman and Smith (2013) to have a strong non-linear relationship for the base-metals traded at LME. It implies that base-metals are fairly predictably on a 1-2month time perspective by using inventory level as input.

2.2.2. Technical approach

“You can use all the quantitative data you can get, but you still have to distrust it and use your own intelligence and judgment.” – Alvin Toffler

Technical analysis has been defined by Pring (2002) as:

“The technical approach to investment is essentially a reflection of the idea that prices move in trends that are determined by the changing attitudes of investors toward a variety of economic, monetary, political, and psychological forces. The art of technical analysis, for it is an art, is to identify a trend reversal at a relatively early stage and ride on that trend until the weight of the evidence shows or proves that the trend has reversed.”

Actors on the commodity market have a long and widespread history of using technical analysis. An early study by Smidt (1965) reviled that over half of the amateur traders in U.S. commodity future markets use charts exclusively or moderately in order to identify trends. In more recent times, Billingsley and Chance (1996) found that sixty percent of commodity trading CTA advisors rely heavily or exclusively on computer-guided technical trading systems. Also in line with Fung and Hsieh (1997) finding that trend-following was the single dominant strategy among CTA advisors.

In contrast to this view, academics tend to be sceptical towards technical analysis. The scepticism can be derived from two perspectives, firstly, the acceptance of the efficient market hypothesis, which implies that it’s meaningless to attempt to make profits by exploiting currently available information such as past price trends (Fama, 1970; Jensen, 1978). Secondly, the alignment of several early negative findings of technical analysis in the stock market, such as Fama and Blume (1966), Van Horne and Parker (1967; 1968) and Jensen and Benington (1970).
2.3. Forecasting

Forecasting is commonly categorized into quantitative and qualitative methods. There is no generally optimal forecast method. Best practice is dependent on a variety of factors, such as commodity forecasted, supplier relationships, availability of historical data, correlation to external indicators etc. When forecasting several commodities, it is therefore not unlikely that the optimal solution is a combination of several forecast methods. (Green, 2001)

2.3.1. Quantitative methods

“The big problem with models is that managers practically never use them.”

-Little (1970)

Jokes aside, quantitative methods are becoming an increasingly more popular and can be applied in several ways (Rode, 1997).

Quantitative models are exposed to implications of human decision-making as multiple forecasts of the same variable are often available to the decision maker. The choice of model is reflected by the forecaster’s subjective judgements, partly due to heterogeneous information sets. The choice of model could heavily impact the expected value, explainable by judgemental differences, and determine the choice of constant versus time varying parameters, linear versus non-linear models etc. (Graham s. 137)

There are mainly three categories of quantitative methods; indicator-based, time series analysis and structural models.

Indicator based models

Indicator based forecasts are mainly used for business-cycle analysis, due to its characteristics of early detecting turning trends. It consists of single or multiple indicators that reacts in advance of the forecasted variable and are in this way able to indicate where the forecasted variable is heading. The limitation of the method is its predictable power, where a single indicator seldom gives a stable output and multiple indicators tend to give a diverged picture of the future (Carnot, et al., 2011). This problematic situation has been exemplified in literature as the predictability of recessions, where Marcelliono et al. are arguing for the leading composite indicators for US inflation and GDP growth being too instable to achieve a predictable value, instead a single indicator model are proposed (Marcelliono & Banerjee, 2006). Graff (2012), on the other hand, is arguing for a composition of multiple indicators, due to its broader information basis as well as the structure of the multi-sectional design (Graff, 2012). These contradictive findings fail to put forward the optimal number of indicators for all situations. It does however put forward the caution with which indicators should be added to achieve a higher accuracy.
**Time series models**

Time series analysis is a statistical forecast method that only takes past behavior into consideration, regardless of any interpretation or relationship related to economic theory (Carnot, et al., 2011).

Time series analysis consists of three groups of models, the stochastic, the neural networks and the support vector machine. The most commonly known model nowadays is the Autoregressive integrated moving average (ARIMA). It’s based upon the assumption that the time series is linear and follows a known statistical distribution. ARIMA has later on been added a seasonal component by Box and Jenkins, named SARIMA. The recognition of the ARIMA model is mainly due to its simplicity and flexibility in variations of time series. The limitation of the model is however its linear assumption which seldom is the case in practical use. To exceed this limitation, several nonlinear model has been presented in the literature, one of them, the neutral networks (ANNs) which were developed for biological use, have recently been getting a lot of focus in forecasting literature due to its self-adaptive nonlinear modeling-technique. The attention for the model has resulted in a variety of ANN models, the most common are the multi-layer perception model (MLPs) including a Feed forward network (FNN). The most recently developed ANN model is the Seasonal artificial network (SANN) which is surprisingly simple and has been experimentally verified to be quite successful. One last group of models, the support vector machine (SVM), has been addressed with the breakthrough in forecasting during the nineties and has brought clarity to the classifying and generalization of data series. It uses structural risk minimization (SRM) to find decision rules with good generalization capacity. (Adhikari & Agrawal, 2013)

In general, time series models have an advantage in being easy to use, requiring relative small data sets and having the ability to capture statistical relations whilst requiring low level of knowledge about the forecasted variable. The drawback is however its limitation in breaking down the contribution of various explanatory factors, which limits the understanding for the forecaster. (Carnot, et al., 2011)

**Structural models**

Structural models, also referred to as econometric, is an explanatory approach, where the aim is to explain as much as possible of the underlying factors which drives the forecasted variable. The models range from small, single-equation models, with the intent to assess behavioural patterns for enormous macro-economic models; containing hundreds of equations, with the aim to provide an overall picture of the economy. The models generally include endogenous and exogenous variables, where endogenous are determined by the model, such as key economic indicators as GDP, inflation, employment, fiscal deficit, import and export and exogenous are treated as given, such as demography, technical progress, international environment (including commodity prices) and economic policy decisions (Carnot, et al., 2011).

The advantage of this type of model is the sense making of the extensive quantity of information included in the model, which put forward a coherent picture of the forecasted variable. It is essentially used for analysing alternative scenarios and to evaluate the impact
of policy measures. From an adverse point of view, the model requires a high degree of expertise and is expensive to set up and maintain and seldom produces a high degree of accuracy in the short and middle time range (Qin, et al., 2008).

2.3.2. Qualitative methods

Qualitative forecasts, also referred as subjective forecasts, exclusively rely on the forecaster’s common sense, intuition, and experience, without using an explicit model. It is, and has long been, the most popular forecasting method among managers (Dyussekeneva, 2011). It emphasizes on predicting the future, rather than explaining the past (Makridakis & Wheelwright, 1989). The method has, due to its nature, been criticized for being heavily dependent on human judgment, resulting in a high degree of biases. This has governed the development of group assessments, to diversify and limit the biased perception from one person. Researchers have, however, showed that participants in a group have a tendency to influence each other’s thinking, due to the desire to support each other’s positions and leadership within the group, as well as a tendency to search for superficial and supportive information (Janis & Mann, 1982). After all, qualitative forecasting have outperformed other methods within several areas, usually where historical data have been unavailable or limited, such as forecasting sales for new products or to predict if and when new technologies will be discovered and adopted (Batyrshin & Sheremetov, 2007; Dyusseke neva, 2011; Carnot, et al., 2011).

During its long time in operation several qualitative forecasting methods have been introduced. The four most common are: jury of executive opinion, survey expectations, Delphi- and the Naïve method. However, the theoretical framework will only present methods treated in the analysis, therefore remaining methods has been allocated to the appendix of this thesis.

Delphi method

Delphi method is similar to jury of executive opinion in taking advantage of the wisdom of experts (Green, 2001). However, it has the additional advantage of anonymity among participants. It was defined by Skulmoski and Hartman (2007) as “an iterative process to collect and distill the anonymous judgments of experts using a series of data collection and analyses techniques interspersed with feedback”.

The Delphi model is characterized by four key features (Skulmoski, et al., 2007):

1. Participants are to be interviewed separately in order to avoid social pressure affecting the end result.
2. Iteration, aimed at letting participants review their opinion in light of the progress made by the group.
3. Controlled feedback, giving participants the chance of correcting their views when informed of the opinions of other participants.
4. Statistical aggregation of data gathered in order to enable quantitative analysis and interpretation.
2.3.3. Combined forecast method

Forecasts can be combined in several ways and across the methodological sections described in this study. The choice of whether to include several models into the forecast is treated by Timmerman (2006, p. 157). He suggests that when dealing with observable information set, using one model is always superior to the use of multiple models. When having unobservable information sets, the introduction of several models could be suitable. The belief that compiling all information into one model, if possible, was shared by Clemen and expressed as (Clemen, 1989):

“Using a combination of forecasts amounts to an admission that the forecaster is unable to build a properly specified model. Trying ever more elaborate combining models seems to add insult to injury as the more complicated combinations do not generally perform that well”

Lim and O’Connor (1996) further investigated the efficiency of forecasts when information is obtained from multiple sources. Their findings could be applied when designing a decision support system (DSS), aimed to increase the level of accuracy in forecasts. Similar to the findings of Timmerman (2006), Liam and O’Connor (1996) found that observable information should be, as far as possible, included in the model, thus decreasing the need for multiple sources. This means that the amount of human judgement included in the decision-process should be determined by the amount of extra-model, or unobservable, information available through human involvement.

Liam and O’Connor also found that it is essential to involve de-biasing mechanisms into DSS-systems. These should be implemented so that they can help forecasters in every step of the judgemental adjustment of the forecast. These de-biasing mechanisms should be related to “anchor development, selection of reference forecasts, combination and lastly feedback” (Lim & O'Connor, 1996).

2.4. Knowledge creation

As previously described in this paper, the learning processes of the firm is assumed to be an explanatory factor for the methods used. This is due to the assumption that companies possessing more knowledge are likely to implement more accurate forecast methods. The knowledge creation of the company can thus be deemed an explanatory of the accuracy achieved.

At first sight, knowledge may intuitively seem to be a familiar term. However it is quite complicated to find a general definition of knowledge; therefore the authors have used Davenport and Prusak’s definition (2000):

“Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often

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4 Section 2.4 - 2.4.3 is influenced from a previous thesis of David Fagersand
becomes embedded not only in documents of repositories but also in organizational routines, processes, practices, and norms.”

There are two main types of knowledge; tacit and explicit. It is important to separate these two types of knowledge, because there are large differences in their transferability, in relations and over distances. Explicit knowledge refers to knowledge that can be codified through documents and formal methodological language unlike tacit knowledge which is attached to individuals and subject to personal intuition, viewpoints and values. Tacit knowledge can be separated into cognitive and technical elements; the cognitive part deal with schemas, paradigms and beliefs.

2.4.1. Absorptive capacity

Cohen and Levintahl (1990) created the term absorptive capacity in 1990 and it was later developed by Zahra and George (2002) and Todorova and Durisin (2007). The original framework explains firms “ability to recognize the value of new information, assimilate it, and apply it to commercial ends” on individual, group or firm level (Cohen & Levintahl, 1990). The absorptive capacity consists of five different components; recognize the value, acquire, assimilate, transform and exploit (Todorova & Durisin, 2007).

Recognize the value

A premise for absorptive capacity to take place is prior knowledge. Cohen and Levintahl (1990) emphasizes the need for prior and relevant knowledge and refers to behavioral studies by Bower and Hilgard (1981). Research on learning and memory processes from a cognitive perspective suggest that e.g. for a salesman to recognize and exploit new knowledge to increase sales, experience of conditions and context of the market is needed value, judge and implement methods to increase sales (Cohen & Levintahl, 1990). If organizations lack existing knowledge, organizations will not be able to recognize value of new information and consequently fail to absorb it.

Acquire

This component mainly influences absorptive capacity in three ways: intensity, speed and direction. By Acquisition the authors mean firms “ability to acquire externally generated knowledge that is important for its competitiveness”. Intensity and speed refers to the quality of obtained knowledge while direction of aggregated knowledge influences “the paths that the firm follows in obtaining external knowledge” (Zahra & George, 2002).

Assimilation or transformation

Cognitive structures build on earlier acquired structures and become more sophisticated with time (Friedman & Schustack, 2006). A schema is triggered by a given situation. Suppose a salesman is going to perform a product presentation for a customer, expectations on how the salesman is supposed to act influence his behavior. This can be verbal communication, body language and conversational topics. This schema differs from other social contexts and events; such as a date where business language would be inappropriate. Organizations
understand its situation, context and new information with the existing cognitive framework of reference. Cognitive research suggests two alternative ways of learning new schemas through either assimilation or transformation. When a new idea can be fitted into the existing schemas with little or no change, it is called assimilation; knowledge is adjusted to existing cognitive frameworks.

When new knowledge differs too much to be incorporated in the existing cognitive structures, schemas themselves must change and this process is called transformation. Two initially incompatible schemas may through the process merge and form an innovation.

The transformation allows firms to use new incompatible knowledge with prior knowledge to form new ideas and processes in order to handle path dependency (Todorova & Durisin, 2007). In reality, firms fail to distinguish between knowledge that needs to assimilate or transform. Todorova and Durisin (2007) use the example of the analog camera industry in 2000s, were managers initially tried to assimilate new knowledge instead of changing their existing cognitive framework. As a result, they became path dependent and failed to understand the structural transformation in the industry. An important note is that knowledge may cognitively be processed back and forth between assimilation and transformation before it can be exploited (ibid).

Exploit

Exploit refers to the mechanism that allows organizations to use, refine, extend or leverage existing competencies through assimilation or to create new one by using transformed knowledge. Zahra and George (2002) focuses on routines, however firms can learn without systematic routines. An organization’s absorptive capacity is dependent on the absorptive capacity of the individuals within the organization. Although the absorptive capacity of the firm is dependent on the absorptive capacity of individuals, the organizations absorptive capacity is not simply a sum of the absorptive capacity of the individuals. The absorptive capacity of a firm is a combination between exposing itself to new information and the ability to exploit it (Cohen & Levintahl, 1990).

2.4.2. From individual to organizational absorptive capacity

In order to investigate the absorptive capacity of a firm, it is necessary to focus both on the communication with the external environment and how communication is handled among sub-units within the organization. As the level of expertise is often not equal among all the members of an organization, certain individuals will often have a function of assimilating information into a level suitable for the different members of the organization. This person is often referred to as a gate-keeper. Even if there is no need to assimilate the external information, a gate-keeper system might be beneficiary as it “relieves others from having to monitor the environment” (Cohen & Levintahl, 1990). Critical knowledge among the members of an organization is not just “substantive, technical knowledge; it also includes awareness of where useful complementary expertise resides within and outside the organization. This sort of knowledge can be “knowledge of who knows what, who can help with what problem, or who can exploit new information” (Cohen & Levintahl, 1990).
2.4.3. Contingent factors

There are several factors that affect absorptive capacity such as activation triggers, social integration mechanism, regimes of appropriability and power relationships. As only activation triggers and power relationships are of interest to this thesis, these are further described in the following chapter.

Activation triggers

The term activation triggers refers to critical events which a firm needs to react upon. These events can be external such as an industrial transformation based on rapid technological change, change in government policies or changes in demand. An event can also be internal such as performance failure or events that alter the firm’s strategy e.g. M&A (Zahra & George, 2002). Knowledge can be acquired on the market through e.g. consulting services or M&A. However, some knowledge may not be available on the market or is not easily accessed; therefore a firm response could be increased investments or R&D (ibid).

Power relationships

Power relationships can be defined as: “relationships that involve the use of power and other resources by an actor to obtain her or his preferred outcomes” (Todorova & Durisin, 2007). These relations exist within and outside organizations, e.g. the relations with suppliers and buyers. Power relations also influence resource allocation to critical new product or process development; however this may cause distraction of emerging opportunities or threats (ibid). Existing relations with customers, partners and other external stakeholder thus have both negative and positive effects on absorptive capacity (ibid). Power relationships explain why some firms are better in taking advantage of new knowledge than others, and why only some of the new knowledge is used.

Summary of absorptive capacity

The absorptive capacity explains how companies recognize the value in new knowledge. A condition for this to occur is prior knowledge. Further it explains how new knowledge, through the processes of transformation and assimilation, merges into the existing schemas in an individual’s mind. The new knowledge can then be exploited in the organization to yield commercial results. There are four contingent factors that affect absorptive capacity. Activation triggers refers to critical events, these can be external and internal. Social integration mechanism explain how members within and between organizations distribute knowledge. The regime of appropriability refers to firms’ “ability to protect the commercial utility of new knowledge while power relationships explain internal structures of powers in an organization. The power relationships are important for companies to enforce new innovations.
2.4.4. Single- and double loop learning

The concept of single- and double loop learning was established by Agyris and Schon, through their concept called theory of action (Greenwood, 1998). According to this theory, the human being constantly evaluates the consequences of his actions and learns to adjust the behavior in order to achieve his goals. Behavior might chance as a consequence of reflection or failure to achieve goals. Single loop learning is when a person changes his behavior as a mean to obtain the same goal as before the learning process. Double-loop learning, on the other hand, is when a person changes his behavior as a consequence of having questioned the appropriateness of goals set. Double loop learning therefore involves the questioning of values and norms and as a consequence also the social structures which rendered the original goal to be meaningful in the first place.

The implication of single- and double loop learning on decision-making within organizations was investigated by Argyris (1976). He found that most organizations advocate single-loop learning as that keeps employees from questioning the values and routines of the organization. This is done in order to obtain the current structure of the firm and achieve conformity; at the cost of limiting the potential development derived from new knowledge. In other words, employees are often deterred from implementing knowledge that is not in line with the current structure of the firm.
3. Method

3.1. Research approach

The purpose of this study is to explain the reasons for variation in accuracy between different forecast methods by studying the choice of methods, learning processes, biases and opinions within the firms using them. Due to the exploratory character of the study and the general complexity of forecasts, a qualitative cross-sectional approach, using triangulation, was considered the most suitable in order to acquire a deeper and more comprehensible understanding of the subject. This is in line with Flick (2009), stating that triangulation is a suitable method for cross-sectional studies. A qualitative method was chosen due to the inability of capturing necessary company-specific information in quantitative methods; which is better suited for validating gathered information. As cross-sectional studies aim to explain a certain phenomenon at a certain period of time (Saunders, et al., 2007), we argue that this approach is best suited as accuracy, as a phenomenon, was studied at investigated companies during the course of this thesis.

The cross-sectional study is built upon a triangulation between the findings of the pre-study, theories related to forecasting and the information retrieved from interviews. This provides a convergence of evidence which reduces the potential impact of biases related to the qualitative method, and eases the analysis of whether the choice of a certain method could be deemed rational. (Denzin, 2005) As Patton (1990) points out, triangulation of methods is essential to avoid accusations that the findings are artificial outcomes of a single method, source or a result of the researcher’s biases.

![Diagram of the process of triangulation](image)

**Figure 2. Process of triangulation**

The process of triangulation, which is illustrated by the figure above, describes how the information flows intervene and affects each other. The study is based upon the pre-study and the theory, together forming the basis upon which the research questions are formulated and the interview aim is set. The three information-sources; pre-study, theory and interviews, together aim to generate a convergence of evidence.

3.2. Literature strategy

The aim of the theoretical framework is to create a foundation, out of which the empirical findings can be analyzed. The theoretical framework will also help introducing the reader into the subject and create a context upon which the contribution of our findings is visible.

As there will be a lot of empirical material to analyze and the information received from interviews are likely to be widespread, it is important to create a solid and well-defined...
theoretical benchmark that can be used in putting the empirical findings into context. The authors have therefore chosen to limit the theoretical benchmark to matters that have implications on the obtained accuracy of forecast models, especially focusing on the impact of human judgment.

The theoretical framework is constituted by books, doctoral theses and scientific articles from various journals.

3.3. Choice of companies and interviewee object

The choice of companies to include in the study was based upon a combination of aspects. The first aspect was to capture the differences between different forecast methods, divided into three groups. These are qualitative, combined and quantitative methods. Interviewees were chosen so that the authors could get companies represented in all categories mentioned above.

Secondly, only companies that are purchasing, speculating or consulting in the field of price-levels of base-metals and ferrous were chosen for the study. This choice is natural, as these companies are most likely to engage into the forecasting of the chosen commodity price-levels.

Thirdly, as interesting findings might not only emerge due to variation in forecasting methods, but also as a consequence of business environment, the authors have attempted to involve firms from a variety of business areas in order to enable a visualization of features specific to different business sectors. The most prominent difference between business sectors is likely to be identified when comparing industrial companies and banks.

In order to avoid the choice of interviewee becoming an uncontrolled variable, where the company chooses the person they believe to be best suited for the interview, the authors have chosen to talk to the person in charge of forecasting of metals at all firms. This might have some negative implications as the employee responsible for forecasting of metals might not always be the person having the best insight into all fields of forecasting being performed at the firm. This problem might be especially relevant for firms working with general and aggregated forecasts of for example macro-economic development, where commodities are of limited significance to the total forecast. The reason for choosing this strategy, despite its flaws, is that the authors believe that the employee responsible for forecasting metals often has the highest level of commodity-specific knowledge. Excluding the employee responsible for the forecasting of metals and turning to a person in charge of more aggregated forecasts could lead to failure in recognizing important information regarding for example knowledge levels and decision-making processes. It is, however, important to recognize that this approach does not take into consideration the potential implications of forecasters senior to the employee in charge of the forecasting of metals intervening and altering the final forecast. This might implicate the accuracy achieved in a way that is not captured in this thesis.
The professional title of the interviewees has been identified as either analyst or employee at the purchasing department. The analysts’ have a specialized profession as commodity analysts, market analysts, business analysts, macro analysts or commodity strategists. The professions in the purchasing department are either metal purchaser or purchasing manager. The experience of commodity forecasting ranges from 2 to 30 years, where the service and strategy subgroup contains more experienced employees.

3.4. Conducted interviews

To open up for sharing this sensitive information, all firms were informed that the information derived from the interview would be treated anonymously and only be presented in an aggregated form, together with other companies in the same category. This method is recommended by Saunders (2007).

The interviews were conducted in line with Saunders semi-structured interview-technique, which was an appropriate approach for having the respondents talk about the topic in a freely manner, reviling their thoughts and opinions. However, the semi-structured interview technique increases the risk of biases being transferred from the interviewer onto the interviewee (Saunders, et al., 2007). This risk was decreased by dividing the role of the interviewers, where one interviewer was responsible for keeping an open climate and the other being responsible for all the questions being answered and understood correctly. Another disadvantage of the semi-structured interview technique is the subjective interpretation of information, because of the researcher’s frame of references and values, which potentially could be interpreted differently by another person (Saunders, et al., 2007). In order to tackle this issue, the authors transcribed all interviews, giving the interviewee the chance of correcting the interpretation of the interview. The authors also read all transcriptions before using them in the analyses in order to validate the interpretation of the interviews.

Due to long distances to investigated companies, phone interviews with the interviewees were considered suitable. The interviews were recorded, enabling the transcription to be made afterwards. This shifted the focus of the interview, from writing the answers to controlling the mindset and climate during the interview in order to gain as much information as possible. Each interview lasted for 55-75 minutes, depending on the willingness to discuss and share information.

3.5. The pre-study

The pre-study was conducted in cooperation with a Swedish industrial company in order to develop their forecasting-methods regarding volatile commodities related to their production. During this time, several analyses where conducted, such as descriptive statistics, macro-economic analysis, lagging content analysis and forecast evaluation. The aim of the analysis where to further develop their knowledge regarding commodity fluctuations and to benchmark their forecast accuracy towards experts, such as international
banks. Their main goal was to develop a simple technical forecast model with equivalent or better accuracy compared to their present forecast method.

3.6. Operationalization of the theoretical framework

In order to evaluate the methods used for forecasting metal-prices, the authors have chosen to focus on the imperfections of human rationality, learning processes and theoretically optimized methods as tools for evaluation. It is important to recognize that human logics are not only affecting the forecast in terms of qualitative judgment but also in the assessment of quantitative models.

All forecast-methods investigated in this paper contain some degree of human judgment although the structural application of human judgment varies for different forecast methods. The theory chosen will therefore be applied in a manner that suits the method described.

The theory-section treating the subject of decision-making is essential in order to, in the analysis; evaluate the implication of biases in human judgment. Decision-making has implications on all methods investigated. Through identifying biases in human reasoning, the authors can shed light on imperfections that are negatively affecting the accuracy of current methods used at investigated companies.

Further, learning processes at investigated companies are investigated for two reasons. At first, current knowledge-levels, and thus performance, can be related to the previous learning processes. Secondly, the companies’ potential for future development of the methods used is likely to be found in the evolution of new learning-processes.

The theoretically optimized methods are used as a comparison to the methods implemented at investigated companies in order to illustrate the gap between literature and practice. This helps the reader in comprehending methods available and clarifies the potential flaws in currently used methods. Further, the theoretically optimized methods can be used argumentatively as they provide a comparison between the arguments put forward by academia and the arguments put forward by investigated companies concerning specific methods.

3.7. Discussion on transparency, reliability, validity and generalizability

The reliability of this study was implicated by the fact that a qualitative method was used. This makes the findings hard to verify as they are specific to the cultural aspects of investigated companies as well as personal reflections of interviewees. The impact of personal reflections of interviewees was enhanced due to the semi-structured interview technique used. Although negatively affecting the reliability of the study, this interview-technique was used in order to capture abstract information necessary. Understanding of the cultural aspects captured in the semi-structured of this paper has, as proven in our
results, been of utmost importance in understanding the processes determining methods used at investigated companies.

The validity of the study is rather strong as a result of limiting the findings to companies investigated. Here, the authors can identify a trade-off between reliability and validity as increasing the generalization of findings through the implementation of a different methodology would increase reliability. On the other hand, this would render it impossible to consider important cultural aspects that are necessary in generating comprehensive findings. Given the limitations of the study, the validity of this study is to be considered as strong.

The transparency was reduced due to commitments made to some participating companies to treat company names anonymously. Companies where the names are provided have been labeled in a way that hides what company has said what. This does reduce the accountability as there is no way of confirming statements provided within in this thesis. Our way of handling this issue has been to improve transparency as much as possible without breaching the anonymity of participating companies by dividing firms into sub-categories represented by fields of forecasting. This enables the verification of information given towards a specified group of companies rather than forecasters in general. Swedish banks, for example, is a rather limited group and although the reader doesn’t know which bank has said what, the scope of where to seek for confirmation of information provided is limited.

Another way the authors have considered transparency when conducting this thesis was to include detailed information about the pre-study and interview-questions in Appendix. Further, when presenting the empirical findings, quotes were used to demonstrate the opinion of interviewees in order to reduce the implication of author-interpretations.

The authors argue that due to the triangulation of the pre-study and theory of forecasting, findings related to accuracy and method can to some extent be generalized. This ability to generalize findings is limited to the current situation and might not be valid over time. This is due to the fact that the relation between prices and factors affecting the price might change in the future.
4. Findings

In order to compare and evaluate the findings in a rational and standardized manner, a framework has been used. The framework consists of a two level hierarchy. The first level represents the type method used, such as qualitative, quantitative and combined method, hereafter referred to as group. The second level represents the purpose of the forecast, such as budget, hedging, risk management, service, strategy and strategic purchasing, hereafter referred to as subgroup. The distribution of the groups and subgroups within all firms are presented in table 1.

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Budget Bu 1</td>
<td>Hedging He 1</td>
<td>Strategy St 1</td>
</tr>
<tr>
<td>Risk management Rm 2</td>
<td>Hedging He 2</td>
<td>St 2</td>
</tr>
<tr>
<td>Service Se 1</td>
<td>Risk management Rm 1</td>
<td></td>
</tr>
<tr>
<td>Service Se 2</td>
<td>Service Se 3</td>
<td></td>
</tr>
<tr>
<td>Service Se 4</td>
<td>Strategic purchasing Pu 1</td>
<td></td>
</tr>
<tr>
<td>Strategic purchasing Pu 2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Distribution within the groups

It should be noted that two of the firms are using dual forecasts for separate purposes. In these cases the interview answers has been separated to differentiate between the methods used, and therefore identified as two subgroups.

4.1. Forecast method

In general the methods vary significantly within the whole group depending on the industry in which the firm operate the forecast horizon and the purpose of the forecast. What stands out is the distinct orientation towards a fundamental approach within all groups except the firms who’s hedging the commodity risk. The fundamental approach is applied even though numerous of the firms indicating an awareness of the speculative behaviour in some of the commodities. As SE 4 puts forward;

“...there is a high degree of speculation towards some metals, especially copper, which rather reacts as a function of speculative behaviours than fundamental factors.”

Even though the speculation in commodities increases, fundamental factors linked to the commodity supply is essential as countries nationalistic behaviour increases. Exemplified by Se1;
“There is a clear pattern of emerging countries being nationalistic about their natural resources, as they strive to add value within the country. An example is the unprocessed Nickel ore export from Indonesia which has been banned since January to spur investments in Indonesia’s metal refining industry. This behaviour is a result of the mining industry becoming more profitable and countries wanting to have a bigger share of the industry.”

Further, the argument for using a certain method and the view upon the pros and cons for each method reveal no clear expressed answers. However, when considering the concept of the forecast a clear relation between the purpose and the method emerges. The firms who are providing the forecast as a service for customers are skilfully arguing for how the commodity market works and why the price fluctuations occur. This seems to be an essential part in selling the forecasts to the customers, where a quantitative method would not have been providing as much market knowledge. While the firms who are using the forecast for strategy purposes uses a combined method to forecast both demand and supply which in turn demands both quantitative and qualitative methods. The firms who are using the forecast for hedging purposes seems to doing so mainly due to the technical orientation of hedging and the purpose of handling risk rather than forecast commodities.

After all, the purpose and usage of the forecast is seemingly clear in the subgroup of service, budgeting and strategy, while hedging, risk management and strategic purchasing are three different approaches of handle the short to middle term risk. The argue for the chosen purpose is representative in the three quotes;

“The alternative to strategic purchasing would be to hedge it financially but the spread of the Swedish banks are too extensive, due to the usage of intermediaries, which in turn makes use of another intermediary, which in the end leads to very costly method to handle risk.” (Pu 1)

“The majority of our purchases are finished articles; it is the suppliers who purchase the commodities. The suppliers in turn receive volume forecasts from us to avoid having large inventories and are in turn purchasing commodities on futures. We are thereby mainly affected by commodity prices through commodity clauses in the agreement with the supplier. Our purpose of the forecast is thereby primarily to estimate the future cost trends.” (Rm 2)

“Our purpose is to manage risk, not to forecast commodities.” (He 1)

The first quotes imply the purpose being chosen due to economic reasons while the latter two imply the fit of purpose being linked to the firm’s strategy of handling risk.

Further, the group of forecasting purposes applying a qualitative method consists of service, budget, strategic purchasing and risk management. Within this group all except the service subgroup is applying the forecast as a group decision, a consensus approach, which is stated by Rm 2:

“The approach is strongly anchored in the decision making and the culture of the firm, which is based on a consensus approach.”
Within the group of firms applying a group decision are there however, none who’s executing the more unbiased method, the Delphi method. The effect of this will further be discussed in the section upon decision making.

The only subgroup where a technical approach is applied is within the firms who are hedging the commodity risk. These firms are essentially applying simple short term statistical analysis, such as simple moving average (SMA). The simplicity of this method is argued for the purpose being to managing risk and not to forecast commodities (He 1).

Quantitative methods are however applied in other areas as well, such as risk management, strategic purchasing and forecasting as a service, but all of these fall into the category of econometric, driven by fundamental indicators and thereby identified as a quantitative method with a fundamental approach. This is exemplified by Pu 1, who’s using the econometric model for strategic purchasing:

“We uses three sources; LME, inventory level index and Kairos commodities. When the combination reviles a benefit to purchase, we purchase in accordance to our demand and storage capabilities.” (Pu 1)

The last group of methods is the combined. This group solely contains the firms who are using the forecast for strategy purposes. Compared to the other groups, which is focused upon monthly and quarterly forecasts, the strategy forecasts are conducted for a longer time horizon, from 5 to 30 years. This puts the focus upon information sources such as global industry production and BNP to estimate future demand. As ST 1 puts forward:

“When GDP reaches 5,000 - 15,000 dollar per capita, the outmost change in demand occurs for our type of metals. Generally speaking, one can say that the demand of metals is primarily driven by the urbanization of the world, which in turn leads to investment in infrastructure such as expansion of the power- and road networks”

To estimate the future supply, the strategy group focuses upon production cost and its structures to estimate future floor prices, this however is a difficult matter which is clear when reviewing past forecasts, exemplified by ST 1;

“...no one could have foreseen the increased costs in the mining and smelting industry. The reason for the increased costs in the last 10-15 years has been due to increased requirements of new equipment, mines had to become deeper, the water supply has been worse than expected and the concentration of minerals has decreased.”

For estimating future supply, the startups and closures of mines, so called boom burst cycles is also of interest. To estimate the supply the climate in which the mines operate has to be considered, such as profit margin, capital to invest and so forth. (ST 1)
4.1.1. Type and sources of information

Since the majority of the firms is applying a fundamental approach, the type and sources of information is an important factor. Table 2 and table 3 below reveal the percentage of usage within each subgroup and the average usage within the whole group. The average usage is however dependent upon the number of firms in each subgroup, which is a skew distribution and therefore not representative in a statistical matter.

<table>
<thead>
<tr>
<th>Type of information</th>
<th>Hedging</th>
<th>Budget</th>
<th>Risk management</th>
<th>Strategic purchasing</th>
<th>Service</th>
<th>Strategy</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyclical macro-economic indicators</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
<td>75%</td>
<td>100%</td>
<td>71%</td>
</tr>
<tr>
<td>Supply</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
<td>75%</td>
<td>50%</td>
<td>50%</td>
<td>54%</td>
</tr>
<tr>
<td>Demand</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
<td>75%</td>
<td>50%</td>
<td>50%</td>
<td>54%</td>
</tr>
<tr>
<td>Mining startup/closedown</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
<td>75%</td>
<td>100%</td>
<td>46%</td>
</tr>
<tr>
<td>Production cost</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Global industrial production</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Scrap</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>100%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Feedstock</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>100%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Inventory level</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>100%</td>
<td>33%</td>
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</tr>
<tr>
<td>Export</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
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<tr>
<td>Import</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>100%</td>
<td>33%</td>
<td>33%</td>
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<tr>
<td>Key interest rate</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>100%</td>
<td>33%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Table 2. Type of forecasting information

<table>
<thead>
<tr>
<th>Sources of information</th>
<th>Hedging</th>
<th>Budget</th>
<th>Risk management</th>
<th>Strategic purchasing</th>
<th>Service</th>
<th>Strategy</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal bulletin</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>CRU</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>SMR</td>
<td>50%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
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Table 3. Sources of forecasting information
4.2. Decision-making

Companies are diverse in the opinion of whether indicators affect the forecast positively or negatively. Most companies express that forecasts are not skewed in either way. However, company Se 3 deliberately skews their forecasts negatively because of the potential consequences for the customers if the results are lower than expected. This is expressed by company Se 3 as:

“As investors use the forecast for investment-decisions, we don’t want to be too positive as failed investments in the mining industry are extremely expensive. On the other hand, too negative forecasts might render the investor with missed opportunities. It is a balance, but we are rather a bit more negative”

One way of handling the issue of too optimistic forecasts was expressed by company Bu 1:

“We previously had problems with sales-representatives creating too positive forecasts. We have corrected this bias by installing new software that provides the sales-representatives with continuous feedback and evaluation of their forecasts”

5 of 11 companies investigated, within the qualitative- and quantitative method group, used forecasts from other firms in order to evaluate the methods used. None of the companies within the combined-method group had included this procedure. This is expressed by company Se 2 as:

Yes, we evaluate our methods by looking at other forecasters. Especially when somebody does it better, it is the competition that drives the development.

Further, about half of companies involve previous forecasts as an anchor in some form. Companies having long-term forecasts often use this as guidance for more short term forecasts (Pu 1; St 1; Bu 1; Rm 1). The connection to previous forecasts seems to be connected more to the reason for forecasting rather than the method used; there are also clear signs of companies following up previous forecasts; not as an anchor for coming ones, but rather as a way of improving general operations. This is illustrated by company Se 2, stating that:

“We follow up previous forecasts in order to establish credibility amongst customers. If we are too much wrong 2-3 times; we are likely to lose the customer”

Company Pu 1 states that:

“We follow up our forecasts in order to evaluate our purchase-method and see whether it would have been more cost-efficient to use direct-purchasing”

Regarding anchors, other than previous forecasts, the answers are quite diverged, and there are no specific trends for companies within the same method-group. Some examples of complementary anchors are; seasonal patterns (Se 2), Metal bulletin (Pu 2), expected sales
(Bu 1), other companies forecasts (Se 3) and scrap-prices (Pu 1). What the authors can observe is that companies, to some extent, tend to use anchors related to their reason for forecasting. For example, Bu 1 naturally uses expected sales as their forecasts are a part of the budgeting process. Another example is company Se 3 using forecasts conducted by competitors; this is natural as there within the banking industry is relatively easy to come over publicised material from competitors that are compatible to the internally produced forecast. This is due to all forecaster within the Se-group per definition having external forecasts.

All investigated companies share the opinion that forecasts could have been conducted better, at least occasionally, when looking back at the results. What varies is the degree of improvement possible. Generally, companies using qualitative methods seem to locate bigger room for improvement. Out of 6 investigated companies, 4 experienced significant room for improvement in retrospect. This is illustrated by company Bu 1:

“Yes, it is almost always like that as there is high degree of uncertainty in forecasting, there is always room for improvement”

Even though qualitative methods seems to experience the greatest amount of room for improvement when looking back at the methods used; this does not, de facto, state that qualitative methods are less efficient. When looking at companies using quantitative methods; perceived room for improvement in retrospect is smaller. However, this might also imply a lack of questioning of the methods used. As quantitative methods are more static, little room for self-criticism is left to the forecaster. This static approach to forecasting is somewhat illustrated by company Se 3:

“We try to evolve our models, there haven’t been any significant errors, but we have been laying a bit low on the results”

Interpreting previous quote, it is clear that the models are general for all forecasters and thus leaves little room for the individual operator to question his/her results. Even though there seems to be little room for self-criticism within companies using quantitative methods; it is clear that companies within the method-group seems more content with the results achieved and that implies higher accuracy results.

In retrospect, companies using combined methods tend to be the least prone to believe that the forecast could have been conducted in a better way (St 1; St 2). One room for improvement within the companies using combined forecast methods was expressed by company St 1 as:

“We have come far, but there is still room for improvement concerning the structuring of fundamental parameters”

It is visible throughout the interviews that most forecasts are produced as a result of a group decision. The only unity between forecast-type and method could be observed within forecasts used for strategic purposes, where both St 1 and St 2 are using a combined method built upon group-decision-making. The reason for this could be that management is naturally involved in strategic processes, resulting in a group-decision as management have aligned
interests with the forecasters. As most forecasts are produced as part of a group-decision, there is a risk related to communication if the areas of expertise of each forecaster are varying significantly. The dividing of knowledge-areas might also be beneficiary as in increases the capabilities of the group. Such a divide in areas of expertise is visible in company Se 3 and He 2 and stated by He 2 as:

“I am responsible for 2 metals and the figures are then compiled centrally”

The potential risk in communication is related to the covering the knowledge-gap to other group members when communicating the forecast model.

Interestingly, companies using qualitative methods are to a greater extent conducting the forecast without including any form of group decision. This is visible in Se 1, Se 2 and Pu 2. Whereas there is only one company using individual decision-making in the other two groups combined.

According to Janis and Mann (Janis & Mann, 1982), qualitative methods have, as a consequence of the high risk of biases moved towards more group assessment within the decision-making process. However, this has resulted in group-members affecting each other’s thinking, in a desire to support the beliefs of group-members and leaders. As a consequence, a desire to produce supportive and superficial information within group-based decision-making has emerged. This is referred to in the theory section as the confirmation trap. (Bazerman & Moore, 2012). This is supported in our findings, where the interviewee in company Rm 2 stated that:

“There is far too much consent within the group, it is sad. You’ll get emotionally attached to the other group members and are carried away by the opinion of the group. It is the same if you go to conferences; in the beginning everybody thinks differently, but when you go home everybody thinks the same way”.

Given that there seems to be a trade-off between the risk of biases occurring in individual decision-making and the risk of decision-making within groups resulting in illogical decisions based on interpersonal processes; the authors find it surprising to find more individual decision-making within qualitative methods as that group is the one already most exposed to biases.

Within companies using quantitative methods; 2 out of 3 are using customers or suppliers as a source for complementary information. Companies using combined methods are not generating information from suppliers, this is likely due to companies forecasting as a service being unable to consult forecasting strategies with their own customers. The conclusion is that it seems to be the level of interaction with a business-environment possessing relevant knowledge rather than the field of operations or methods used that determines the need for external knowledge.

Throughout investigated companies, there seems to be a general consensus within groups of forecasters. This is valid for all method groups and is expressed by company St 1 as:
“The mining industry is transparent due to the vast supply of official data. Due to everyone accessing the same information, a consensus usually evolves quite fast within the group”

However, this could imply that individuals in the investigated company search for information in the same area, as a result of the confirmation trap. As information provided is vast, it seems reasonable to assume that the information gathered should be more diverged. This idea is supported in a statement by company Se 3, stating that:

“A consensus usually evolves quite fast. We have worked together for many years and thus we have come to think alike. When a new individual enters the group, the thinking of the group becomes a bit more diverged. We recently hired a new staff for our London-office; this has lead to some new inputs on how we operate.”

Regarding the reason for eventual disagreement within groups of forecasters, the answers are diverged. Differences do not seem to be explicable by the choice of forecasting methods but rather as a result of field of operations. Two out of three participating banks (Se 3; Se 4) mentioned difficulties in evaluating the economical situation in China as the major cause of disagreement. The authors can also observe that companies forecasting as a result of risk management tend to put forward differences in information sources within the group as the main explanation for separating views (Rm 1; Rm2). This is probably explainable, as previously mentioned by the higher degree of knowledge-transferring relationships with supplier/buyers. These relationships tend to be diverse depending on position within the company; consequently information generated from these relationships becomes more diverged.

Company Se 2, interestingly mentions another reason for group-disagreement; the overconfidence bias; stating that:

“In the world of banking; bonuses are connected amount of sales generated. As a consequence, forecasters tend to set a high forecasted value if that is what is required in order for them to settle a deal”.

As customers’ demands varies amongst forecasters within these banks, it is reasonable to assume that adapting forecasts after the individual demand of the customer will result in diverged opinions concerning forecasts.

4 out 6 investigated companies using qualitative methods experience problems in prejudices affecting the forecasts produced. Lack of tools for analysing data leaves plenty of room for speculation, resulting in a high degree of perceived prejudices. This is expressed by company Bu 1 as:

“Unfortunately, due to the lack of tools for handling information we experience a lot of personal opinions rather than facts. We try to avoid this, although doing so is rather difficult in practice. Because of the final aggregation into a group decision, we find the final forecast to be rather free of biases after all”
Companies using quantitative methods seem to have less perceived difficulties with prejudices affecting the forecast, where only 1 in 3 investigated companies experience such problems. The probable explanation for this is that there is less room for interpretation in a quantitative model. There are however other concerns experienced by companies using quantitative methods. This is expressed by company Se 3 as:

“Using a quantitative model is by definition based on certain models or routines. It is important to think bigger and identify turning trends and new indicators. There is a risk of people only adjusting current models while failing to recognize the bigger picture.”

Companies using combined methods do not consider the risk of prejudices having a major impact on the outcome of forecasts; this is valid for all companies within this category (St 1; St 2).

4.3. Learning

There is a varying level of perceived stability regarding the methods used in companies using a qualitative method. Most companies mention the methods to be relatively stable; although elements of instability are mentioned by all but one company (Pu 2). One reason for instability is mentioned by company Se 2:

“When sudden events, such as crises occurs, our forecasting becomes ad-hoc”

Another reason for current instability was mentioned by company Rm 2:

“The method has been stable, but since we are in a phase of overseeing our methods the method is currently not as stable as before”

Companies using quantitative methods experience a high degree of stability in the methods used for forecasting. All three companies within this method-group shared this opinion. Regarding companies working with combined methods, there was only one company able to answer this question as the other had only recently introduced new methods. Company St 1 experience moderate levels of stability, leaving room for flexibility within the method used.

Regarding goals set for achieved accuracy, there are only two companies in the entire study using them. One is found in the qualitative method-group (Se 2) and one is found in the quantitative method-group (Se 3). Further; two companies have rather vague goals upon which they evaluate the accuracy achieved. This is explained by company Pu 2:

“We don’t really have any specific goals, but we sometimes compare our forecasts to index in order to evaluate our accuracy”

Generally, there seems to be little interest in evaluating the forecasts and one company (He 2) states that:

“We don’t evaluate the forecasts. At least not that I know of”
A response in the same line was generated by company Rm 2.

All companies within this study having goals set requiring desired accuracy levels are to some degree experiencing that they are fulfilling these goals. This is interesting as at the same time as this finding indicate that companies are performing rather well, the fulfilment of current goals also indicate a possible lack of motivation for reviewing current forecasting methods. While all companies using goals related to desired accuracy perceive that they to some extent are able to reach the goals set, most companies are not completely satisfied.

The reason for companies reaching set goals varies a lot between companies and method-groups. Here the authors can identify that companies working with quantitative methods seems to benefit from the standardized working method. This is expressed by company Se 3 as:

“I believe that we generally reached set goals. As we have been working with the same method for a long time, we have had lot of time to improve the input-data. This is a continuous job for us”

Interestingly, there seems to be other phenomena’s rather than accuracy that motivates the forecast-method chosen. This is especially valid for companies working with a qualitative forecast-method. 3 out of 5 companies using qualitative methods stress the need for reaching other goals than high accuracy when conducting forecasts. This is expressed by company Se 2, Pu 2 and Rm 2 as:

Se 2: “If my task was just to forecast the metal-prices, I would not have used the same method as I use today. We have also have to weigh in the situation we are in, where an important factor is communication to shareholders and customers”

Se 4: “I think we are using suitable methods; you’ll have to keep in mind that we have an interest in being able to communicate our results in a comprehensible way to media and our customers”

Rm 2: The forecast-accuracy is only a part of the result. In order for us to be successful, it is more important for us that there is a consensus amongst co-workers. If our purchasers are involved into the forecasting, they are more likely to use it. This is important for us”

Within companies using quantitative models; companies are generally contempt, given the relative small quantities traded within this group. The same contempt is observable in companies using combined methods.

The authors can observe that companies using qualitative methods generally utilize external experts to a bigger extent than companies using other methods. Out of the 6 companies using qualitative methods, 4 companies relied on external experts to some extent. Even though all companies express the existence of complementary knowledge within the company, the main reason for utilizing external experts appears to be a need for access to new fields of knowledge rather than deeper insights into existing fields of knowledge. This is expressed by company He 1 as:
“Yes, we often involve experts from banks, since they are more involved in the commodity trading industry”

Within the five companies utilizing quantitative or combined methods; only two hires external experts. It would be reasonable to assume that these companies to a bigger extent would operate in businesses where they have natural access to complementary information; this is also to some extent the case. Even though the spread of business fields over forecasting methods is diverse; companies that interact with their buyers/suppliers seems to have less need for external experts.

Out of 11 companies; 7 experienced room for improvement in their forecast methods. The other 4 believed that the current methods were optimal when put into the context in which they are used. No company believed their model to be generally optimal supreme over other models. The perceived room for improvement was diverged over method-groups and if the authors were to draw any conclusions regarding the field of forecasting, it is noticeable that companies using forecasting as a tool for hedging all experienced current methods to be optimal when considering the context in which they are used (He 1; He 2). Some mentioned rooms for improvement are; accuracy follow-up (Pu 1), inclusion of simulation capabilities (St 1) and more employees in order to process more data (St 2). St 2 was however hesitating whether the potential gains in accuracy through more staff would carry the increased salary-costs.

Half of investigated companies evaluate their methods by comparing it to other forecasters. The same ratio of companies evaluating their methods this way is found in all method groups. Regarding field of forecasting; the authors can observe that companies forecasting as part of a service all evaluate their forecasts by comparing to other actors (Se 1; Se 2; Se 3). This is likely to be due to the transparency of the forecast-service market. It is relatively simple to come over reports published by banks over the internet. Difficulties of retrieving comparable reports seem to be an issue, at least some, companies in other fields of forecasting. This is expressed by company St 1 as:

“It is hard for us to evaluate our forecasts by looking at that of competitors as we do not have access to their figures”

Why other companies do not evaluate their forecasts; using bank reports for comparison remains unanswered, however the authors can see one example of a company not operating within service-forecasting using the forecasts for banks for forecast-evaluation (He 2).

Other companies use other methods of evaluation; such as comparing purchasing price to PLATO low (Pu 1) or comparing to market-index (Pu 2).

There is no clear tendency of companies within specific method-groups having more or less external reports. It is observable that companies producing forecasts as part of a service are more prone to communicate reports externally. Some companies tend to keep the reports within the company (Rm 2; St 2; He 1; Pu 1) whilst other communicate it only to suppliers (Rm 1; Pu 2; St 1).
The reason for not sharing the information externally or with others in the supply-chain is varying. Rm 2 explains:

“We only use our forecasts internally; for what I know, the suppliers have never asked for it”

Another view is presented by company Se 2:

“We rarely demonstrate our method towards the client in order to protect it. Long-term forecasts, such as our five year macro-economic forecast, is something that we never communicate externally”

Forecasts are spread to a higher degree within companies forecasting as a service. As these companies to a higher degree use a qualitative method, forecasts are more widespread within organizations using this forecast-method. This is explained by companies Se 2 and Se 4:

Se 2: “We use the forecasts on all our offices as it is regarded as our core-competence. Thus, you can walk into one of our offices and take part of our forecasts”

Se 4: “As we package our forecasts into financial products, the forecast becomes widespread throughout the organization”

As the quantitative method-group is represented with a higher degree of producing firms, the spreading of forecasts takes a different shape. Companies within this group to a higher extent shares the forecast with the purchasing; sales; and production-department. This is expressed by Pu 1:

“We share the forecasts within a closed group of around 10-15 people. The group consists of purchasers and factory-managers. Those who have an interest in the reports can usually contact members of the group in order to get a hold of the forecasts”

Most companies using qualitative and combined methods agree have a clear idea of how to increase the accuracy of forecasts produced (Se 2; Se 4; Rm 2; Pu 2; St 2). This would mostly be a question of increasing number of indicators taken into consideration. However, companies within this group seem to be questioning whether the gains from increased accuracy would outweigh the increased costs of producing the forecasts. This is expressed by company Se 2 and St 2 as:

“To a certain extent, this is a question of resources and to evaluate the potential gains to the increased labour-costs”

St 2 argues in the same line, stating that:
“The accuracy is related to the number of employees, this leaves us back at the question whether increased accuracy through more staff would carry the increased salary-costs it would bring”

For companies using quantitative methods, the question is not as much to find new indicators but rather to make current models more efficient. It is important to bare in mind that companies using forecasts for purchasing also have to take purchased volumes into consideration. These companies tend to focus on creating more stable volumes in order to stabilise the total purchasing-costs. This is expressed by company Pu 1 and Rm 1:

**Pu 1:** “We work on improving and warehousing and logistics”

**Rm 1:** “We have worked with the suppliers in order to reduce the volatility on article-level, this has resulted in small adjustments that increases the stability in volumes purchased. It is a continuous job with small improvements and it has not resulted in any revolutionary changes”

Forecasters using a qualitative method generally perceive themselves to have sufficient knowledge in order to perform their work. Although interviewees are generally satisfied with their level of knowledge, 2 out of interviewees (Pu 2; Se 4) feel that there is room for improvement. This is expressed by company Pu 2 as:

“I am currently obtaining all goals set on beating index whilst at the same time keeping production going without any shortages of supply. I am sure that it would be possible to further beat index through improved working-methods”

Within companies using a quantitative forecast-method; 2 out of 4 experience insufficient knowledge-levels. This is expressed by company Rm 1 and Pu 1 as:

**Rm 1:**“No, I absolutely don’t have sufficient knowledge. It is important to be humble towards ones knowledge-levels in order to leave room for improvement”

**Pu 1:** “Hmm, good question, previously my knowledge-level has been insufficient, however it starts to improve”

Companies using combined method express the highest levels of knowledge. Companies within this method groups are both working with strategic forecasting and have a lot of experience within the field. The knowledge-level is, however, not perceived to be sufficient for all areas necessary to conduct forecasts. As stated by company St 1:
“I have sufficient knowledge for my part in the group, however, it is necessary that other members complement my knowledge as it is not sufficient for all parts of the process of creating accurate forecasts”

All interviewees experienced to have some degree of influence over the methods used at the company. A few respondents experienced individual control over methods used although the majority described methods used as part of a group-decision. There are no differences describable when comparing method-groups or field of forecasting. One example of a representative answer was given by company He 1:

“I possess influence over methods used; although there has to be others involved in these decisions as well”

None of the interviewees participating in this study are personally investing in metals in particular. 5 out of 10 interviewees are investing in financial products that sometimes contain metals. There is no tendency for forecasters in any particular method-group to invest more than other in metals. The same relation occurs when looking at field of forecasting.

There is one example of companies regulating the speculation of personal investments. This is expressed by company Se 2 as:

“Our company’s rules state that we have to keep an investment for at least three months. This is a clear disadvantage, but sometimes you are convinced that an investment will be profitable also in the longer perspective”
5. Analysis

5.1. Analysis of forecast method

In the empirical findings; several methods for commodity forecasting are presented. The method has been shown to be closely linked to the forecast purpose, which in turn is related to the firm’s situation and strategy concerning risk management. It’s therefore problematic to find any best practice among diverge methods and concepts. However, this chapter will put forward a triangulation towards the theory and the statistical analysis performed in the pre-study to interpret the pros and coins upon the different methods applied.

The choice of forecast method were, throughout the empirical findings, found to be more related to the forecast approach and the purpose of the forecast rather than the benefits or accuracy of the chosen method. This is evident when reviewing the choice of methods from the perspective of the interviewee and his/her purpose of forecasting. For example, firms who are selling the forecast as a service have a need to communicate the factors that drives commodity prices when selling the forecast to customers. This requires a method that captures the underlying reasons for the market reaction rather than an explicit forecasted price. It’s therefore argumentative best suited with a qualitative method in this scenario. Another example is forecasts used for strategy purposes, which in our study were found to be allocated at the combined method group. This is due to the demand being driven by macroeconomic indicators, where a quantitative method is best suited while supply is better described by qualitative methods. The supply data is used to capture the mining firms’ opinion regarding opening and closing of mines. The last example is the forecasts for hedging purposes, which tend to use quantitative methods due to the technical orientation of hedging. In one hedging firm, there was also a case of dependency upon the speculative behaviour of the commodity. The other forecast purposes, such as risk management, strategic purchasing and budgeting have diversified arguments for the method chosen.

Forecast method from the perspective of the forecast horizon

It’s seemingly clear that the majority of the firms are applying a fundamental approach, in which the information is an essential factor for the forecast accuracy. In table 2, macroeconomic indicators are identified as the most used type of information. This stands in contrast to the theory of Miao and Elder which states that macroeconomic indicators seldom is linked to the commodity prices in short- to midterm horizon (Miao & Elder, 2012). This is also identified in the pre-study, where relatively few commodities correlate to macroeconomic indicators in monthly and quarterly perspective (Appendix I, section 2.1, Correlation to macro-economic indicators). However, the metals who does correlate seems to be the more speculative ones, such as copper and aluminum. Additionally, the use of macro-economic indicators seems to bring forward valuable information in the long term perspective, since it’s used in the strategy subgroup, where the firm’s success more or less depend upon an accurate forecasts. Furthermore, within the subgroup of strategy the combined method is applied in order to interpret the different properties of demand and supply, where demand is driven by macro-economic indicators and is thereby estimated
with a quantitative method. The supply is driven by the climate in which the mining firms operate and is thereby estimated by qualitative method. Since the choice of method is in line with Timmerman’s definition of when a combined method is suitable, this implies a rational choice of method (Timmerman, 2006, p. 157).

Further, one may argue that a technical approach is the best practice in quarterly commodity forecasts since the technical model, Theta, outperformed the average twelve top international banks participating in Metal bulletins analyst price expectancy. (Appendix I, section 4.4, Benchmark towards technical forecast model) On the contrary, the performance of the Theta model was acknowledged prior to the financial crises and could therefore be argued not to achieve the equivalent accuracy in present time. This is certainly the case, which shifts the discussion towards how much the accuracy would differ and how long time it would take for the model to adapt to a turning trend. This is however not evaluated in the literature nor in this study, which makes the statement neither unverified nor verified. A time-series forecasting model would however been suitable in the industrial forecasting process since it is easy to use, requiring relative small data sets and having the ability to capture statistical relations whilst requiring low level of knowledge about the forecasted variable (Carnot, et al., 2011).

Furthermore, the short term perspective has shown to be dependent upon the commodity in focus and its relation between financial speculation and fundamental factors. This is clear when reviewing the forecasts conducted by Pu 1 in comparison to He 1, where Pu 1 is using fundamental factors to forecast a couple of months ahead while He 1, due to the speculative behavior of the commodity, is limited to simple statistical analysis such as SMA. This case strengthens De Meo’s (2013) analysis, which concluded that some commodities are rather driven by speculation than fundamental indicators. However, the most commonly used method amongst investigated companies in short term perspective is reviled, to some extent, being econometric, with input such as feedstock and inventory level variables. The interpretation of this goes in line with Qin et al. (2008), emphasizing its advantage of bringing forward a coherent picture and sense making of vast quantity of information. The forecast value of an econometric model was also analysed in the pre-study, describing steel, which reviled that several fundamental factors had a lagging correlation towards the steel price and were therefore judged as a fundamentally driven commodity with relative good predictability upon a monthly perspective (Appendix I, section 3, Lagging feedstock analysis). Additionally, the theory of storage, validated for base metals by Gemen and Smith (2013), confirms the predictably by using inventory level as input.

The factors that drives speculative commodities has not been evaluated in the pre-study, even though they seem to react to macroeconomic indicators, as previously mentioned. The difference, however, in forecast accuracy between a fundamental and a speculatively driven commodity cannot be distinguished in Metal bulletins analyst price expectancy. This could in term be interpreted as a function of volatility rather than lack of fundamental factors (Appendix I, section 4.1, Mean average percentage error).
5.2. Analysis of decision-making

Several potential biases can be identified in the decision-making conducted at investigated companies. It is generally not possible to identify whether biases are actually occurring in present operations; thus the analysis focuses on identifying processes that are exposed to potential implications of biases.

Throughout the analysis, it was observable that field of forecasting had substantial impact on bias-exposure. For instance, companies involving several departments into their forecasting-method experienced a higher risk of too positive forecasts. This was due to colliding interests with other parts of the company. These findings where further strengthened by the identification of similar processes within companies working in the forecasting-field of banking. The occurrence of too positive forecasts over time implies the existence of an overconfidence- and insensitivity to base rates –bias (Bazerman & Moore, 2012). One way of reducing the risk of external departments negatively affecting the accuracy of forecasts would be to remove this information, currently acting as anchors for forecasts produced (Bazerman & Moore, 2012). This is however problematic as it is important for forecasters to consolidate with concerned departments. Other anchors mentioned were somewhat more neutral, even though there is a potential risk of biases in using forecasts of competitors as anchor, and no company used previous forecasts in a way that could bias the results of coming forecasts.

Further, companies using a qualitative model appear to be more prone to think higher accuracy could have been obtained in retrospect. The potential bias related to this phenomenon is referred to as the hindsight-bias (Bazerman & Moore, 2012). However, it is not possible to determine whether the hindsight-bias could explain the perceived room for improvement in retrospect as companies working with qualitative methods experience more room for individual interpretation. This increases the number of variables that could have been taken into consideration. The more static information gathering of companies using quantitative methods could also experience potential biases as the defined scope of information could create a confirmation trap where only certain information is deemed interesting (Bazerman & Moore, 2012).

According to Janis and Mann (Janis & Mann, 1982), qualitative methods have, as a consequence of the high risk of biases moved towards more group assessment within the decision making process. However, this has resulted in group-members affecting each other’s thinking, in a desire to support the beliefs of group-members and leaders. As a consequence, a desire to produce supportive and superficial information within group based decision-making has emerged. This is referred to in the theory section as the confirmation trap. (Bazerman & Moore, 2012). This is supported in our findings, where the interviewee in company Rm 2 stated that

“There is far too much consent within the group, it is sad. You’ll get emotionally attached to the other group members and are carried away by the opinion of the group. It is the same if you go to conferences; in the beginning everybody thinks differently, but when you go home everybody thinks the same way”.
Although there seems to be a trade-off between the risk of biases occurring in individual decision making and the risk of decision making within groups resulting in illogical decisions based on interpersonal processes; the authors find it surprising to find more individual decision making within qualitative methods as the combination of individual decision making and qualitative methods leads to the highest possible rate of bias-exposure. Companies using qualitative methods could therefore focus more on implementing available methods for avoiding the negative implications of group-decision making such as the Delphi-method (Bazerman & Moore, 2012), described in the theory-section. Generally, it is also important to consider the impact of varying knowledge-levels within the group a too wide gap between individuals might cause miscommunication within the forecast group. This is referred to as the curse of knowledge by Bazerman and Moore (Bazerman & Moore, 2012).

When looking into the problem of prejudices affecting the forecast, the authors could observe that companies using qualitative methods were more likely to observe implications of prejudices affecting the outcome of forecasts than companies using quantitative or combined methods. As forecasters using qualitative methods are working with a broader scope of information, the risk of employees testing the validity of information by matching it to a broader category within their minds increase. This is referred to as the conjunction fallacy (Bazerman & Moore, 2012) As the forecaster, by definition, will seek to confirm his/her prejudices, there is also a risk of them resulting in the forecaster becoming emotionally attached to some probabilities while failing to comprehend the underlying statistics presented. This effect is also likely to disregard the sample-size as it is likely that prejudices would cause the forecaster to over react even though the sample size indicates that the impact of potential prejudices are minor. This was referred to as the insensitivity to sample size- and insensitivity to base-rates biases by Bazerman and Moore (Bazerman & Moore, 2012). Further, according to us, prejudices are likely to be vivid and that might result in the implication of the ease of recall-bias, stating that the human mind tends to overestimate probabilities of vivid events occurring (Bazerman & Moore, 2012).

As stated by Kahneman and Tversky (Kahneman & Tversky, 1973), there is a risk of overweighing small probabilities and under weighing large ones, especially when assessing quantitative models. This might cause implications as companies investigated are using anchors such as expected sales into the models used. If the model is correctly weighed the problem is non-existent. However, potential risks could be identified in companies investigated. For example, one company within the quantitative method-group, Pu 1, uses scrap prices as an anchor for forecasting the price of hot rod coil (HRC). This might result in a skewed model if Pu 1 is not aware of the exact correlations between scrap-prices and HRC. Our findings give some indications of this, as there are more appropriate metals available for correlation analysis. According to our pre-study, the scrap-price has a lower correlation towards hot rod coil (HRC) than for example pig-iron and iron ore (visual in section 3. Lagging feedstock analysis). Even though this is just one example, the authors find it unlikely that companies are aware of the exact implications of included indicators. This assumption is made by looking at the anchors mentioned.
by investigated companies and evaluating the possibility of estimating the indicator’s specific implication on the model used.

Lastly, companies using the forecasts of other firms as a mean for accuracy- and method-evaluation are taking a risk as performance over time tend to regress towards the mean (Bazerman & Moore, 2012). Implementing a method that is used by a firm that has been successful over a shorter period of time is not to be recommended as it is more suitable to measure accuracy towards stable data such as price-indexes and methods towards firms that have shown a long track-record of high accuracy forecasts.

5.3. Analysis of learning

Current knowledge-levels was amongst interviewees was investigated, partly in order to grasp the current situation but also in order to establish the prerequisites for organizational learning as current knowledge levels determine the ability of the firm to acquire new knowledge (Cohen & Levintahl, 1990). The knowledge-levels where found to be highest within companies using a combined method and lowest within companies using a quantitative method. One potential explanation for this might be that interviewees within the combined method-group are having more experience than interviewees using quantitative methods. In order for firms to acquire new knowledge firms needs to be aware that a lack of knowledge exist in current operations. According to Zahra and George (Zahra & George, 2002), failure of operations works as activation triggers enhancing increased learning. As only 2 out of 11 firms investigated have set goals regarding desired accuracy, and 2 others have vague goals, the possibility of learning from failure is limited at investigated companies. There is no tendency of any method-group having more goals related to accuracy than others. Even though there is no tendency of more goals related to accuracy within any method-group, companies using a qualitative method might experience activation triggers through the higher level of external experts used within this group. According to Zahra and George (Zahra & George, 2002), knowledge working as activation triggers could be found on the market through consultancies.

Another important part of organizational learning are the sources for organizational learning. As described by Zahra & George (Zahra & George, 2002); the acquisition of new knowledge is determined by three factors: intensity, speed and direction. Speed and intensity refers to quality of obtained knowledge while direction determines the path a firm follows in obtaining new knowledge. Directing learning-processes towards other forecasters in order to obtain knowledge of how to increase accuracy seems logical. However, only half of companies investigated had imposed this method of learning. The primary explanation for this was lack of access to material and, what seems to be, un-matching forecast-methods. Whether or not companies had the possibility of evaluating current methods by looking at that of competitors seems to be explained more by field of forecasting than method used, although firms working with qualitative methods are slightly overrepresented.
Banks in particular easily could obtain compatible forecasts. This implies that banks could more easily introduce efficient learning processes.

Further, according to Friedman and Schustack (Friedman & Schustack, 2006), cognitive research suggests two alternative ways of learning new schemas through either assimilation or transformation. When a new idea can be fitted into the existing schemas with little or no change, it is called assimilation; knowledge is adjusted to existing cognitive frameworks. When new knowledge differs too much to be incorporated in the existing cognitive structures, schemas themselves must change and this process is called transformation. Two initially incompatible schemas may through the process merge and form an innovation. The ability to exploit information through assimilation or transformation is dependent on the firms, and individuals, exposure towards new information (Cohen & Levintahl, 1990). Due to the limited scope of information utilized within quantitative models, it is reasonable to assume that companies using qualitative and combined methods would have easier to implement new knowledge.

Even though there seems to be most potential gains from learning-processes within companies using qualitative methods, the highly expressed need for conformity within the group implies the occurrence of ineffective learning processes. According to Argyis (Argyris, 1976), single-loop learning is often promoted in group-decisions as a way to obtain current structure and reach conformity within the group. As a consequence, knowledge derived from double-loop learning that questions current models will often be put aside. This approach to new knowledge limits the potential for development of current methods. The assumption of single-loop learning hindering effective learning-processes is further strengthened when observing companies perceived ways of improving current methods. All companies within the qualitative method-group believed that believed that the best way of increasing accuracy was to wither include more indicators into current methods or hire more staff. None of the interviewees mentioned potential changes in current methods.

Power relationships are significantly affecting methods used at investigated companies using qualitative methods. These relationships were identified towards suppliers, buyers as well as within the firms. According to Todorova and Durisin (Todorova & Durisin, 2007), power relationships can explain why only some new knowledge is used as it have to be in-line with present power structures in order to be implemented at the firm. This was especially clear when looking at companies working with qualitative methods. 3 out of 5 companies investigated within the qualitative-group expressed the need for obtaining goals other than accuracy when conducting forecasts. As forecasters using qualitative methods to a higher extent were dependent on other departments within the organization, there is a risk of these departments acting as gate-keepers regarding input-data related to that specific department. According to Cohen & Levintahl (Cohen & Levintahl, 1990), a gate-keeper is responsible for obtaining and spreading information throughout the organization. As these departments are unlikely to posses the knowledge-levels of the forecaster, potential room for accuracy-improvement might be blocked due to
the inability of the forecaster to evaluate information provided in the strive for conformity. The authors argue that the gate-keeper should be the person with the highest level of forecasting-knowledge as that would improve the company’s ability to evaluate information. This potential problem within internal relations is described by company Rm 2 as:

*Rm 2: The forecast-accuracy is only a part of the result. In order for us to be successful, it is more important for us that there is a consensus amongst co-workers. If our purchasers are involved into the forecasting, they are more likely to use it. This is important for us”*
6. Conclusion

6.1. Research question

*What role does the feature of firm operations play in the choice of commodity forecasting method?*

It is observable throughout this study that companies within particular method-groups, to a significant extent are affected by firm operations when choosing commodity forecasting method. The reason for this is that the field of utilization differs between firms with varying fields of operation.

- Service – to a large extent use qualitative methods due to needs of communicating methods used when selling the forecast to customers.
- Strategy – Use combined methods due to the demand driven by macro economical (quantitative) and supply by the opening and closing of mines (qualitative)
- Hedging – Use quantitative methods due to the technical orientation and in one case also dependent upon the speculative behaviour of the commodity

In other sub-groups the feature of firm observation could not be found to explain the choice of commodity forecast method. These groups are:

- Risk management
- Strategic purchasing
- Budgeting

*In what ways do biases related to decision-making affect the accuracy of forecast methods at investigated companies?*

The authors found that there were potentially substantial impacts of biases depending on forecast-methods used. This could, however, also be explained by the matter of approach to commodity forecasting. Companies involving several departments into the forecast-method were found to be more exposed to the overconfidence- and insensitivity to base-rates biases. Further companies evaluating accuracy and forecast-methods towards competitors faced a risk of exposing themselves to the regression to the mean-bias.

*Qualitative:* The most prominent finding was that companies using this method to a greater extent than companies using other methods used individual decision-making. This is somewhat surprising as companies using a qualitative method are highly exposed to biases in decision-making, such as the conjunction fallacy, and conducting the forecast as a part of a group-decision would reduce the impact of these biases and help reducing individual prejudices. The authors therefore recommend companies using a qualitative method to conduct forecasts as part of a group-decision, installing de-biasing elements, such as the Delphi-method. Further, companies using this method were found to be, potentially, more exposed to the hindsight bias as they were more prone to believe that the forecast could have been improved in retrospect. However, this finding is somewhat contradictive as the
increased freedom of interpretation within this group provides more data that potentially could have been included in the forecast. These findings might thus indicate that companies using qualitative methods had a greater chance of improvement through the recognition of alternative methods.

*Quantitative:* Companies using this method were not exposed to a potential hindsight bias, on the other hand, this might indicate that companies using this method are unable to recognize potential improvements to the method used; leading to an inability of identifying potential improvements to methods used. Companies within this group should also be aware of the potential risk for skewed results due to indicators not being properly weighed when assessing the model. This was illustrated by the inclusion of scrap-prices by company Pu 1.

*Combined:* As companies within this group were all using group-decisions and with some indications of varying knowledge-levels within the group, there is a risk of miscommunication through the curse of knowledge-bias. It is important that communication is conducted at a level that provides all members of the group to fully grasp the reasoning leading up to anticipated values.

*Could the use of certain forecast methods, at investigated companies, be related to effective learning processes?*

The authors found that effective learning processes were a result of a combination between methods used and field of operation. Further, companies operating in a business field that provided transparency regarding forecast methods had an increased opportunity to improve their methods by comparing them to others. This was especially valid for the banking industry. A general finding, concerning all method-groups, was that the lack of goals set on desired accuracy diminished the chance of acquiring new knowledge.

*Qualitative:* Companies were found to possess, what the interviewees described as sufficient knowledge-levels. The wide scope of information gathering in combination with extensive use of external experts enhances effective learning processes within this group. On the other hand, companies using qualitative methods where hindered from developing their forecast methods by a desire for conformity within the group; this obstructed the potential to improve methods by double-loop learning and limited the potential for radical chances in the forecast method. Power relationships, together with the risk of dependency on secondary gate-keepers were another factor that negatively could affect accuracy within this group. Further, the use of external experts could to some degree compensate the lack of goals set on desired accuracy in implementing activation triggers for the generation of new knowledge.

*Quantitative:* A major risk for companies using quantitative methods is the lack of double-loop learning. As only one company within this group uses some form of
follow-up on accuracy, there is little feedback given for measuring performance. This exposes companies to the risk of focusing too much on efficiency rather than effectiveness and is likely to result in an inability for the firm to exploit new information.

Combined: Companies within this group were experiencing the highest knowledge-levels of companies investigated. It is naturally hard for companies within this group to find compatible forecasts to use as a benchmark for increased accuracy. There were signs of companies within this group focusing on double-loop learning as desired improvements mentioned by St 2 referred to the inclusion of new capabilities through simulation.

In summary, all method-groups possessed both pro’s and con’s when it comes to implementing effective learning-processes. Even though there is no simple answer as to which method enables the most effective learning processes, the group using combined methods seems to have been able to implement the most effective learning processes.

Is it possible to identify a best practice, when:

a. Dividing methods into quantitative, qualitative and combined

The authors found that the scope of methods implementable was highly determined by the operational field of the company, the commodity forecasted and the time horizon. This made the choice of best practice method a contextual matter.

b. Dividing the forecast horizon into long-, mid- and short term perspective

When applying the long-term perspective, 2-30 years, upon the field of strategy, it was found that macro-economic indicators were a relevant variable for estimating future demand. This was usually done with a quantitative method. Estimating future supply where found to be done by applying a qualitative method in order to interpret the climate in which the mines operate and to foresee the boom-burst-cycles and future production costs.

When looking at the mid-term perspective, it was found that macro-economic indicators were not a well-suited source of information; especially for non-speculative metals. The technical model, Theta, where found to be acknowledged prior to the financial crises and its performance where not demonstrated in present time. This made the comparison in the problem statement unverified.

Regarding the short-term perspective, the choice of method was found to be explained by the commodity in focus and its relation towards speculative and fundamental factors. Inventory level was found to provide relatively good predictability for both speculative and fundamentally driven commodities. Further, feedstock analysis was found to provide some predictability for fundamentally driven commodities. These input variables was it turn found, to some extent, being applied with an econometric model.
Furthermore, the speculative commodities has not been found to be more complicated to forecast than the fundamentally driven commodities, arguing that this result could be explained rather as a function of volatility than a lack of fundamental factors.

6.2. Recommendations for participating companies

The main recommendation for participating companies is to measure and evaluate the forecast accuracy to enable continuous improvements of the forecast process.

Companies using *qualitative methods* should implement de-biasing methods into the decision-making process. This could be done by implementing methods, such as the Delphi-method, previously mentioned in this thesis. This would also help in addressing biases related to individual prejudices. Also important, is for companies within this group to realize the affect power relations has on the acquired accuracy. In order to handle this issue, companies could implement multiple forecasting methods, such as time-series analyses previously described in this thesis, in order to obtain necessary communication within various parts of the firm whilst at the same time ensuring a higher accuracy. Using several methods separately enables forecasts to confirm each other. If possible, forecasters within this group could establish relationships with the external environment in order to avoid being dependent on secondary information through other departments within the firm.

Companies using qualitative methods should include stable and neutral data, such as price-indexes for forecast evaluation.

Companies using *quantitative methods* should include elements where double-loop learning is promoted. This could be done by encouraging learning of alternative forecast methods in order to increase effectiveness. Generally diversifying the flow of information by increased involvement of external experts is likely to help diversification of information gathered. Companies using quantitative methods should also include stable and neutral data, such as price-indexes, for forecast-evaluation.

As *combined methods* are constituted by a combination of qualitative- and quantitative methods; suggested improvements for these methods are applicable also for companies using combined methods. As well as for other groups, the use of multiple and separate forecast methods could be used in order to confirm or disconfirm the main forecast.

Further, the authors propose that commodity exposure should be reported independently in the annual report, such as currency exposure, to provide transparency towards the increasing risk in commodity management.

6.3. Suggestions for further research

The authors propose a further research in the field of technical models for commodity forecasting in the time horizon of 1-4 quarters, since to most industrial firms are exposed in this time frame and few fundamental approaches covers it.
Further, the speculative versus the fundamental driven factors of commodities has been pointed out earlier in the study as inconclusive. This field of study would contribute to the discussion which commodities drives of which and why certain metals are chosen for speculative purposes.
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Appendix I: The pre-study

The pre-study was conducted in cooperation with a Swedish industrial company in order to develop their forecasting-methods regarding volatile commodities related to their production. During this time, several analyses where conducted, such as descriptive statistics, macro-economic analysis, lagging content analysis and forecast evaluation.

1. Descriptive statistics

The first analysis was conducted with the aim to get an overall view of how investigated commodities relates to each other, by focusing on how they correlate. This analysis contributed to the conclusion that all commodities, except aluminium are more or less correlated.

1.1 Correlation matrix between commodities

<table>
<thead>
<tr>
<th>Quarterly</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Aluminium</td>
<td></td>
<td>1</td>
<td>0.74</td>
<td>0.72</td>
<td>0.85</td>
</tr>
<tr>
<td>2 Copper</td>
<td>0.74</td>
<td></td>
<td>0.72</td>
<td>0.77</td>
<td>0.86</td>
</tr>
<tr>
<td>3 Lead</td>
<td>0.72</td>
<td>0.72</td>
<td></td>
<td>0.84</td>
<td>0.95</td>
</tr>
<tr>
<td>4 Nickel</td>
<td>0.85</td>
<td>0.77</td>
<td>0.84</td>
<td></td>
<td>0.86</td>
</tr>
<tr>
<td>5 Zinc</td>
<td>0.69</td>
<td>0.86</td>
<td>0.95</td>
<td>0.86</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monthly</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Aluminium</td>
<td></td>
<td>1</td>
<td>0.75</td>
<td>0.71</td>
<td>0.84</td>
</tr>
<tr>
<td>2 Copper</td>
<td>0.75</td>
<td></td>
<td>0.71</td>
<td>0.77</td>
<td>0.83</td>
</tr>
<tr>
<td>3 Lead</td>
<td>0.71</td>
<td>0.71</td>
<td></td>
<td>0.86</td>
<td>0.94</td>
</tr>
<tr>
<td>4 Nickel</td>
<td>0.84</td>
<td>0.77</td>
<td>0.83</td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>5 Zinc</td>
<td>0.69</td>
<td>0.86</td>
<td>0.94</td>
<td>0.85</td>
<td></td>
</tr>
</tbody>
</table>

2. Macro-economic analysis

The second analysis was conducted with the aim to analyse the relation between macro-economic indicators and commodities. The analysis revealed divergent pattern of relations, where aluminium where most dependent upon macro-economic indicators with four correlations; merchandise import/export growth, WPI inflation and exchange rate (monthly average). Copper and zinc where both correlated to quarterly GDP growth. Copper was also correlated to retail sales growth and Nickel to merchandise export growth. The statement that commodities are heavily dependent on macro-economic indicators could not be confirmed or disconfirmed.

2.1 Correlation to macro-economic indicators

<table>
<thead>
<tr>
<th>Quarterly</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real GDP Growth</td>
<td>0.62</td>
<td>0.82</td>
<td>0.72</td>
<td>0.70</td>
<td>0.80</td>
</tr>
<tr>
<td>Industrial Production Growth</td>
<td>0.59</td>
<td>0.78</td>
<td>0.69</td>
<td>0.68</td>
<td>0.79</td>
</tr>
<tr>
<td>Real Retail Sales Growth</td>
<td>0.45</td>
<td>0.82</td>
<td>0.70</td>
<td>0.69</td>
<td>0.79</td>
</tr>
</tbody>
</table>
3. Lagging feedstock analysis

To evaluate the use of indicator based forecasting, the lagging relation between commodities, in this case steel, towards its feedstock commodities is investigated. The table below reveals interesting; but not significant relations. The first value is the correlation and the second value is the lagging in number of months, where the correlation reaches its maximum.

### Monthly

<table>
<thead>
<tr>
<th>Monthly</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industrial Production Growth</td>
<td>0.58</td>
<td>0.77</td>
<td>0.66</td>
<td>0.67</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>Real Retail Sales Growth</td>
<td>0.45</td>
<td>0.79</td>
<td>0.66</td>
<td>0.59</td>
<td>0.76</td>
<td></td>
</tr>
<tr>
<td>CPI Inflation</td>
<td>0.77</td>
<td>0.44</td>
<td>0.30</td>
<td>0.43</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>WPI Inflation</td>
<td>0.85</td>
<td>0.61</td>
<td>0.46</td>
<td>0.63</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Merchandise Exports, Growth</td>
<td>0.83</td>
<td>0.75</td>
<td>0.69</td>
<td>0.78</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Merchandise Imports, Growth</td>
<td>0.82</td>
<td>0.74</td>
<td>0.66</td>
<td>0.77</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td>Money Supply, Broad</td>
<td>0.12</td>
<td>-0.33</td>
<td>-0.20</td>
<td>-0.06</td>
<td>-0.35</td>
<td></td>
</tr>
<tr>
<td>Interest Rate, Short-Term</td>
<td>0.50</td>
<td>-0.10</td>
<td>-0.06</td>
<td>0.16</td>
<td>-0.18</td>
<td></td>
</tr>
<tr>
<td>Interest Rate, Long-Term</td>
<td>0.54</td>
<td>-0.04</td>
<td>0.06</td>
<td>0.36</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Interest Rate, Money Market</td>
<td>0.54</td>
<td>-0.05</td>
<td>0.02</td>
<td>0.23</td>
<td>-0.11</td>
<td></td>
</tr>
<tr>
<td>Exchange Rate, Monthly Average</td>
<td>-0.90</td>
<td>-0.71</td>
<td>-0.71</td>
<td>-0.79</td>
<td>-0.69</td>
<td></td>
</tr>
<tr>
<td>Unemployment Rate</td>
<td>-0.55</td>
<td>-0.04</td>
<td>-0.09</td>
<td>-0.24</td>
<td>0.06</td>
<td></td>
</tr>
</tbody>
</table>

1. Aluminium
2. Copper
3. Lead
4. Nickel
5. Zinc
4. Evaluating the forecast accuracy

The analysis progressed through studying the accuracy of commodity-price forecasts performed by international banks and Swedish industrial companies, together with the accuracy of technical models. These studies revealed interesting and varying results that made us question what methods and interests that could explain the choice of not using the optimal models. These findings paved the way for our thesis “Commodity forecasts – accuracy, methods and interests”.

4.1 Mean average percentage error

The mean average percentage error is one of the more common evaluation methods when it comes to forecast accuracy, due to its simplicity and easiness to understand. MAPE is defined as:

$$\text{MAPE} = \text{Avg} \left( \text{ABS} \left( \frac{\text{Forecast} - \text{Price}}{\text{Price}} \right) \right)$$

4.2 Biases evaluation

The mean percentage forecast error reveals tendencies to over- and underestimation.
4.3 Benchmark towards Naïve forecast

This evaluation has been constructed in order to bring forward the forecast accuracy relative to the price fluctuation, by using the equation:

\[
\text{Naïve} = \text{ABS(PC)} - \text{ABS(PE)}
\]

The equation is used for calculating the absolute percentage change minus the absolute percentage error. A positive answer is indicating a larger percentage change than the percentage error, which is the case when the forecast method is better than the naïve forecast method. A negative answer responds to the opposite, when the naïve forecast is better than the benchmarked forecast method.
4.4 Benchmark towards technical forecast model

Benchmarking towards the winning algorithm in the M3 competition, Theta, reveals that technical forecasting outperforms both the industry and the average forecast accuracy of banks in MB Apex. When benchmarking towards individual performance in the MB Apex, the results reveals that Theta performs better at 1-2 quarters than 3-4 quarters.
Appendix II: Interview guide

Introduction

1. Please tell us about your position at the company and describe some of your work tasks?
2. Did you work at the company before the implementation of the currently used forecast method?
3. What were your work tasks before the implementation of current forecast method?

Setting the forecasts

4. What forecasting-method do you use?
5. Do you use indicators such as macro economical indicators?
   a. If yes, do you always use the same indicators?
   b. How do you judge the indicators future effect?
   c. Is your opinion that these indicators usually effects the forecast negatively or positively?
6. Are you a group of staff which in collaboration produces the forecast?
   a. If yes, do you all possess the same knowledge or do you also invite experts?
   b. Would you say that you generally agree on the forecast?
      i. If not, what is the most common reason?
7. Do you think your or your colleagues’ prejudices affect the forecast?
8. Do you use previous forecasts as an anchor for future projections?
   a. If not, do you use other starting points?
9. Do you intuitively estimate the probability of the forecast to be right?
10. Is it common that you afterwards are of the opinion that the forecast could have been better?
11. Do you fully understand all aspects of the method? Do you consider them to be well formulated or difficult to interpret?
12. Where does this method derive from?
13. Which sources do you use for the forecast(s) (qualitative, quantitative)
14. Does the commodity volume ever exceed the firms needed volume?
15. Is the purchase timing or volume adapted to the forecast?

Evaluating the method

16. Do you perceive the method as stable over time?
17. Do you have any goals set regarding the desired accuracy of forecasts?
   a. If so, do you consider that you have the ability to reach the desired levels of accuracy?
18. Do you find current method used to be reasonable?
19. Do you find current method used to be optimal?
20. Do you evaluate your method by comparing it to others?
Individual performance

21. Do you, as an individual, have a clear idea of how to create high accuracy forecasts?
22. Do you believe that you have sufficient knowledge?
23. Do you have any influence regarding the methods used?

Interests

24. Does the firm have internal and external forecasts?
25. What parts of the organization is using the forecast?
26. Do you personally invest in the forecasted commodities?
Appendix III: Further reading:  
Implications of human judgment on forecasting

Information analysis
Estimating the future price of commodities becomes complex as the price is a function of a large number of variables. The risk of errors increases with the number of variables. Solving a problem could be compared to laying a puzzle, with the answer becoming clearer for every added piece of information. (Gladwell, 2007) However, if you don’t know what kind of information you’re looking for, there is no way of knowing whether information added is relevant for the solution of the problem. In other words, people must be able to validate information gathered for it to be of use when laying a puzzle. (Gladwell, 2007)

An alternative way of addressing a problem is to define it as a mystery, meaning that there is no given solution to the problem. “Mysteries require judgments and the assessment of uncertainty, and the hard part is not that people have too little information but that they have too much” (Gladwell, 2007). The problem of too much information could be related to several errors that might occur when evaluating information given. In some cases people simply don’t know if they can trust the information given. In other cases, people might trust the information, but find it to be conflicting with other information that we also believe to be true. People might also have access to information that they consider trustworthy but don’t know how to put into context. (Klein, 2009)

Attempting to solve a mystery as a puzzle often becomes a confusing task as trying to reduce uncertainty with the gathering of more information might lead to increased uncertainty with the information gathered becoming more and more contradictory. When the contradiction of data gathered increases, people run the risk of trying to reduce the uncertainty by gathering further information, thus creating a vicious cycle. On the other hand, trying to solve a puzzle as a mystery might complicate the problem as there is no need to question the information given. It is therefore important to define whether the problem at hand is to be solved as a mystery or as a puzzle and solve it accordingly. (Klein, 2009)

Risk management
In order to handle our environment, the authors divide risk into three categories. These are risk as feelings, risk as analyses and risk as politics. Risk as feelings refers to instinctive and intuitive reactions while risk as analyses uses our parallel system of reason, logic and scientific deliberation to address a given situation. (Slovic, et al., 2004)

In relating to risk as feelings, the authors use what Slovic defines as the experiential system. This system explains the characteristics of risk when assessing it from an emotional point of view. In the same way, the analytic system is used for handling risk as analyses. These two systems for handling risk are illustrated in table 4:
Experiential System | Analytic System
---|---
1. Holistic | 1. Analytic
2. Affective: pleasure-pain oriented | 2. Logical: reason oriented (what is sensible)
3. Associationistic connection | 3. Logical connections
4. Behavior mediated by "vibes" from past experiences | 4. Behavior mediated by conscious appraisal of events
5. Encodes reality in concrete images, metaphors, and narrative | 5. Encodes reality in abstract symbols, words, and numbers
7. Self-evidently valid: "experiencing is believing" | 7. Requires justification via logic and evidence

| Table 4. Risk systems (Slovic, et al., 2004) |
Whether people use the experiential system or the analytic system, when relating to risk, will impact the outcome. According to Slovic, feeling positive about an activity will lead us to consider the related risk as low and the benefit as high. Activities that are associated with negative feelings will be considered as carrying high risk and low benefit. Slovic defines this phenomenon as the affect-heuristic. (Slovic, et al., 2004)

As a consequence, the affect-heuristic further implies that receiving information of benefits/risks related to a certain activity will impact the way people feel about the given activity. As previously stated, the way people feel about an activity will affect how they perceive related risk/benefit. This way, receiving information that an activity is beneficial will reduce the perceived risk and vice versa. (Slovic, et al., 2004)

Interestingly, the affect heuristic also affect the analytic system, reducing the logicality of human decision-making. This is illustrated by Denes-Raj and Epstein (1994), through an experiment showing that when given the opportunity of winning $1 by drawing a red ball from a bowl, participants chose the odds 7 out of 100 rather than 1 out of 10. Although the probability of drawing a red bowl is higher when the odds are 1 out of 10, participants overestimated the value of each added red ball. These lead participants to the non-logical decision of drawing from the bowl with the lower odds. The effect of the affect-heuristic on human logic regarding probability has been illustrated though a number of experiments, examples are Yamagishi (1997) and Hendrickx et al. (1989). One exception to this rule is when consequences carry a sharp and strong affective meaning, such as in the case of winning a lottery-jackpot or receiving a cancer-diagnosis. In this case, humans are rather indifferent to changes in probability. According to Loewenstein et al. (2001), this could be explained by the fact that humans tend to start seeing rewards as possibilities instead of probabilities when the affective reward is significant enough. This could in term explain why people spend money on lottery-tickets with a greatly negative income-outcome ratio.
Information overload

I have a theory about the human mind. A brain is a lot like a computer. It will only take so many facts, and then it will go on overload and blow up.

—Erma Bombeck

According to Klein (2009) too much information can have a negative impact on decision-making. As more information is added, the value of each new point of data is decreasing while, at the same time, the strain of sorting all the new information is increasing. Klein describes a point where additional information hinders us from solving a task. This point is referred to as the saturation-point. People would be wise to stop gathering information before reaching this point; however, the human being has a tendency to keep gathering information in order to reduce the uncertainty of the decision at hand. This leads us to gather much more information than what is optimal for a rational decision. This phenomenon is called “Information overload” and was introduced by Alvin Toffler in 1970 (Toffler, 1970).

Gladwell (2007) puts forward some examples of when too much information has led to potential drawbacks in the decision-making process. One example is the Enron scandal where the information that the company was overvalued was there but management claimed to have had no knowledge about the situation. The reason for this was that the actual financial performance of the company was hidden by mark-to-market accounting, where estimated revenues were valued incorrectly. This lead to the concealment of, intentional or non-intentional, vital information leading to the financial ruin of the company and the loss of billion dollars in employee pension-funds.

The exposure to information overload has increased exponentially during later years as a consequence of the increased pace of technological innovation. New information systems provide platforms upon which people are increasingly exposed to information. The research in the field of information overload has not followed this development. (Bell, 2000)

To handle this obstacle technical filters have been introduced, available for individuals experiencing information overload. Some examples are Xerox, who is developing a new information-filter system, and Google, trying to personalize searches. It has been argued, however, that screening of information is interfering with personal integrity as it requires storing of personal information (The Economist, 2011).
Appendix VI: Further reading:
Qualitative forecast methods

Jury of executive opinion

Jury of executive opinion is a top-down forecasting method, where the forecast is conducted by combining top executives’ views concerning future sales and then proportioned throughout the organization (Kahn, 2006; Green, 2001). The method uses a composite forecast, prepared by a number of individual experts. The experts form their own opinions, initially from the data given, and revise their opinions according to the opinions of others. Finally, the individuals’ final opinions are combined into a decision. When working in accordance with this method, experts are able to interact with each other (NASDAQ, 2014). However, research including the recent Nobel Prize winners in economics, Engel and Granger, have proven that expert’s opinions seldom produces better accuracy then the index over a long period of time (Nobel Media AB, 2014).

Sales force composite

Sales force composite is a reverse approach to the jury of executive opinion, a bottom-up technique, where lower level of forecasts from individual salespeople or sales managers are aggregated higher up in the organization (Kahn, 2006). The advantage of this method is that knowledge is generated from individuals close to the market, possessing awareness of customer expectations. Additionally, it gives the sales force greater confidence in the forecast and strengthens the motivation of goal setting. On the other hand, it often pictures a positivistic view and overconfidence in the forecast. This characterizes the mechanisms of expectations, linked to the theory of expectations, which proposes that “an individual will decide to behave or act in a certain way because they are motivated to select a specific behavior over other behaviors due to what they expect the result of that selected behavior will be” (Oliver, 1974). To handle this obstacle in sales force composite Cox has suggested five improvements; providing the salespeople with more information, providing the salespeople with enough time to forecast, providing incentives for accuracy, adjusting the salesperson’s forecast, and making organizational changes to improve accuracy. (Cox, 1989)

Survey expectations

Survey expectations, is a method using the public expectations as the basis for estimating the future. It’s used for estimating macro-economic variables, such as inflation, interest rates and exchange rates. It’s also used for estimating sales by using customer surveys (Green, 2001). As with sales force composite, this method is also linked to the theory of expectations and is widely discussed in literature, within the area of rationality of expectations (Elliott, et al., 2005) and the accuracy of expectation surveys (Nolte & Pohlmeier, 2007). Pesaran raises a couple of questions to consider when using this method (Pesaran, 2006);

- What is the nature of expectations and how do they relate to any particular loss function?
- How are expectations formed and to what extent do people learn from experience?
Naïve method

The naïve method assumes that the next period will be identical to the present. The forecast is based on the most recent observation of data (Green, 2001). Naïve models, therefore, works independent of the statistical structure of data of the time series. Naïve models has for a long time been utilized in forecast evaluation, although autoregressive benchmarks that take statistical structure into consideration have shown to be superior and less affected by biases then naïve models. (Mincer & Zarnowitz, 1969)