An insight in the under-pricing of new products by decision makers' numerical abilities.

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Abstract

For companies it is important to set adequate prices for new products in order to get high profits. According to consultants 80-90% of all new introduced products are priced too low. This thesis provides insight in under-pricing by conducting a literature analysis and by conducting an experiment. Literature indicated that prices are often set too low because managers need to make estimations in their final price decision, especially when they base their decision on value information. The conducted experiment was aimed to find relations between price-levels (based on different types of information) and estimation abilities. The results indicated that price levels, based on value information, were higher than when it was based on cost information. Also when respondents had access to both types of information, and respondents were first confronted with value information the price level was higher than when respondents were first confronted with cost information. Finally, the experiment indicated that being skilled in approximate estimation and making a price decision based on value-information yielded a higher price level. However, the experiment showed that being skilled in approximate estimation does not lead to a lower price when the price decision is based on cost information. The advice to companies is to provide managers with value information when they need to make price decisions and to train/hire managers which are skilled in approximate estimation.

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1. Introduction

1.1. Problem formulation

Pricing is a tool that is under-utilized by managers even though it is extremely important for firms. A study conducted by Hinterhuber (2004) found that a price increase of 5% will lead to an improvement of 22% of the operating profit. Therefor it is understandable that pricing is a very important tool for organizations that are pursuing profit. However, it appears that companies underestimate the importance of pricing since a study indicated that 80-90% of all new products that enter the market are priced too low(Marn et al., 2003). This under-pricing of new products seems odd because the price contributes a lot to companies' profits. Therefore it can be reasoned that, since pricing is such an important tool for companies, a lot of attention should be dedicated to pricing. Actually, this is far from the truth because a mere 15% of companies do any research on pricing(Clancy and Shulman, 1993).

Studies also indicated that the scientific community has little interest in pricing. It was found that a mere 2% of all published articles in great marketing journals covers pricing, while their main focus was on other marketing tools(Malhotra et al., 2005). Though the research that is conducted in the field of pricing, indicated a lot about pricing strategies conducted by organizations. However, little or no attention has been paid to how prices are set on the individual level such as managers or other decision makers and what they incorporate in their final price decision(Ingenbleek and van der Lans, 2013). In the end a price decision is made by individuals and eventually is adopted by the organization. Shortly, it can be reasoned that under-pricing and individual abilities of price decision makers are closely related and worthwhile to conduct research on.

This thesis provides a better understanding of under-pricing and gives useful advice to companies to counter this practice. To provide this better insight, a literature review was conducted and indicated that the model of Monroe (2003) plays a big role in the understanding of under-pricing. This model indicated that different types of information used in pricing decisions, yielded different price levels. It is logical because in reality, price decision makers also let them inform by different departments that provide different information. For example, the accounting department gives information regarding the cost of the product. While the marketing department can provide the price decision maker with value information about the product. Finally, the model of Monroe (2003) indicated that when a price is set with value information, and with the goal of making profit, the final price level is being estimated. In summary, the types of information used in the price decision, and the numerical

abilities of price decision makers could contribute to under-pricing. Taken this information into account, this thesis will perform an experiment that let price decision makers, make price decisions under different types of information and are tested on their individual numerical abilities.

1.2 Research questions

Preliminary literature indicated that different types of product information tend to influence the price levels that are set by decision makers (Ingenbleek et al., 2003). However, no research is conducted on the relation between the individual numerical abilities of decision makers and the price level. Therefore, the following research questions are formulated:

- *To what extend are product information and individual numerical abilities of managers contributing to the under-pricing of new products?*
    1. To what extent are heuristics used for setting prices by organizations?
    2. According to the literature, how can different types of information result in different price levels and how can it be measured?
    3. How can managers' individual numerical abilities influence the price level?
        a) According to the literature, which numerical abilities are there and can influence the price level?
        b) To what extent is it possible to measure the numerical abilities and its effect on price levels and how can this be analysed?

This thesis is divided in to six chapters. The first chapter that is already discussed is the introduction chapter with the research questions. The second chapter consists of the review of pricing literature and ends with a conceptual framework. The third chapter provides an explanation of the used methodology. The fourth chapter will discuss the results and test the hypotheses. In the fifth chapter conclusions will be drawn. The sixth, and last chapter, will discuss this thesis and provides insight for managers and points for further research.

2. Literature review

2.1 Pricing strategies

To start reviewing the pricing literature, it is important to know what the most important concepts are for this thesis. The first concept is the price itself and according to the financial dictionary it is the "*quantity of payment or compensation given by one party to another in return for goods or services. In more economical terms, the payment or compensation is almost always expressed in currencies (e.g. in euros). Setting prices can serve different goals for a company, for instance: increase sales to increase market share, optimize profits or deter competitors of entering the market*".

As was stated in the introduction, the literature that was published about pricing was mainly about pricing strategies and -practices of organizations. Therefore it is required to first clarify these concepts before more literature is reviewed about underpricing. Ingenbleek (2003) stated that pricing strategies of organizations serve the goal that the organization wants to achieve. For instance, if an organization wants to maximize its profit, a price strategy needs to be chosen that have a high price. It can be reasoned that pricing strategies differ per organization due to the different goals of the organizations. Pricing strategies that organizations follow can be revealed in the market by looking for instance, at the target consumer segment. So in short, pricing strategies can be seen from outside the organizations boundary (Ingenbleek et al., 2003).

The organization can pursue its goal by implementing an adequate pricing strategy, which can be seen from outside the organization. However, the price strategy only implicates, dependent on the goal of the organization, the *direction* in which the price-level is going. For instance an organization that is introducing a new product in the market and wanting to increase its market share as quick as possible, the most congruent price is a low price. When the goal is to maximize the profit, a higher price is more fitting. The next paragraph will give an overview and elaborate more on the most used pricing strategies in different situations by organizations.

2.1.1 Strategies in new product pricing situations

It is important to understand that pre-specified pricing strategies does not necessarily mean that it leads to an optimal price level. Nowadays the two dominating strategies are the *price skimming*- and *price penetration* strategy(Noble and Gruca, 1999). The first one implies that the initial price is high, and after a certain amount of time the price will gradually be lower. The latter strategy means that, when a new product enters the market, the price is low from the beginning to increase its market share and deter other possible competitors. The price penetration strategy already indicates that the price that is set is low and is not meant to make profit. Therefore it can be stated that this strategy is

less congruent with under-pricing. The price-skimming strategy on the other hand is focused to get a high profit by setting higher prices, implying that under-pricing is more likely to occur.

2.1.2 Motivation for managers to under-price new products.

If managers are responsible for setting prices, and 80-90% of the new products are under-priced, than what could be the motivation for managers to set such a price level? Apparently managers are victim of some common misconceptions, being the first that premium pricing is not compatible with an high market share(Hinterhuber, 2004). An example of this is Apple in the smart phone industry since they ask a premium price for their iPhone, while their market share is at 41.4% (Forbes). So the first misconception is the paradigm of the inability of a high market share and a premium price.

The second misconception is the fact that customers are not as sensitive to the price as currently believed. This is closely related to the first misconception, if many people buy an expensive iPhone it can be concluded that the price does not necessarily have a big influence on the purchase behavior. So other product attributes are more important to customers. A previous study conducted by (Avila et al., 1994) even showed that the price is considered the *least* important aspect to customers, while managers and sale representatives consider this as important. Currently managers rather not increase their price or set the initial price too high mainly due their fear to deter and alienate (potential) customers. Though in the article of (Marn and Rosiello, 1992) it is stated that a company operating in the manufacturing business increased their price with 3% leading to an increase of the operating profit by 35%. Also it was compared that if the manufacturing company improved its price, variable cost, volume and fixed cost with 1% the operating profits would increase to 11,1%, 7,8%, 3,3% and 2,3% respectively. Furthermore it was stated that this does not only count for the manufacturing industry but also for the consumer packaged goods, energy and banking and financial services. Once again this underpins the lack of understanding of the importance of pricing.

2.2 Pricing practices and under-pricing

2.2.1 Pricing practices

Section 2.1.1 gave an overview of the most common pricing strategies that are adopted by organizations. However, it was said that pricing strategies give the direction of the price level. Though, the specific price level is not set with pricing strategies but with pricing practices. Pricing practices are the sets of activities that are executed by managers in order to come to an price decision(Ingenbleek et al., 2003). Naturally, it can be reasoned that managers adopt their price decision based on the price strategy of the organization. However, setting prices in the organizational

context is very complex (Oxenfeldt, 1973). According to Oxenfeldt (1973), a lot of pricing decisions of new products are made on an intuition or are based on routine procedures, so called heuristics in pricing. However, this approach of making pricing decisions is declining but still many price decision makers are using these practices. This is extra underpinned by (Carson, 1993) who also stated that managers sometimes base their prices on hunches. Nowadays the most used pricing practices are based on heuristics, such as cost-plus pricing. Table 1 will provide the most common pricing practices used by managers.

From Table 1 can be seen that pricing practices are all based on different types of information (e.g. value information and cost information). Since managers are the individuals' that are responsible for setting the price, they have to process the product information and eventually come with a price decision. If a lot of new products are under-priced by managers and the type of information is essential in the decision process of managers, it can be reasoned that information has an effect on the price-level. This was also found by Monroe (2003) who created a price discretion model that will be discussed in the next section.

Table 1 Summary of pricing practices

Price practice	Definition
Cost-plus pricing	*A pricing practice that let the price be determined by adding a percentage of mark-up to the cost price of the product.*
Value-based pricing	*A pricing practice that determines the price based on the value of the product that is perceived by customers.*
Competition-based pricing	*A pricing practice that determines the price based on the perception of the value that competitors offer.*

2.3 Monroe's price discretion model

The previous sections indicated that managers use different types of information in their price decision making. Therefor the price discretion model of Monroe(Monroe, 2003) is used as a red line to clarify the effect of the used information on the price. The model (Figure1) shows that the price floor is set by the variable costs of the product (cost information). While the price ceiling consists of

the perceived added value (value information) that the product delivers in the eyes of the consumer. Mostly, the final price is set between the price floor and the price ceiling. However, in reality it is far more complex since other factors also influence the price floor and ceiling. The competition for instance can reduce the price ceiling, while the organizations objective to earn back the cost for the R&D of the new product can drive up the price floor. Taken these factors into consideration, it can be reasoned that coming to a final price decision is rather complex.

In the Model of Monroe (1990) can be seen that managers set a price ceiling based on value information. With the value information being processed by managers in what they think the product is worth to the consumer. This value is often determined by the perceived trade-off between price and quality(Zeithaml, 1988).

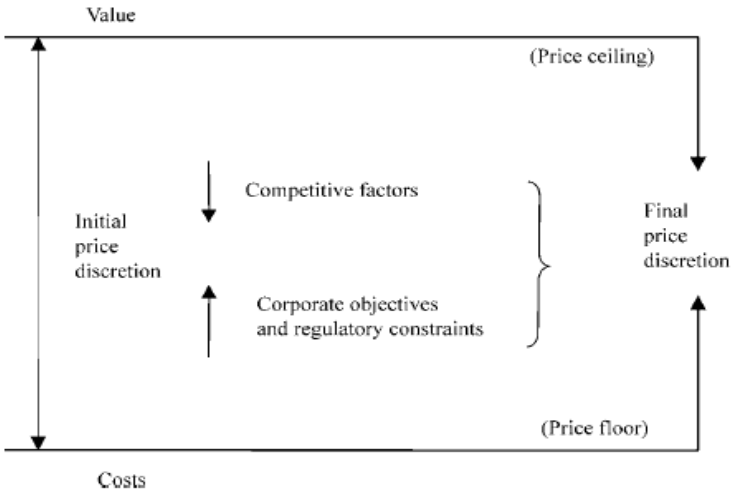

Figure 1 Monroe's price discretion model

Thus value information can be expressed in different ways. For instance, the increased life-span of the product, the cost-savings of the product or the increased productivity(McMahon-Beattie, 2002). However, this value information cannot all be quantified and calculated into a final price. Therefore, the value that is hard or not possible to quantify seems to be possibly resulting in different price ceilings what can result in under-pricing. Since the value is transferred into a price by managers and it is hard to quantify value information, it is evident that the final price is being estimated by managers. This implies that the estimation abilities of managers can also contribute to under-pricing.

To summarize this chapter, on one side the types of information influence the price levels. While on the other hand we have the estimation abilities of managers that contribute to under-pricing. Therefore the next section will discuss literature about numerical cognition and its relation to price decisions made by managers.

2.4 Numerical cognition and insight

It is important to know what numerical cognition is and how numerical insight is measured. Numerical cognition is a sub-stream in the literature that is based on the cognitive science. With the cognitive science divided into specific sub-disciplines such as: neuroscience, cognitive linguistics, and cognitive psychology. Particularly, which is relevant for this thesis is the development and processing of numbers and mathematics by decision makers (humans). The way numbers are processed is subjected to many different aspects e.g. distance between numbers, the size of numbers, the representativeness of the numbers. Multiple studies are conducted on this field of research, for example on the response times and the estimated numerosities (GinsburgIT, 1991, Piazza et al., 2002). Though the numerical cognition literature for this thesis is more specified on the approximate estimation of individuals, since the model of Monroe indicated that it had something to do with under-pricing. However, the focus will not only be on the approximate estimation literature but also on the arithmetic abilities of managers (e.g. division, multiplication, subtraction abilities) (Imbo and Vandierendonck, 2008). This sub-stream is also taken into account because managers also need to make calculations to come to their price decision. The next step is to relate pricing practices, specifically the price floor and -ceiling of the price discretion model of Monroe, with the approximate estimation and arithmetic' literature. The literature will provide insight in how people in general, process estimates and compute different numerosities.

2.4.1 Approximate estimation

What exactly is approximate estimation and how is it possible to measure this in individuals? Approximate estimation is defined by (Lemaire and Lecacheur, 2007) as finding the approximate number of elements in sets of items (e.g. the number of black dots in an area). The literature indicates that there is a difference between the set of number of items that needs to be compared or estimated. When the set contains up to 3-4 items and needs to be compared it's called subitizing, though some studies indicated that the number of items can be up to 6 to be still called subitizing(Mandler and Shebo, 1982).

2.4.2 Overview studies on approximate estimation

There have been a lot of studies that focused on the estimation process and it is shown that it can be measured in multiple ways. Though which way to measure the approximate estimation abilities differs per research goal. Therefore a review will be made on previous studies conducted on the approximate estimation process. Finally a decision will be made to use one of the experiments that were used in previous studies for this thesis. In the literature about estimation there is a difference in estimating numerosities (subitizing) and larger numerosities. The estimation experiment of the large

set of numerosities has been conducted in multiple ways. The first being the experiment in which two sets of items needed to be compared by competitors and finally asked which set was bigger(Dehaene et al., 1998). Another experiment was that participants needed to estimate, as quickly as possible, the number of black dots in a computer screen(Lemaire and Lecacheur, 2007). Other experiments measured the estimation of different geometrical shapes with different colours. The experiment that is used for this thesis will be discussed in the methods chapter. The review of the literature in this chapter has been processed in the conceptual framework which can be found in section 2.5.

2.5 Conceptual framework

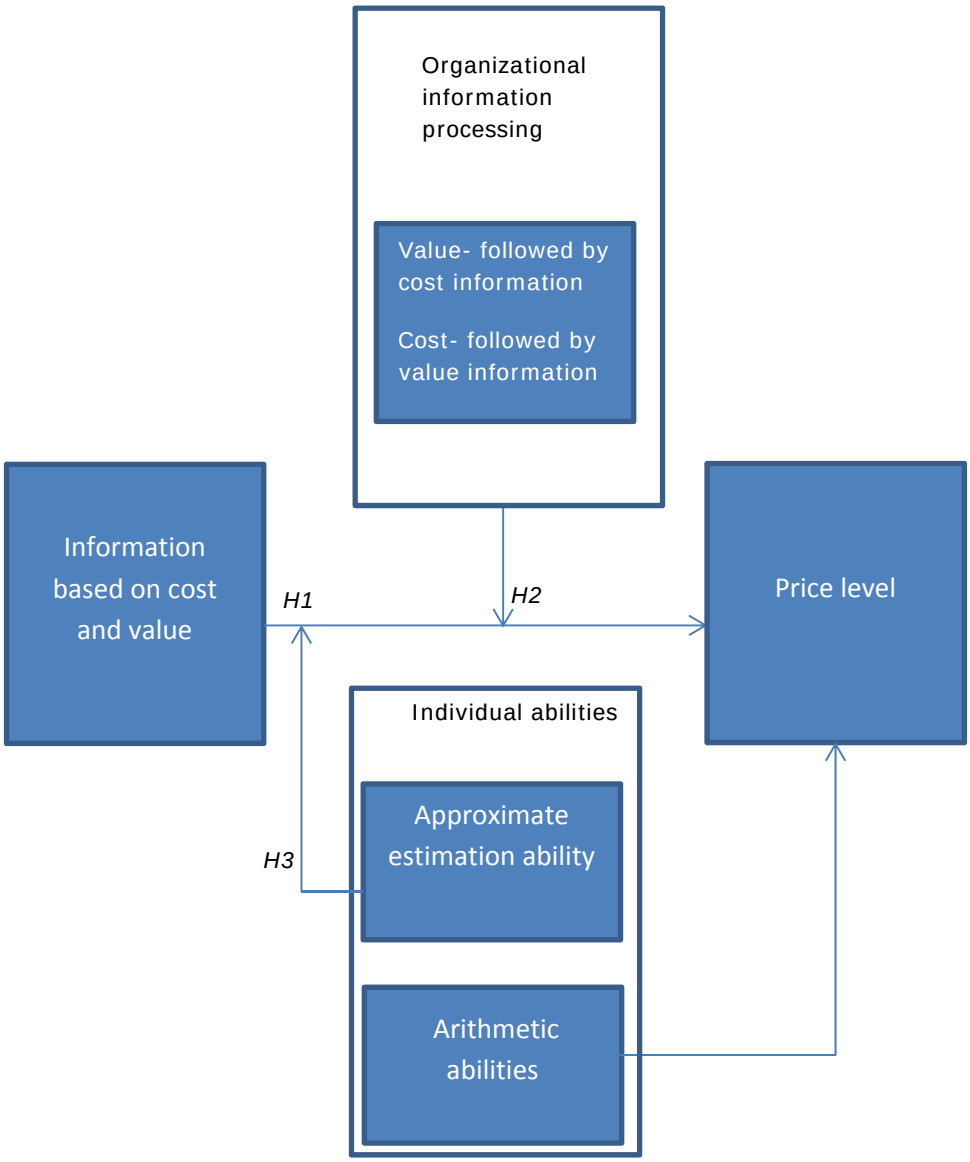

Figure 2 Conceptual framework

The conceptual framework has been established by using pricing and numerical cognition literature. While the pricing literature reflects on the value-, cost information and the price level. The individual measures box consists of the approximate estimation ability and the computation abilities of price decision makers. It shows how value- and cost information together with individual capabilities influences the price level.

Price level

The price level is influenced by the different factors.

2.5.1 Information

The stream of value- and cost information is of great importance because they are used in the pricing decision for new products. As was shown in the model of Monroe (1990), price decisions based on cost information will lead to a price floor, while a price decision based on value information will lead to the price ceiling. Therefore we can formulate the following hypothesis:

H1: When price decision makers make price decisions based on cost information the price level that will be set is lower than when managers make price decisions based on value information.

2.5.2 Organizational information processing

The organizational information processing box states the importance of the sequence in which the information is exposed to the price-decision makers. In reality, managers are asking for information to different business departments about the product information with the intent to help them set a price. For instance, the accounting department communicates the information about the cost(Anderson and Simester, 2003), while the marketing department tries to show the value for the consumers of the product (Pauwels et al., 2004). So the sequence in which the organization communicates information to its managers leads to the following hypothesis:

H2: When price decision makers use both types of information in their price decision and start with value- followed by cost information, the price that will be set will be higher than when they start with cost- followed by value information.

2.5.3 Individual abilities

The stream of information is under influence by individual factors such as the ability to correctly estimate quantities and the ability to be good at solving mathematical problems. The reason why the stream of information can be influenced by the individual capabilities is due the fact that managers rely on hunches in decision making processes such as price setting(Scarborough and Zimmerer,

1984). This implies that the same information can be processed very differently be managers due to their personal abilities in calculation and estimation.

Since prices are set by managers, it is understandable that their personal abilities in arithmetic's and estimation are also reflected in the final price. For instance, when managers have to estimate their price decision, it is understandable that the price level can vary between managers. The arithmetic abilities also differ between managers. Therefore the factors, approximate estimation and arithmetic's are displayed in the conceptual framework and have influence on the price level. However, the literature only indicated that approximate estimation could influence the price and therefore the arithmetic abilities were added as a control variable to make sure that there are no other numerical abilities influencing the price level. This resulted in the following hypothesis:

H3: The relation between information (cost and value) and the price level will be stronger when managers are skilled in approximate estimation.

3. Methods

3.1 General overview study

In order to look at price levels and under-pricing, this experiment will let participants make price decisions under different kind of manipulations. These manipulations are in the sense that participants need to make price-decisions based on different sets of information which are presented in a different sequence. The participants are asked to make a scenario in which a new engine has to enter the market but the price must yet be determined. A Table was created to provide a clear overview of the groups by tasks and type of information. This resulted in Table 2 and shows the different groups of respondents that are subjected to the tasks and the type of information. The price scenario is the first step that the respondents have to take, followed by the approximate estimation and arithmetic tasks. Since the final goal is to understand how price-levels are determined, the dependent variable is the final product of the scenario, meaning that it is the question to the participants about what the price should be of the new product.

Table 2 Groups of respondents

Groups	Scenario	Tasks
Group 1	Value	Approximate estimation/ arithmetic
Group 2	Cost-information	Approximate estimation/ arithmetic
Group 3	Integrated Value- and cost information	Approximate estimation/ arithmetic
Group 4	Integrated Cost and Value information	Approximate estimation/ arithmetic

Group **one** starts with the price scenario that is based on value information. Subsequently participants need to make approximate estimation and arithmetic tasks. Group **two** starts with the price scenario based on cost information followed by the approximate estimation and arithmetic tasks. Group **three** starts with the price scenario based on value and cost information followed by the approximate estimation and arithmetic tasks. Group **four** starts with the price scenario based on cost and value information followed by the approximate estimation and arithmetic tasks. Group three and four have access to both types of information, but the sequence in which it is presented is different. The results of the dependent variable will be processed and compared in order to come to conclusions. There will also be looked at the interrelation between multiple aspects such as the individual skill in either computation or estimation and the sequence in which information about value and cost is processed. Finally, the results will try to reflect in which manner the highest or lowest prices will be established. A more elaborated explanation will be discussed further on.

3.2 Scenario

In order to find out how participants set price levels based on value information, it is first important to exactly know what the definition of value is. According to (Anderson and Simester, 2003), the definition of value in business markets is: *"The worth in monetary terms of economic, technical, service and social benefits a customer firm receives in exchange for the price it pays for a product*

offering, taking into consideration competing suppliers' offering and prices". From this point onward it is understandable that a change in value in business markets can express itself in different ways. The first way of a change in value can be changed by offering a product that has the same functionality and performance as the previous product, while the cost to use it changes for the customer. The second way is that the functionality or the performance of the product changes while the cost to use the product stays the same. According to (Anderson and Narus, 1998) and (Anderson and Narus, 1999) the difference between value and price is considered as a customer incentive to purchase. Implying that the reduction in the price of a products' offering does not change the value of the product, but only the intention of the customer to buy the product. Thus it also counts the other way around, meaning that the value can change while the price stays exactly the same. These are all implications for the context of the scenario in which participants need to make the price decision.

The definition of value stated that the value is expressed in monetary terms of economic, technical, service and social benefits, and the consideration of competing suppliers' and prices. From this perspective it is already possible to implement this in the scenario of this current thesis, in the sense that it must present a current initial offering and an offering from the competitor.

To avoid an order effect, the groups in which the information was presented was divided and switched up. This measure was derived from a previous study by(Anderson et al., 2000). They measured the change in value with respect to the price by making use of a scenario. They came up with a potential problem implying the sequence in which the information was presented to the respondents and thus came up with the measure. Though for this scenario it is important to keep in mind the ambiguity of value, if a reduction in production cost is presented, the decision based on value will be compromised. Thus therefore the decision is made to, in the scenario with value information, not to decrease the cost price but increase the value. With the scenario based on cost information the decision is made to change the cost.

General explanation scenario based on value information

the introduction of the scenario is presented in such a way that the participants are seeing themselves as a general manager of a firm that supplies engines to another manufacturing firm. In other words it is clear for them that they are operating in a Business-to-business market. Furthermore, the context and the state in which the firm currently operates are explained. For instance it is told that the company is losing market share due to a lack in innovation for the past five years. The scenario finally presents the fact that a new engine is developed and the participants need to give a price for it. It is also explained how the new engine provides better value than that of the

competitors'. In the scenario the price of the competitors' engine is also presented which serves as a reference price. The main reason to give an reference price is due the fact that prices in engines can vary greatly, implying that the answers will be corrupt and worthless to use to test the hypotheses. The reduction in operating cost serves as the value information for the participants, because the value for the manufacturing company increases through the purchase of the new engine.

General explanation scenario based on cost information

Just like the scenario based on value-information, the scenario based on cost-information will also be presented in such way that the participants are empathizing themselves as general managers. A lot of elements will remain the same, though the main differences will be the replacement of the value information for the cost information. The scenario states that the cost to produce the new engine will be lower than the engine of the competitor. The distribution of these costs are chosen to be perceived as the most realistic by dividing them into variable- and fixed cost. The establishment of fixed cost are explained by stating that the cost to produce the engines is a total of €3.000.000 divided by the total amount of units produced each year.

3.3 Protocol

Students are asked whether they want to participate in this study and will receive an explanation of the goal of this study. When the students indicated that they are willing to participate in the study, they are asked to, dependent on which group they are in, make the price scenario followed by the approximate estimation and arithmetic tasks. When participants are willing to participate in the experiment they will receive a link to the Qualtrics survey that contains the tasks and the scenario'(s). The participants are first confronted with the price scenario and are allowed to use a pen, paper and calculator. When the participants are finished with the approximate estimation tasks they will receive final instructions of the approximate estimation tasks which say that they should try to estimate and not calculate the number of black dots. This also includes that the participants should put away their calculator and pen and paper. In the Qualtrics software, ten different approximate estimation tasks with different numbers of black dots will be presented in a cloud form in a sequential fashion. The last set of tasks are the arithmetic tasks and in total 12 arithmetic tasks have to be solved, with two complex tasks in addition-, subtraction-, dividing- and multiplication category and one easy task of each category.

3.4 Sample

The data for this study will be obtained from students of the university. First of all it is important to question whether students are representative for real managers in managerial decision making and thus whether the results are generalizable. Previous studies pointed out that the use of students

instead of real managers should be conducted very careful, especially coming to generalizable conclusions (Khera and Benson, 1970). Whether the findings of the experiment can be generalized is also called external validity (McDermott, 2011).

Another important aspect to consider is the distinction between managerial decision making and managerial attitudes of the students. The latter concept is often found very different from real situations, since students do mostly not have a lot of experience in real business situations and therefore behave different from real managers (Remus, 1986). In the article of (Remus, 1996) a difference is found between the results in the substitution of managers with undergraduate- and graduate students in the sense of making costly decisions and less-costly decision, respectively. This result is mostly derived from the fact that undergraduate students lack experience more than graduate students. Though in this current experiment it does not matter, since there will be looked whether the individual abilities of the respondents are influencing the dependent variable. The remaining question here is why there are no real managers used in this experiment, since it will reflect the reality more accurately. An argument for this is the time limit of this research together with the fact that the requested behavioural information is quite sensitive. Naturally, it is understandable that managers do not like their pricing process to be scrutinized. Participants are 60 individuals consisting of young adults, both male and female, between the ages of 18-26 years. The students will be addressed face-to-face. As soon as students are willing to comply with this research they receive the link with price scenario and the tasks based on arithmetic's or approximate estimation.

3.5 Measurement

Dependent variable

The dependent variable will be determined by asking the respondents, after they did the scenario, what they think the price should be of the new product.

Approximate estimation tasks

Since this thesis focuses on the relation between price levels and numerical cognitive abilities (e.g. arithmetic's and estimation), this paragraph will be about the relation between approximate estimation tasks and the price level and how approximate estimation abilities can be measured and used for this experiment. The article of Lemaire and Lecacheur (2007) used an experiment with the goal to check whether adults have different performances in approximate numerosity tasks and to determine whether memory representations for numerosities vary with age in adults. After reviewing different experiments on approximate estimation, the experiment of Lemaire and

Lecacheur (2007) seems to be the most used method to provide insight in approximate estimation abilities and how to measure them (Gandini et al., 2008, Price et al., 2014). Therefore the experiment of Lemaire and Lecacheur will be used for this thesis.

Lemaire and Lecacheur asked participants to give an approximate estimation of a number of black dots varying between 40 and 460. The tasks consist of exposing participants to stimuli in the form of black dots displayed in a white square on a computer. For the thesis the task will also be presented on a computer in a survey program called Qualtrics. Each participant is asked to solve ten approximate estimation problems. Each problem was preceded with a blank screen for 1000 milliseconds then followed by a fixation point which lasted for 750 milliseconds. After that the pattern of dots was displayed for 6000 milliseconds. However these six seconds seems a lot, and therefore it can be reasoned that it provides participants enough time to count the stimuli (when the array is small). Therefore, it still is imperative to emphasise to the respondents that they need to assess, not count the array, as quick as possible. This results will be processed in a formula derived from (Lemaire and Lecacheur, 2007) which goes as following:

$$1 - \left(\frac{\boldsymbol{Estimated\ Numerosity - Correct\ Numerosity}}{\boldsymbol{Correct\ Numerosity}}\right) * \mathbf{100\%}$$

Figure 3 Formula for % of correctness of the estimation tasks

Lemaire and Lecacheur (2007) used the formula in his article to show the percentage of errors in approximate estimation between the young and old participants. For this thesis however, it is more convenient to measure the percentage of average correct answers. The formula shows the percentage of the correct estimation that the participants make. For instance, imagine that a participant estimate the number of dots at 23, though the exact number of dots are 25. The percentage of correct estimation than is: $1-(\frac{23-25}{25}) * 100 = 92\%$ .This formula is applicable to this study since the individual abilities of the participants are tested regarding approximate estimation. Differences in the abilities of the participants should be monitored very closely in order to get the most accurate results. Therefore the formula is very useful since it measures errors accurate on the percentage.

Other literature on approximate estimation used different kind of experiments to measure effects. Though, these experiments were not able to give accuracy of individuals, and thus were not chosen to use for this thesis' experiment. For instance, some experiments let individuals compare two

different magnitudes of intermixed dots(DeWind and Brannon, 2012) or other geographical shapes(Iuculano et al., 2008). It is possible that participants are able to correctly assess which magnitude is bigger, though it is still not as accurate as the method used in the article of Lemaire and Lecacheur (2007).

There are two advantages concerning this formula and therefore applicable to this thesis. First, it is less time consuming to use this method instead of letting participants estimate two different sets of dots. Second, this method overcomes the problems of distance effect and the measurement of accuracy. The distance effect can be noticed when the participants are first shown a square with a number of dots. Subsequently, they have to assess two similar situations but then with a different number of dots. Though this method seems effective but it does not give the accurate answers that this research is looking for, in the sense of that the participants only have to say which of the two new situations are closer to the first. Another argument against the distance effect is that people in general are better in distinguishing the difference between two situations as soon as the distance becomes bigger. Though, in this experiment the participants are considered to be more intelligent than the average person. Therefore, results will not be sufficient to distinguish their personal skills. The accuracy is measured with ease due to the formula and gives the right overview of which of the participants is skilled in making estimations.

Arithmetic calculation tasks

This thesis was ought to provide insight in the relation between individual numerical abilities of managers and price levels. In order to find this relation, participants are asked to make different arithmetical mental tasks. Before the tasks are further explained it is important to know what arithmetic is. Arithmetic is the oldest aspect of math and consists of addition, subtraction, multiplication, division and decimals. The main focus for this thesis is a narrowed section of arithmetic and contains addition-, subtraction-, multiplication- and division tasks. The reason for the focus on arithmetic and these aspects are due the fact that they are used in the most leading numerical literature that can be used for the experiment that is conducted in this thesis. However, it is important to know that in the literature, multiple variances in arithmetic tasks are used. For instance, the tasks that participants need to make are simple and used on children, which do not have fully developed arithmetic abilities, and adults which were not trained in arithmetic's (Barth et al., 2006). Simple arithmetic tasks are classified in multiple experiments for addition and multiplication as both operands having one digit (e.g. 5x4), with an exception of the integers 0 and 1 and tie-problems (Imbo and Vandierendonck, 2008). Simple subtraction and division arithmetic tasks having the first operands consisting of two digits and the second operand having one digit (e.g. 81/3)

(Imbo, 2007). Complex arithmetic abilities are based on two operands, consisting both of two digits for addition and multiplication (e.g. 84+63 and 13x 68), and requires more cognitive processes to solve (Geary, 1994, Geary and Widaman, 1987).

There are also distinction between the arithmetic tasks for instance there are **1)** production tasks which requires exact answers (e.g. 5x 8 = 40) **2)** and verification task which ask the participants whether the answer is correct or false (e.g. 5 x 8 =30 True/false?). The verification tasks are not adequate to the experiment of this thesis due to three reasons. The first reason is that participants confronted with the verification task are more eager to make estimations of the estimation instead of actually calculating the answer. This reflects back to a comparison of magnitude, which helps to come to an answer. For instance when confronted with 4 x 9 = 78, it is possible that participants do not even start with calculating (Ashcraft and Stazyk, 1981). The second argument is that participants can use odd-even rules in order to check whether the given answer is correct(Krueger, 1986, Lemaire and Fayol, 1995). The last argument is that, when the correct answer to the sum is presented, it can trigger a direct retrieval process (Campbell, 1987) which makes the task less useful for this thesis.

From the information above it can be seen that the arithmetic tasks that respondents are given are production tasks. These production tasks are more appropriate to the respondents of this thesis, because the respondents are university students and imply that they have an average higher education. Also when taking the research objective in to account it can be stated that production task are the most suitable because there are more cognitive processes involved(Geary, 1994, Geary and Widaman, 1987). To get a better overview of the abilities of the respondents, in compliance with their education, they are given complex arithmetic tasks. Note that the these task needed to be made mentally because if they have pen and paper to write answers down, it is likely that participants skip the storing of the answer in short-term memory, thus implying the involvement of less cognitive processes. The cognitive processes involved in complex arithmetic tasks, often involves first the problem breakdown followed by fact retrieval, storage of the answer and the following actions (Geary, 1994, Geary and Widaman, 1987). The specification of a complex arithmetic task with respect to addition and multiplication is already discussed, though it has not been done for subtraction and division therefore other experiments are consulted. For complex subtraction the study of (Geary et al., 1993) let participants do tasks that consisted of the first operand with two digits, while the second operands consist of one digit (e.g. 83-9). The study of (Lemaire and Arnaud, 2008), which is published more recently, also gives an example of a complex subtraction task as 32-7. Complex division tasks are discussed in the article of (Kurovski, 2012) and states that in complex divisions the first operand should consist of three or more digits, while the second operand should have one digit (e.g. 1326/4).

At the start of the arithmetic tasks, participants needed to solve 4 simple practice tasks that consisted of the four categories (addition, subtraction, multiplication and division). The reason for this is due the fact that participants then are already a little familiarized with the tasks e.g. how the task is displayed, the procedure etc.(De Rammelaere et al., 1999).The tasks are programmed in a survey using Qualtrics, implying that participants needed to make the tasks at a computer. Participants were first introduced with a slide that explained the purpose of the experiment and the things that were (not) expected of them. For instance, they were asked to make the task as fast as possible without calculator. The tasks were presented one at a time and were presented when participants pressed the space bar. Though, the task was not directly presented, first a fixation point in the form of an exclamation mark was presented for 500 milliseconds. The reason is to extra alert the participants that the task is beginning.

3.6 Pre-test

Before the start of the real interviews there will first be conducted a pre-test. The main reason for this is due to mistakes that are not foreseen or unclear instructions. Therefore, participants of the pilot study are asked, just like regular participants, to do the measures and scenario. Though the difference is that they should think out loud in order to find out what is unclear to the participants and thus improving the experiment. Around five to ten people are used for the pilot study, though it is not a strict number since it is dependable on the result of how well the experiment is structured. When enough respondents are addressed in the pre-test, the main feedback of them will be processed in to the final experiment. The application of the pre-test prevents the gathering of corrupt data which can be caused by the inability of the respondents to comprehend what is asked of them.

3.6.1 Results Pre-test

Scenario

In the pre-test of the scenario's it came forth that the scenario those participants needed to read was perceived as long. The perceived long scenario mainly consisted of the context of the company, in order the emphasize the empathy in the respondents. However, now it was perceived as "long" which resulted in the "scanning" of the scenario and leaded to the not including essential data in their price decision. Therefore the decision was made to reduce the empathic aspect of the scenario in order to encourage the participants to carefully read the scenario. When the alterations were made, the expectation was that the essential information was taken into account. However this was still not the case and therefore the decision was made to extra emphasize the important information by underline the information.

Approximate estimation tasks

Initially the tasks were designed in such a way that the black dots were stacked at the side of the screen. From that point onward, participants needed to make an assessment of how many dots there were. When the approximate estimation tasks were done by the participants, they were asked to give feedback in how they estimated the number of dots. In some cases it came forth that participants unintentionally tried to calculate the number of black dots. The possibility existed that the reason for this "calculative behaviour" was due to the stacked presentation of the stimuli. Therefore, after reconsideration, it was decided to present the stimuli in the shape of a cloud.

Arithmetic task

The first arithmetic tasks were developed without using a clear format on how complex tasks actually should be. It resulted in that arithmetic tasks were too difficult for the participants; this was reflected back in the number of errors. Therefore the tasks were made easier, and were based on existing literature that also conducted experiments on arithmetic tasks. These tasks seemed to be easier than the original tasks, due to better results.

4. Results

4.1 General results

The means, standard deviation, minimum and maximum of the prices set by respondents of different groups are used to provide a general overview and were generated by comparing the means of the groups and are shown in Table 3. The results are also graphically presented in a box-plot which can be found back in Appendix C.1. This result is generated by comparing the means with the price as the dependent variable and the groups as the factor, ($F(3, 56) = 7.916$, $p < .001$, $\eta^2 = .298$) and show that there is a significant difference in the prices between the groups. Other results serving as covariates (approximate estimation, arithmetic abilities, number of courses and years of attending the university) are also presented in tables below to provide a clear overview of the sample.

Table 3 Price means, standard deviations, maximum and minimum for all groups.

Groups	Type of information	Mean	SD	Max.	Min.
Group 1	Value	*9579.67*	*1719.88*	*12000*	6575
Group 2	Cost	*6839.93*	*2076.67*	*10000*	2000
Group 3	Value & Cost	*10951.33*	*3300.61*	*17325*	7500
Group 4	Cost & Value	*8999.87*	*2000.57*	*14000*	5000
Total		9092.79	2737.13	17325	2000

* Numbers are in euros

The approximate estimation abilities of the sample are presented below in Table 4. It can be seen that the groups do not differ greatly in their percentage of correctness. Both group 1 (cost information) and 3 (value- and cost information) have an average percentage of correctness of the approximate estimation tasks of 63%, while the lowest percentage is that of group 1(value) with a score of 56%. The average percentage of the correct approximate estimation tasks of all the groups is 61%. By comparing the means of the groups, ($F(3, 56) = .382$, $p = .766$, $\eta^2 = .020$) it can be seen that there are no significant differences in approximate estimation skills between the groups. The reliability of the approximate estimation tasks is measured using Cronbach's Alpha test and showed that all approximate estimation tasks were reliable. The Cronbach's scores were all around $\alpha = .813$, which can be found back in Table 5 below. The fourth and tenth task were also removed, in order to test the reliability of the rest of the tasks. However, this resulted in no significant differences.

Table 4 Approximate estimation abilities per group

Groups	Information	Mean*	SD	Min.	Max.
Group 1	Value	.56	.23	.000	.80
Group 2	Cost	.63	.21	.000	.84
Group 3	Value & Cost	.63	.19	.000	.87
Group 4	Cost & Value	.60	.20	.010	.80
Total		.61	.21	.000	.87

*All number are expressed in % of correctness

Table 5 Cronbach's Alpha scores

Tasks	Cronbach's Alpha if item is deleted
Task 1	.812
Task 2	.804
Task 3	.785
Task 4	.828
Task 5	.789
Task 6	.772
Task 7	.767
Task 8	.792
Task 9	.781
Task 10	.882
Total	.813

The sample was also tested in their arithmetic abilities, from which the results can be found below in Table 6. Group 3 with the highest performance (value- and cost information) has a mean of 96% correct answers of the arithmetic tasks, while group 2(cost information) and group 4 (cost- and value information) both have the lowest performance of 89% correct answers. By comparing the groups, ($F(3, 56) = 1.751$, $p = .167$, $\eta^2 = .086$) it can be seen that there are no significant difference of arithmetic abilities of the groups.

Table 6 Arithmetic abilities per group

Groups	Information	Mean*	SD	Min.	Max.
Group 1	Value	.90	.11	.583	1
Group 2	Cost	.89	.09	.750	1
Group 3	Value & Cost	.96	.05	.833	1
Group 4	Cost & Value	.89	.09	.677	1
Total		.91	.09	.583	1

*All number are expressed in % of correctness

During the survey, the sample had to give the number of mathematical courses that they attended in the university. From Table 7 it can be seen that group 3 (value- and cost information) had the highest average of 5 courses per respondent, while the first group (value information) had the lowest average of courses per respondent which was 4.3. A mean comparison of the groups, ($F(3, 56) = .244$, $p = .865$, $\eta^2 = .013$) indicated that that there was no significant difference in the attended courses between the groups.

Table 7 Followed mathematical courses per group

Groups	Information	Mean*	SD	Min.	Max.
Group 1	Value	4.33	1.79	2	8
Group 2	Cost	4.6	2.09	2	8
Group 3	Value & Cost	5	2.07	2	8
Group 4	Cost & Value	4.5	2.53	1	9
Total		4.6	2.10	1	9

*All number are expressed in number of mathematical courses attended

Table 8 shows the average year of attending the university per group. The third group (value- and cost information) clearly stands out from the other groups with an average respondent having attended the university for 4.8, while for the other groups it fluctuated between 3.1 and 3.7. A mean comparison analysis indicated that there was a significant difference between the groups in years of attending the university ($F(3, 56) = 3.042$, $p = .036$, $\eta^2 = .140$. Tukeys' post hoc procedure indicated that the third group was indeed significantly different from the first group (value group).

Table 8 Year attending the university

Groups	Information	Mean*	SD	Min.	Max.
Group 1	Value	3.1	1.87	1	6
Group 2	Cost	3.4	1.64	1	7
Group 3	Value & Cost	4.8	1.47	2	6
Group 4	Cost & Value	3.7	1.68	1	6
Total		3.7	1.76	1	7

*All number are expressed in years of attending the university

In order to test a hypothesis, an analysis of covariance (ANCOVA) was conducted because the data set contained two factors, three covariates and a dependent variable. The two factors were primary information (value- or cost information) and secondary information (additional value- or cost information). The three covariates were the approximate estimation abilities, arithmetic abilities, the year of attending the university. The dependent variable was the price. The choice to make use of an analysis of covariance was made because the literature indicated that the dependent variable (price) was influenced by the type of information (cost or value), but possibly also by numerical abilities of decision makers and therefore the approximate estimation skills and arithmetic abilities were added as a covariate. The other covariate, year of attending the university was also included in the analysis so that it can be in- or excluded as reason for a significant difference in price and Table 8 already showed that it was not equal per group. Eventually, it was chosen to not include the number of mathematical courses as a covariate in the model because it was not important in the literature, it also did not come back in the hypotheses and the effect size was low. The analysis yielded Table 9, which will be further discussed when the hypotheses are tested.

4.2 Hypothesis testing and other results

*The **first** hypothesis postulated that when price decision makers make price decisions based only on value information the price that will be set will be higher than when they set a price based only on cost information*. From Table 3 it can already be seen that group 1(value information) set an average price of €9579.67, while the second group (cost information) set an average price of €6839.93 for the new product. From these numbers can already be seen that price decisions based on value information yields a higher price than a price decision based on cost information. However, to statistically prove whether the difference between group 1 and 2 are significant, an independent samples t-test is conducted. It can be concluded that there was a significant difference in the price for group 1(M=9579.67, SD= 1719.88) and group 2(M=6839.93, SD=2076.67) conditions; t (28) =3, 94,

p< .001. These results indicate that price decision maker set higher prices when only using value information than only using cost information and thus H1 is confirmed.

*The **second** hypothesis stated that when price decision makers use both types of information in their price decision and start with value- followed by cost information, the price that will be set will be higher than when they start with cost- followed by value information.* When looking at Table 3 it can be seen that the prices set by group 3 (value and cost information) and group 4 (cost and value information) are €10951.33 and €8999.87, respectively. To test whether this difference is significant, another independent samples t-test was conducted on group 3 and group 4. It can be concluded that there was a significant difference in the price for group 3(M=10951.33, SD= 3300.61) and group 4(M=8999.87, SD=2001.57) conditions; t (23.07) =1.96, p=.031). These results indicate that the sequence in which information is presented to price decision makers does have an influence on the price level. When managers are first confronted with value information and then confronted with cost information, the price that will be set will be higher than when the sequence is reversed, thus implying that the second hypothesis is confirmed.

The **third** hypothesis postulated *that the relation between information (cost and value) and the price level will be stronger when price decision makers are skilled in approximate estimation*. In Table 9 the interaction effects of the covariates and the factors are presented. It can be seen that the covariate approximate estimation does not directly have an influence on the price level F (1, 59) =.597, p = .443. The interaction effect between approximate estimation ability and the primary factor also does not have an effect on the price level F (1, 59) = 3.974, p=0.051. However, the P-level shows that the effect is indicative. This implies that when managers are confronted with value- or cost information and are skilled in approximate estimation, it will result in a significant different price. Table 4 presents the approximate estimation abilities per group of respondents. However, it remains unclear whether the indicative effect of approximate estimation on the information results in to a higher or lower price level. Therefore a Pearson's correlation test was conducted between groups 1&3 (value- and value & cost information) and groups 2&4 (cost- and cost & value information). Before the analysis was conducted, the covariates approximate estimation and arithmetic abilities were standardized and formulated into new variables because it makes it easier to interpret(Aiken et al., 1991).

Table 9 Analysis price levels under different variables

Factors/covariates	F-value	Df.	p-value	η_p^2
Corrected Model	5.22	6	.000*	.372
Primary	14.15	1	.497	.009
Secondary	4.07	1	.049*	.071
Primary*Secondary	1.48	1	.230	.027
Approximate estimation ability	0.59	1	.443	.011
Primary* Approximate estimation ability	*3.97*	1	.051*	.070
Year of study	*2.89*	1	.095	.052
Corrected Total		59		

* P-value is significant at the, 05 level.

The results of the Pearson's correlation test shows that the relationship between the price, based on value information, and the estimation abilities was small, positively correlated, which was not statistically significant (r = .289, n =30, p =.061). While the correlation was not significant relative to the standard level of .05, the p-value was lesser than .10. This approaching significance implies that there is a likely chance that when price decision makers are skilled in approximate estimation and use value information it will result in a higher price.

Another correlation test was conducted to test whether the price, based on cost information, will result in a lower price when price decision makers are skilled in approximate estimation. These results show that there was a small, negative correlation, which was not statistically significant (r = -.208, n =30, p = .135). The correlation coefficient indicates that when price decision makers, who base their price decision on cost information, will set lower prices when they are more skilled in approximate estimation. However, the correlation between approximate estimation and the price is not significant, implying that this result could be achieved by mere chance and therefore it cannot be concluded that being skilled in approximate estimation will result in a lower price, when the price is set based on cost information.

The previous results were based on the outcomes of the approximate estimation abilities and their influence on the price. However the arithmetic abilities were not taken into account in the analysis even though they were measured from the participants. In order to know whether arithmetic abilities do influence the price, the same analyses are conducted from which the results can be found back in Table 10.

Table 10 Analysis price levels under manipulations

Factors/covariates	F-value	Df.	p-value	η_p^2
Corrected Model	4.620	6	.001	.343
Primary	11.44	1	.001	.177
Secondary	4.689	1	.035	.081
Primary*Secondary	1.204	1	.277	.022
Arithmetic Abilities	1.984	1	.165	.036
Primary*Arithmetic Abilities	0.027	1	.871	.001
Year of study	1.442	1	.235	.026
Corrected total	-	59		

When comparing the results of the covariates approximate estimation and the arithmetic abilities on the price level, it comes forth that the only significant difference between them are the interaction effect with the primary factor. The covariate arithmetic abilities did not have a significant effect on the price level because F (1, 59) =0,027, p =, 871. This excludes arithmetic abilities from having an effect on the price, and thus underpins the effect of approximate estimation on price levels.

5. Conclusion

This chapter of this thesis will consist of the conclusion of the research and is aimed to give an answer to the main research question, which was formulated as following:

To what extent are product information and individual numerical abilities of managers contributing to the under-pricing of new products?

5.1 Conclusion

According to the literature, price levels are determined by two general concepts, the price strategy conducted by companies and the pricing practices of managers. Those managers using different types of information in their pricing practice, yielded different price levels. The model of Monroe clearly indicated how price levels are set under cost- and value information. It indicated that the price level based on value information is referred to as the price ceiling, thus implying a high price. While price levels based on cost information are referred to the price floor, meaning a low price. However, the literature did not indicate how the price ceiling and –floor are exactly determined by managers, but there was an indication that approximate estimation had an influence on the price levels set and thus can be related with under-pricing. Therefore respondents were asked to make a survey, in which they made price decisions under different manipulations and made tasks to test their arithmetic- and estimation abilities.

From the analysis of the experiment it can be concluded that the type of information and the availability and sequence of information have a great influence on the price level that will be set by price decision makers. When decision makers only have access to either value- or cost information, the price that will be set is higher and lower, respectively. When price decision makers have access to both value- and cost information it can be concluded that the sequence in which the information is presented has an influence on the price. The price that will be set will be higher when decision makers are first confronted with value information followed by the cost information. Finally, it can be concluded that approximate estimation abilities has a trend towards a higher price level. The result of the approximate estimation on the price level when decision makers set a price based on value information is indicative, while when decision makers set a price based on cost information the price will not be lower. Furthermore, it can be concluded that individual arithmetic abilities of price decision makers do not have an effect on the price that will be set. Thus providing more evidence for the statement that prices are set by making estimations(Ingenbleek et al., 2003) and that estimation abilities are an important trait for price decision makers.

In short, this study underpinned the importance of estimation abilities of price decision makers on the price level and provided insight in the under-pricing of new products. According to the literature there always was a relation expected between the price level and the estimation abilities. This thesis found the evidence that there is a relation and provides new useful insights to both firms as price decision makers. It also provides explanations for under-pricing, which is not yet found in the current literature. This thesis also found a potential relation between arithmetic abilities of decision makers and the price level, which provides good grips for further research and potential other explanations for under-pricing.

6. Discussion & Further Research

This section discusses the limitations of the research results and will address topics for further research

6.1 Relevance

In the introduction chapter was described that limited research was conducted on price-levels. Related to price levels, pricing practices and -strategies has been subjected to lot of research but the main focus still was on how managers perceive information about the value and competition of the new product. However, the article of Ingenbleek and van der Lans (2013) stated that future research on moderating effects on price levels needs to be examined, implying that the relation between managers and their numerical abilities with price levels still remains an unexplored area in the literature. Therefore this research attempted to improve the knowledge about the effects of numerical abilities of managers on price levels and tries to contribute to the existing adjacent theory. Furthermore this research tried to explain, with help of the numerical cognition- and pricing literature, what reasons there could be for under-pricing. Although there is much literature about pricing practices and strategies, this research looks at pricing from a different and more individual angle. By relating already existing theory and the findings of this research, this research also has scientific relevance.

6.2 Limitations

Some of the limitations concern the external validity of the findings. The sample used in this research was all students from the Wageningen University. However, it can be reasoned that most students almost never needed to set a price in a business context and therefore it becomes difficult to generalize the results to managers. Another aspect that threatens the generalizability of the findings of this research is the fact whether students are good substitutes for managers because in the scientific community some debate is still going on (Khera and Benson, 1970). However, students

were still chosen for respondents because managers in production industry reply only at 50.3% of all surveys (Baruch and Holtom, 2008). Also the article of Ingenbleek and van der Lans (2013) yielded a response rate of 18% of companies and did a similar kind of research. Also the content of the survey required full attention and was perceived as deterring. It can also be reasoned that managers could not always be willing to participate in this research because they would need to give confidential information of their price setting process. Nevertheless, by using students for respondents, results seemed to acknowledge the theory and hypotheses but it still remains important to stay careful when making generalizations.

The next limitation concerns the internal validity of this research. During the writing of the methods chapter, a lot of articles were examined to provide insight in measuring individual estimation abilities. Though, almost all articles measured approximate estimation in different ways. For instance, the estimated numerosity varied strongly in array, some articles included different boxes with different stimuli that needed to be compared and in other articles the stimuli were not presented in dots but in coloured geographical shapes. Eventually, a method was chosen based on the recency and number of citations of the article, and most important the congruency with the goal of this research. Concerning the tasks of approximate estimation and arithmetic abilities, the only deviation is the number of tasks that were used. For instance, a lot of articles indicated that they made use of over a 100+ tasks in multiple sessions to measure the individual skills. If this should be adapted to this research, it can be reasoned that the willingness to participate would drop. However, the choice was still made to test the individual abilities because the tasks are essentially the same and eventually when looking at the results it can be stated the choice of measurement was correct.

Finally, the last limitation concerns the analysis of the relation of approximate estimation and value information on the price level. The outcome that was produced indicated that the significance level was indicative. However, it can be reasoned that some effect had to take place when price decision makers, skilled in approximate estimation, needed to take a price decision based on value information.

6.2 Recommendations and further research

Based on the results of this research, recommendations can be given to companies. For companies that have to appoint managers, which are responsible for pricing new products, this research can provide insight on how the under-pricing of new products can be reduced. From the results it came forth that prices based on solely value information will be higher than when they are set solely on cost information. This implies that companies could better inform their managers about the value of the product than on the costs of the product in order to get a higher price for the new product.

However, it can be reasoned that companies inform their manager which is responsible for the price of the new product, about the costs of the product and its extra features. Therefore implying that the likelihood is very low that prices will be set solely on either cost or value information. But when the manager can only take one type of information into account in his price decision, it can better be value information.

The results also made clear that prices set by managers are likely to be higher when managers take both value information and cost information into account in their price decision. Therefore for companies it will be useful to first let managers be informed by the R&D or marketing department about the extra features or extra added value aspects of the new product and then let them be informed by the accounting department about the costs of the product. For instance, a company that sells engines for agricultural machines can better inform their manager, who is responsible for setting the price, about the extra number of vegetables it can process or the increased lifespan of the product. Then it is best to inform the manager about the cost of the machinery to produce the engine and the number of engine expected to be sold. This sequence in which the information is presented will likely result in the highest price.

Furthermore, the results showed a trend in the relation between price and value information which was stronger when managers are skilled in approximate estimation. Therefore, for companies it could be useful to test their managers on their approximate estimations abilities if they have to make price decisions in the future. This result can be used by companies in two ways. First, in the application process companies can test managers on their approximate estimation abilities. Second, they can let managers which are best skilled in approximate estimation them make a price decision when value information is involved.

The results also indicated that some further research can be done in certain areas. To start with it can be valuable to replace the respondents of this thesis, with managers which have experience in pricing decisions and then look whether the findings reflect reality. Which is also interesting for further research is to look at other varieties of individual abilities and its effect on price levels.

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Appendices

Appendix A.1 Price scenario with value information

Suppose you are the general manager of Agri-Engines Inc. that sells engines for sorting machines that are used by apple- and potato farmers. The apple- and potato farmers use their sort machines to sort their apples and potatoes in different weight categories. Your firm has been operating in the engines market for 75 years. However the profitability considerably dropped due to intensified competition. You decided that it was time for a change and you therefore issued the new product development team a year ago to develop a new engine that is able to compete with those of the competitors. The specific requirements of the new engine that the team has accomplished are that the operating costs are reduced and that the lifespan of the engine is longer. Also the production costs of this new engine are cheaper than the engines of the main competitors. You are aware that the engine is nearly ready and that you should set a price level for the new engine in the near future. You know that the main competitor sell their engines for **€8000** each.

From an email of your colleague of the new product development team you learn that the new engine is more efficient, through a reduction in the energy consumption and through lower temperatures. Normally for the apple or potato producers it cost €2150 a year to keep the competitors' engine running. However to keep the new engine running, it cost only €1675 a year. Also while the competitors' engine only lasts for 4 years, your new engine lasts at least 3 years longer depending on the of the intensity of usage. Therefore, the value of the new engine can vary between your customers' firms. The next step for you is to set the price for the engine.

What price would you charge for the new engine?

Appendix A.2 Price scenario with cost information

Suppose you are the general manager of Agri-Engines Inc. that sells engines for sorting machines that are used by apple- and potato farmers. The apple- and potato farmers use their sort machines to sort their apples and potatoes in different weight categories. Your firm has been operating in the engines market for 75 years. However the profitability considerably dropped due to intensified competition. You decided that it was time for a change and you therefore issued the new product development team a year ago to develop a new engine that is able to compete with those of the competitors. The specific requirements of the new engine that the team has accomplished are that the operating costs are reduced and that the lifespan of the engine is longer. Also the production costs of this new engine are estimated by a consultant as likely to be lower than the engines of the main competitor. You are aware that the new engine is nearly ready and that you should set a price level for the new engine in the near future. You know that the main competitor sell their engines for **€8000** each.

From an email of your accounting colleague from the new product development team you learn that the production cost of the new engine is lower, depending on the number of new engines sold, than those of the competitors. The accounting colleague explains that the production cost per engine is comprised of **€1500** variable cost and the fixed cost per unit. He explains that the €1500 variable cost is simply the extra costs to produce one new engine. While the total fixed cost involved in the production of the new engines are €3.000.000. You do not yet know the exact total sales of your new engines per year, though you estimate that the number of new engines sold will increase too approximately between 1,500 and 2,000. The next step for you is to set the price for the engine.

What price would you charge for the new engine?

Appendix A.3 Price scenario with value and cost information

Suppose you are the general manager of Agri-Engines Inc. that sells engines for sorting machines that are used by apple- and potato farmers. The apple- and potato farmers use their sort machines to sort their apples and potatoes in different weight categories. Your firm has been operating in the engines market for 75 years. However the profitability considerably dropped due to intensified competition. You decided that it was time for a change and you therefore issued the new product development team a year ago to develop a new engine that is able to compete with those of the competitors. The specific requirements of the new engine that the team has accomplished are that the operating costs are reduced and that the lifespan of the engine is longer. Also the production cost of this new engine is estimated by a consultant as likely to be lower than the engines of the main competitor. You are aware that the engine is nearly ready and that you should set a price level for the new engine in the near future. You know that the main competitor sell their engines for €8000 each.

From an email of your colleague of the new product development team you learn that the new engine is more efficient, through a reduction in the energy consumption and through lower temperatures. Normally for the apple or potato producers it cost €2150 a year to keep the competitors' engine running. However to keep the new engine running, it cost only €1675 a year. Also while the competitors' engine only lasts for 4 years, your new engine lasts at least 3 years longer depending on the of the intensity of usage. Therefore, the value of the new engine can vary between your customers' firms.

You also receive an email of your accounting colleague from the new product development team from which you learn that the production cost of the new engine is lower, depending on the number of new engines sold, than those of the competitors. The accounting colleague explains that the production cost per engine is comprised of **€1500** variable cost and the fixed cost per unit. He explains that the €1500 variable cost is simply the extra costs to produce one new engine. While the total fixed cost involved in the production of the new engines are €3.000.000. You do not yet know the exact total sales of your new engines per year, though you estimate that the number of new engines sold will increase too approximately between 1,500 and 2,000. The next step for you is to set the price for the engine.

What price would you charge for the new engine?

Appendix A.4 Price scenario with cost and value information

Suppose you are the general manager of Agri-Engines Inc. that sells engines for sorting machines that are used by apple- and potato farmers. The apple- and potato farmers use their sort machines to sort their apples and potatoes in different weight categories. Your firm has been operating in the engines market for 75 years. However the profitability considerably dropped due to intensified competition. You decided that it was time for a change and you therefore issued the new product development team a year ago to develop a new engine that is able to compete with those of the competitors. The specific requirements of the new engine that the team has accomplished are that the operating costs are reduced and that the lifespan of the engine is longer. Also the production costs of this new engine are estimated by a consultant as likely to be lower than the engines of the main competitor. You are aware that the engine is nearly ready and that you should set a price level for the new engine in the near future. You know that the main competitor sell their engines for **€8000** each.

From an email of your accounting colleague of the new product development team you learn that the production cost of the new engine is lower, depending on the number of new engines sold, than those of the competitors. The accounting colleague explains that the production cost per engine is comprised of **€1500** variable cost and the fixed cost per unit. He explains that the €1500 variable cost is simply the extra costs to produce one new engine. While the total fixed cost involved in the production of the new engines are €3.000.000. You do not yet know the exact total sales of your new engines per year, though you estimate that the number of new engines sold will increase too approximately between 1,500 and 2,000. The next step for you is to set the price for the engine.

You also receive an email of your colleague of the new product development team from which you learn that the new engine is more efficient, through a reduction in the energy consumption and through lower temperatures. Normally for the apple or potato producers it cost €2150 a year to keep the competitors' engine running. However to keep the new engine running, it cost only €1675 a year. Also while the competitors' engine only lasts for 4 years, your new engine lasts at least 3 years longer depending on the of the intensity of usage. Therefore, the value of the new engine can vary between your customers' firms. The next step for you is to set the price for the engine.

What price would you charge for the new engine?

Appendix B.1 Approximate estimation tasks

Figure 4 Approximate estimation task 1

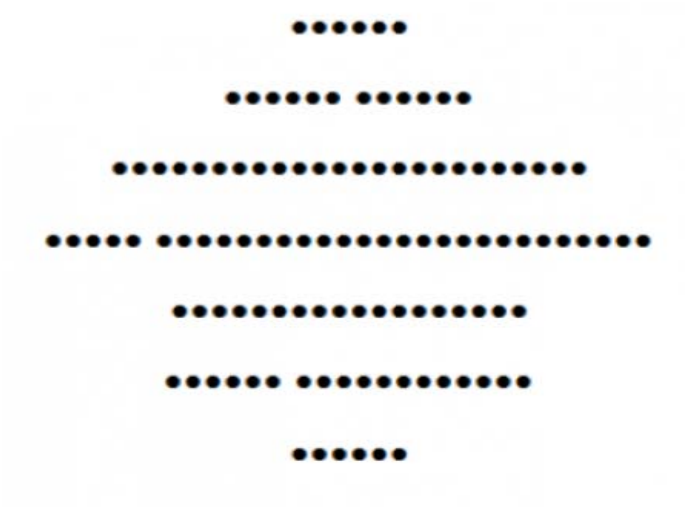

Figure 5 Approximate estimation task 2

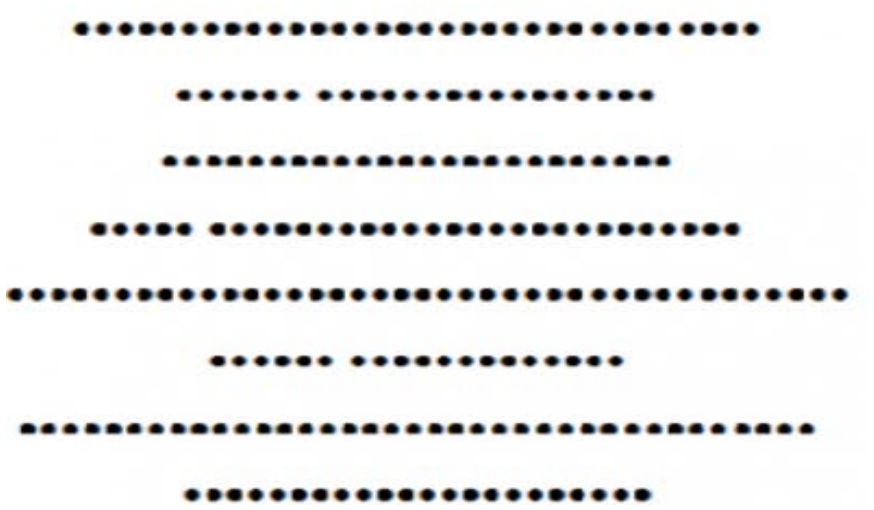

Figure 6 Approximate estimation task 3

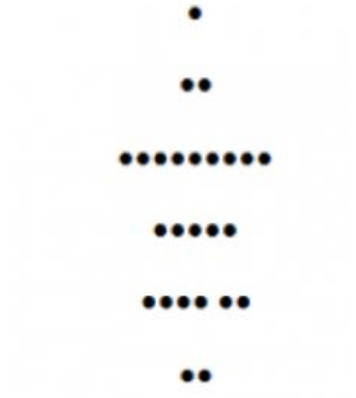

Figure 7 Approximate estimation task 4

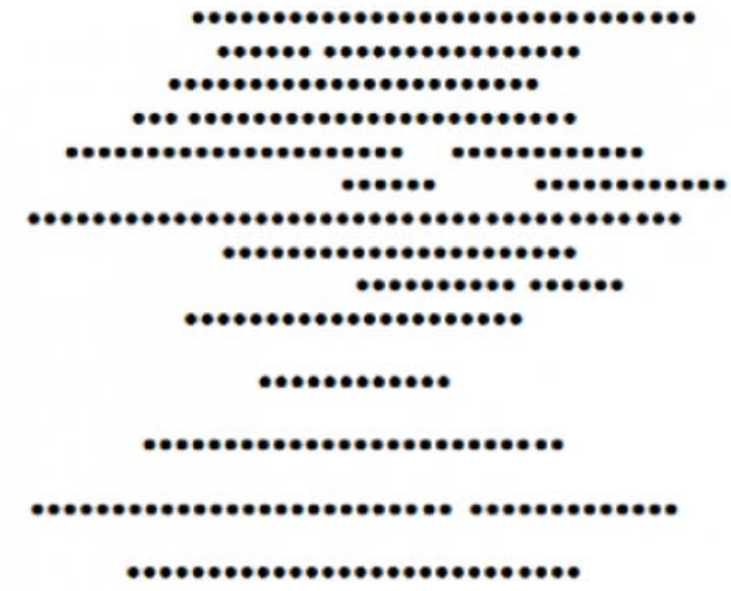

Figure 8 Approximate estimation task 5

Figure 9 Approximate estimation task 6

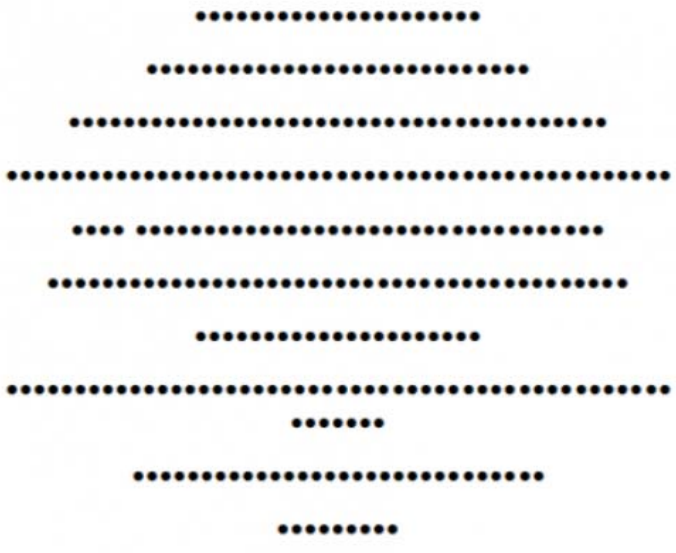

Figure 10 Approximate estimation task 7

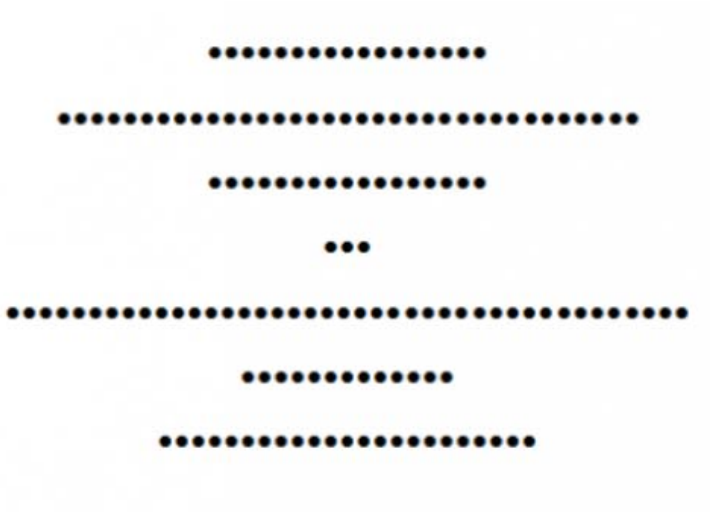

Figure 11 Approximate estimation task 8

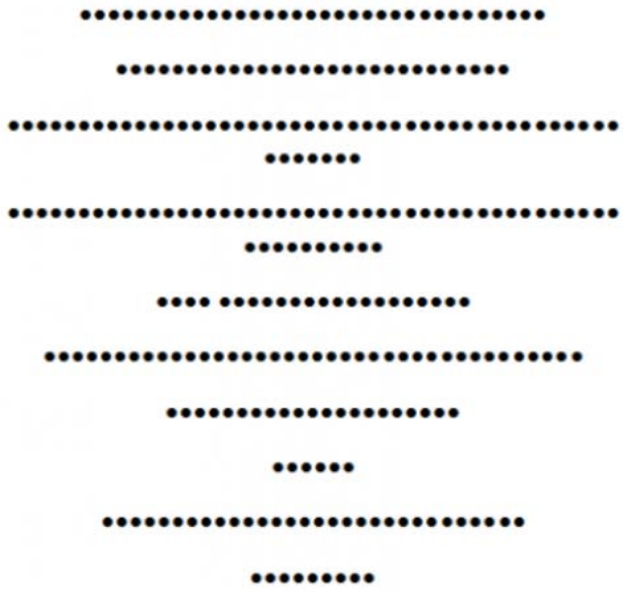

Figure 12 Approximate estimation task 9

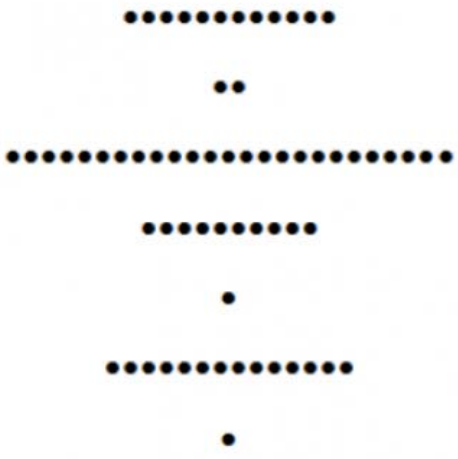

Figure 13 Approximate estimation task 10

Appendix B.2 Arithmetic tasks

Table 11 Arithmetic tasks

Task #	Task	Answer
1	6+5	
2	12-3	
3	81/3	
4	5*4	
5	47+59	
6	84+78	
7	47-8	
8	92-9	
9	126/6	
10	1755/5	
11	13*24	
12	68*44	

Appendix C.1 Boxplot groups

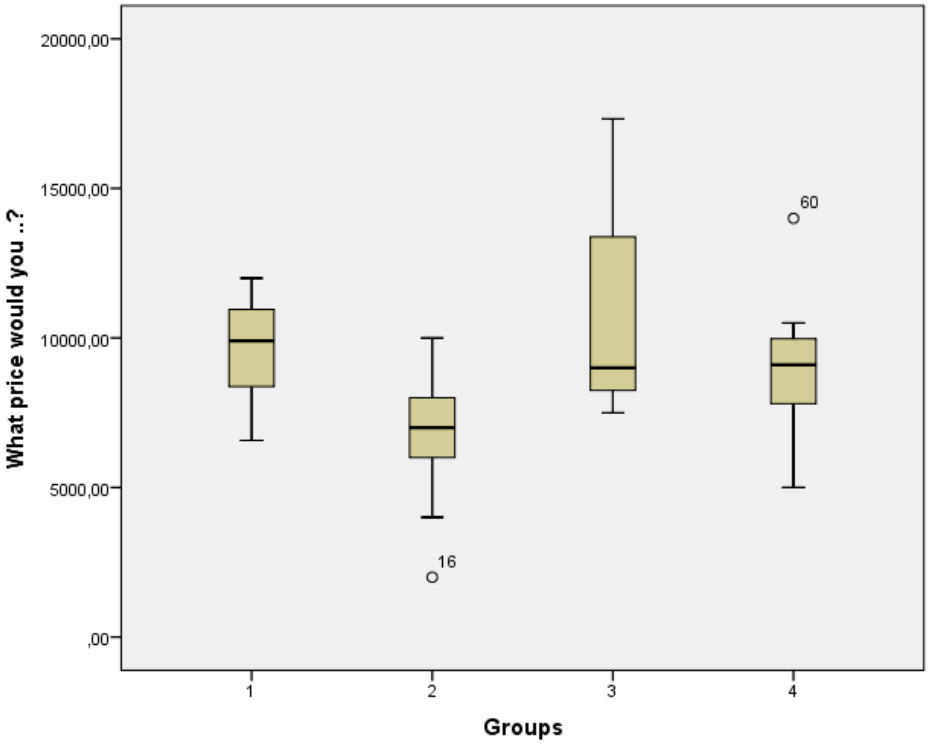

Figure 14 Boxplot of prices of all groups