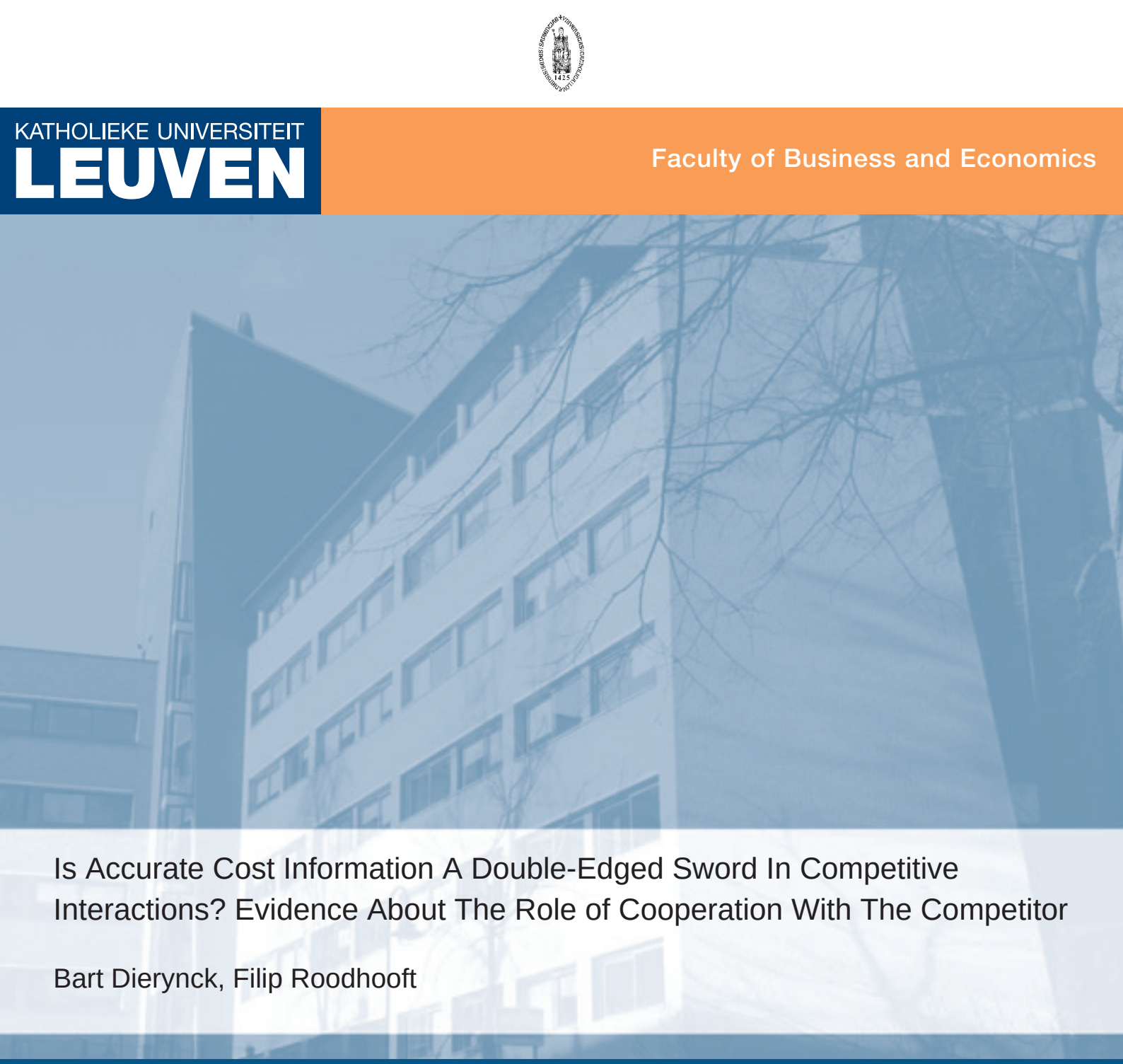

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Is Accurate Cost Information A Double-Edged Sword In Competitive Interactions? Evidence About The Role of Cooperation With The Competitor

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AFI_1153

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December 2010

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We gratefully acknowledge the insightful comments of Jan Bouwens, Eddy Cardinaels, Eva Labro, Jeroen Suijs, Kristy Towry, Alexandra Van den Abbeele, and Luk Warlop. The authors thank participants of the research seminar at the Katholieke Universiteit Leuven and Tilburg University for their comments on an earlier version of this paper. Bart Dierynck thanks the Research Foundation Flanders for financial support.

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Abstract

This study investigates experimentally how investments in accurate cost information affect profits when a competitor also has invested in such type of cost information. On the one hand, better insights in the unit costs can lead to better price-setting, higher profit margins and higher profits. In competitive interactions, however, better insights in the unit cost can instigate competitors to decrease prices until the unit cost without running a high risk of a loss. We propose that the effect of symmetry of cost information between competitors depends on the ease of cooperation between competitors, resulting in a disordinal interaction between cost information symmetry and ease of cooperation. We conduct an experiment, manipulating whether 1) competitors in a sequential duopoly have both accurate cost information or not, and 2) ease of cooperation between competitors. Consistent with our predictions, we find that the effect of cost information symmetry is moderated by the ease of cooperation between competitors. More specific, symmetry of cost information between competitors leads to higher profits when competitors can cooperate than when cooperation between competitors is hampered. Further, a detailed analysis of player's price-setting behavior shows that leaders play a pivotal role in exploiting the positive effect of cost information symmetry. The results of this paper suggest that imitating competitors with respect to the type of cost information may have positive or negative effects, depending on whether market conditions facilitate or hamper cooperation between competitors.

Keywords: cost information, competitive interaction, collusion

I. INTRODUCTION

Proponents of investments in accurate cost information argue that the use of such information will lead to better price-setting, higher profit margins and higher profits (Kaplan and Cooper 1998). Although the superiority of accurate cost information is reasonable for a monopolistic setting, the question arises whether accurate cost information can overcome the limitations of less accurate cost information in competitive settings (Mishra and Vaysman 2001). The aim of this paper is therefore to investigate how characteristics related to the competitive environment influence the profits that a firm can derive from investments in accurate cost information.

Profits in competitive settings are typically determined by the firm's own prices as well as by the prices of the competitor(s). As cost information generates focal points for setting prices, the own type of cost information as well as the type of cost information of a competitor determines the profits that a firm can derive from its investment in accurate cost information. Under cost information asymmetry, the competitor still relies on less accurate cost information and his distorted price-setting will destroy part of the profit potential of the firm's investment in accurate cost information (Cardinaels et al. 2008). Coexistence of accurate and less accurate cost information is not unlikely as Mishra and Vaysman (2001) analytically show that rational cost system choice is driven by the information and incentive environment of the firm.

However, inspired by the benefits of accurate cost information in monopolistic settings, a lot of firms invest in accurate costing systems which leads to situations in which all competitors rely on the same accurate cost information. In this respect, previous research has found that investments in accurate cost information are not always fully rational and subject to herding behavior (Malmi 1999). The effect of symmetry of cost information between competitors, however, is not straightforward. On the one hand, symmetry of cost information can have

positive effects on firm profits as competitors rely on the same focal points to set prices which facilitates the selection of profit-maximizing prices. On the other hand, symmetry of cost information can have negative effects on firm profits as better insights in the units costs, which is an essential characteristic of accurate cost information, can instigate competitors to undercut each other's prices until the unit cost without running a high risk of a loss. Such a competitive spiral is less likely if one competes with a firm that relies on less accurate cost information as the prospect of an accounting loss can restrain such firms to set lower prices than the unit cost that is reported by the less accurate costing system (Cardinaels et al. 2004). This paper proposes that the effect of cost information symmetry will depend on the ease of cooperation between competitors.

Cooperation between competitors is an important theme in industrial organization and a major issue for the design of competition policy (Ivaldi et al. 2003; Tirole 1988). In general, cooperation between competitors in order to maintain high prices or to restrict output is forbidden to protect consumers. Whether competitors can cooperate or not, is largely determined by the characteristics of the economic environment competitors are operating in (Feuerstein 2005; Holt 1995). These characteristics are industry-specific so that competitors in some industries can easily cooperate with each other while competitors in other industries cannot cooperate easily. Therefore, we predict that competitors which both have the same accurate cost information will use that information differently, depending on the ease of cooperation (Mas-Colell et al. 1995). In particular, if competitors can easily cooperate with each other, they will use the accurate cost information to set prices with higher profit margins so that both players obtain higher profits. However, if competitors cannot cooperate easily with each other, the accurate cost information will serve as a guide for undercutting the competitor's prices. This

paper provides evidence on this interactive effect of cost information symmetry and ease of cooperation on profits in a duopoly setting.

We conduct this research using an experiment, in which student participants compete anonymously in a sequential duopoly. These participants act as leader or follower and should set prices in two markets that differ in the amount of overhead costs. Depending on the experimental condition, participants can use accurate or less accurate cost information to set their prices. We use a 2x2 between-subjects experimental design. The first independent variable is cost information symmetry, which we manipulate by giving only one (i.e. leader or follower) or by giving both (i.e. leader and follower) players in the duopoly accurate cost information. The second independent variable is ease of cooperation, which we manipulate by varying the degree of observability of the competitor's prices (observable versus unobservable) and by varying signals of prior cooperation between competitors at the start of the game (competitor's starting prices are close to each other at the start of the game versus no competitor prices at the start of the game).

Our results support our hypothesis that the effect of cost information symmetry is dependent on the ease of cooperation. Specifically, we find that cost information symmetry increases profits when competitors can easily cooperate while cost information symmetry decreases profits when competitors cannot easily cooperate. Results for profit margins are consistent with the results for total profits. Further analysis suggests that leaders play an important role in exploiting the profit-increasing effects of cost information symmetry. More specific, leaders should have cooperative intentions and should be able to show these cooperative intentions to the follower. Comparisons with a control condition in which both players rely on less accurate cost information reveals two important findings. First, if competitors can easily

cooperate with each other, then firms can only benefit from investments in accurate cost information if their competitor has accurate cost information at his disposal. Second, if competitors cannot easily cooperate with each other, firms can only benefit from investments in accurate cost information if their competitor has less accurate cost information. However, prices better reflect the true costs if both firms invest in accurate cost information compared to when both firms rely on less accurate cost information.

This study contributes to the broad stream of accounting research that investigates the costs and benefits of accurate cost information. While prior research has shown that the benefits of accurate cost information are limited due to high implementation costs, the firm-specific incentive and information environment and psychological biases, little is known about the role of the competitive environment, which has changed dramatically since accurate cost information has become a topic of interest for research and practice (Dearman and Shields 2005; Mishra and Vaysman 2001). Only Cardinaels et al. (2008) investigate the role of accurate cost information in a competitive setting, but they do not consider variations in the ease of cooperation between competitors. This paper takes into account that competitors are often prone to imitation behavior which leads to situations where all competitors rely on accurate cost information (Malmi 1999). Our results show that the consequences of competing against a competitor that also relies on accurate cost information depend on the ease with which competitors can cooperate with each other. In general, our results show that ease of cooperation between competitors can serve as an additional explanation for the huge variation in benefits that companies derive from investments in accurate cost information.

By showing that the effect of cost information symmetry depends on the ease of cooperation between competitors, our research speaks to the broader implication that firms

should consider the unintended consequences of accurate cost information before investing in the development of such information. This paper shows that an important unintended consequence of obtaining better insights in the unit cost is related to a possible change in competitive interactions that is induced by obtaining such insights.

The remainder of this paper consists of section 2 developing the theory and the hypothesis to be tested, section 3 describing the experimental design, section 4 presenting the results and section 5 offering concluding observations.

II. THEORY AND HYPOTHESIS

Although economic theory prescribes that firms should choose prices where marginal costs equates marginal revenues, firms often rely on their cost information to set prices. Cost information thus generates important focal points for setting prices. However, all cost information is not equal and while some firms develop accurate cost information based on activity-based costing, other firms still rely on less accurate, volume-based costing information (Gosselin 2007). At this point, it is worth noting that accurate cost information is still an approximation of the truth. Previous research has shown that the focal points generated by less accurate cost information induces people to take decisions that are not wealth-maximizing. Cardinaels et al.(2004), for instance, find that subjects with less accurate cost information do not follow informative market feedback because doing so would result in an accounting loss under the less accurate costing system. In a setting where variations in accounting information refer to the emphasis on (economically irrelevant) unavoidable costs, Kachelmeier (1996) shows that a purely accounting emphasis on these unavoidable costs leads sellers to ask uncompetitively high amounts for their assets.

Competing against competitors with less accurate cost information, a situation that we label as cost information asymmetry, implies that competitors use other focal points for setting their prices. The presence of multiple focal points will insist competitors to set different prices which will reduce the market profits. Furthermore, the distorted price-setting of competitors with less accurate cost information will also reduce the profits of the competitor with accurate cost information (Cardinaels et al. 2008). Coexistence of accurate and less accurate cost information in an economy is not unlikely as the decision to adopt accurate costing systems is driven by the firm-specific incentive and informational environment. Mishra and Vaysman (2001), for instance, show analytically that not implementing an accurate costing system can be rational as managers can use the accurate information to advance their own interests at the disadvantage of the owner's interests.

However, decisions to invest in accurate costing systems are not always fully rational. Malmi (1999), for instance, shows that adoption of accurate costing systems can be explained by imitation and herding behavior. Firms that operate in competitive settings also often underestimate the power of competition and are prone to imitating the choice of monopolists without fully considering how competition influences the benefits one can derive from accurate cost information (Moore et al. 2007; Windschitl et al. 2003). Such imitative behavior leads to situations in which all the competitors have accurate cost information at their disposal, a situation that we label as cost information symmetry. Cost information symmetry implies that the competitors have the same focal points for setting their prices. As a result, it is less likely that the profit potential of investments in accurate costing systems is destroyed by the distorted price-setting of one of the competitors. Cost symmetry is thus an important requirement for obtaining benefits from investments in accurate cost information. However, cost symmetry is not a

sufficient condition for realizing profit increases as it instigates two different uses of accurate cost information.

On the one hand, competitors that both have invested in accurate cost information can use this information to set prices that better cover the unit costs and that lead to high profit margins (Kaplan and Cooper 1998). This way of using accurate cost information is similar to the use of accurate cost information in a monopolistic setting (i.e. both competitors act together as if they are a monopolist) and is sustainable as long as no one of the competitors starts undercutting the other competitors in order to obtain a larger market share. Competitors that both have invested in accurate cost information can, however, also use that information in a competitive way. In this case, the better approximation of the true cost can instigate competitors to undercut each other's prices until the unit cost without fearing a loss. In other words, accurate cost information can weaken people's loss aversion that incites them to maintain high prices if they have less accurate cost information and do not want to decrease prices in order to avoid an accounting loss (Tversky and Kahneman 1991). Importantly, the spiral in which competitors undercut each other's prices until the unit cost will only be observed if both competitors have accurate cost information. That is, if one of both players has less accurate cost information then the undercutting spiral will stop at the point where the price equals the unit cost derived from the less accurate costing system.

Ease of Cooperation

We argue that the ease of cooperation will determine whether accurate cost information is used in a cooperative or competitive way. Ease of cooperation is a theoretical construct that is derived from the literature in industrial organisation and refers to the ease with which competitors can start cooperation with each other as well as sustaining their cooperation (Tirole 1988; Scherer

1980). Ease of cooperation is determined by factors that are exogenous to the firm such as price observability or entry barriers as well as factors that can directly be influenced by the firms such as information sharing (Feuerstein 2005). In order to make the experimental design not overly complex, we will focus in this paper on variations in the ease of cooperation that are determined by exogenous factors.

The moderating effect of ease of cooperation is derived from the fact that a wide range of equilibria are possible in repeated game models and that the setting in which firms compete could make certain equilibria more focal than others (Mas-Colell et al. 1995). Thus, if competitors can easily cooperate with each other, we expect that competitors will end up in a cooperative outcome. Such an outcome is characterized by prices with high profit margins and will increase profits compared to situations with cost information asymmetry. In this case, competitors act together as a monopolist and the benefits of accurate cost information in a monopolistic setting are realized. If cooperation between competitors is however not easy, we predict that competitors will end in a non-cooperative outcome. In this case, cost information symmetry facilitates undercutting of the competitor's prices and although competitors will use their accurate cost information to set prices that better cover the unit costs, profit margins will be lower and profits will decrease compared to situations with cost information asymmetry.

In summary, we expect that the profit-increasing effect of investments in accurate cost information will only be realized if the competitor also has accurate cost information at his disposal and if cooperation with the competitor can be easily started up and sustained. We formalize this prediction in the following hypothesis:

H1: The effect of cost information symmetry on profits is moderated by the ease of cooperation.

III. EXPERIMENTAL DESIGN

In order to test our hypothesis, we use an experimental design that is based on Cardinaels et al. (2008). Their design uses a sequential price-setting duopoly in which a participant has to interact with a competitor for multiple periods. Ease of cooperation is however kept constant in their design. We will adapt their design by varying the ease of cooperation between competitors. In the following sections, we will give information about the model of price competition, the manipulations, the experimental procedures and the manipulation checks.

Model of Price Competition

Similar to Cardinaels et al. (2008), we use a von Stackelberg model of price competition in two markets A and B that differ in the amount of overhead costs. The allocation of the overhead costs is manipulated by varying the accuracy of cost information so that the accurate cost information better reflects the cost differences between the two markets. Participants can increase profits by setting higher prices in market A than in market B ($P_A > P_B$). The demand and cost functions are exactly the same as in Cardinaels et al. (2008) and are given below. The subscripts L and F refer to the leader and follower, respectively.

Sales Volume

Market A $$Q_{a\,L\,(F)} = 5500 - 3.00\,P_{a\,L\,(F)} + 1.05\,P_{a\,F\,(L)} \quad (1a)$$

Market B $$Q_{b\,L\,(F)} = 2325 - 1.25\,P_{b\,L\,(F)} + 0.30\,P_{b\,F\,(L)} \quad (1b)$$

Total $$Q_{tot\,L\,(F)} = Q_{a\,L\,(F)} + Q_{b\,L\,(F)} \quad (1c)$$

It is important to mention that both leader and follower face the same underlying cost structure (i.e. they have symmetric costs). The direct costs of goods sold are represented by a simple,

linear function while a complex, quadratic function is used for representing the indirect costs or overhead costs. As can be derived from the coefficients of the cost functions, market A has a lower direct cost, but the much higher indirect cost for market A leads to a higher total cost for market A than for market B (the fixed overhead costs are higher for market A than for market B, the decreasing linear component is smaller for market A than for market B and the quadratic coefficient is higher for market A than for market B).

Direct Costs

Market A $C_{a\,L\,(F)} = 630\ Q_{a\,L\,(F)}$ (2a)

Market B $C_{b\,L\,(F)} = 710\ Q_{b\,L\,(F)}$ (2b)

Total $C_{tot\,L\,(F)} = C_{a\,L\,(F)} + C_{b\,L\,(F)}$ (2c)

Overhead Costs

Market A $OH_{a\,L\,(F)} = 1{,}750{,}000 - 410\ Q_{a\,L\,(F)} + 0.25\ Q_{a}^{2}{}_{L\,(F)}$ (3a)

Market B $OH_{b\,L\,(F)} = 700{,}000 - 515\ Q_{b\,L\,(F)} + 0.14\ Q_{b}^{2}{}_{L\,(F)}$ (3b)

Total $OH_{tot\,L\,(F)} = OH_{a\,L\,(F)} + OH_{b\,L\,(F)}$ (3c)

Equation (4a) shows the total profit function of a participant while equations (4b) and (4c) shows the prices and profits in the Nash Equilibrium (NE) for leaders and followers. Because of the second-mover advantage, followers can obtain a slightly higher profit than leaders.

Profits and Equilibrium Outcomes

Total profits $Profit_{tot\,L\,(F)} = Q_{a\,L\,(F)}\,P_{a\,L\,(F)} + Q_{b\,L(F)}\,P_{b\,L\,(F)} - C_{tot\,L\,(F)} - OH_{tot\,L\,(F)}$ (4a)

NE leader $P_{a\,L} = 1{,}848.2;\ P_{b\,L} = 1{,}348.0;\ Profit_{tot\,L} = 777{,}215.8$ (4b)

NE follower $P_{a\,F} = 1{,}834.4;\ P_{b\,F} = 1{,}337.3;\ Profit_{tot\,F} = 790{,}998.0$ (4c)

Manipulations

Dispersion of Accurate Cost Information

Participants receive a cost report that contains sales volume, revenue, cost and profit figures in total and by product market. These measures are also updated after each round of play. Total profits can be considered as a reflection of the participant's performance.

The way in which the total indirect costs are allocated to the two product markets A and B is manipulated by using either a volume-based allocation method (i.e. less accurate) or an activity-based allocation method (i.e. accurate). The volume-based allocation method uses total volume to calculate the overhead costs per unit of volume. As no difference is made between a product from Market A and Market B, the indirect costs per unit of volume is the same in both markets. The activity-based allocation method first assigns the total indirect costs to three activities (order processing, software installation and delivery) and then assigns the total costs per activity to the product markets. The calculation of the overhead costs per unit of volume for the volume-based allocation method and for the activity-based allocation method can be found in Appendix 1. Appendix 2 shows the cost report that participants with more or less accurate cost information receive. Panel A of Table 1 shows the actual overhead costs per unit as well as the overhead costs per unit as calculated by using the volume-based and activity-based allocation method. Based on our theoretical arguments, we will make a distinction between the condition where only the focal player (i.e. leader or follower) has accurate cost information (i.e. asymmetric cost information) and the condition where both players have accurate information (i.e. symmetric cost information).

< insert Table 1 about here >

Ease of Cooperation

In Cardinaels et al. (2008), competitors can observe each other's prices. Fouraker and Siegel (1963) argue that prices are the most basic form of communication while Kandori and

Matsushima (1998) provide theoretical support for the conventional wisdom that communication facilitates cooperation between competitors. Taken together, the design of Cardinaels et al. (2008) facilitates cooperation between competitors. We will adapt their design in order to vary the ease of cooperation between competitors.

Our first way of manipulating ease of cooperation between competitors is by manipulating the observability of each other's prices. Half of the participants can observe each other's prices, while the other part of the participants cannot observe each other's prices. Unobservable prices imply that only profits can be used to monitor the competitor's behavior, which will decrease the ease of cooperation between competitors (Stigler 1964).

Our second way of manipulating cooperation between competitors is based on the observation that starting prices in the design of Cardinaels et al. (2008) are very close to each other which can instigate cooperative play between competitors. Furthermore, the presence of starting prices can induce people to conclude that both competitors have a history with each other. Thus, we manipulated ease of cooperation by giving half of the participants the starting prices of Cardinaels et al., while the other half of the participants do not receive starting prices. For the latter group, we also mentioned during the description of the game that participants have to determine prices for products that are introduced into the market for the first time. It is important to mention that participant's can observe each other's prices in the conditions where no starting prices are given. As such, the absence of starting prices is the only difference with the conditions that are replicated from Cardinaels et al. (2008).

Panel B of Table 1 shows the different experimental manipulations. The conditions with starting prices and observable prices are replicated from Cardinaels et al. (2008) (i.e. Game A and B). Game C and D are the conditions where ease of cooperation is manipulated by making

prices unobservable, while Game E and F are the conditions without starting prices. Game A, C, and E are the asymmetric cost information – conditions (i.e. only one player has accurate cost information). Game B, D, and F are the symmetric cost information – conditions (i.e. both players have accurate cost information). Similar to Cardinaels et al. (2008), we will analyze the results of leader and follower separately. As a result, we have 6 treatments for the leader and 6 treatments for the follower. It is important to mention that the focal player in each of the treatments has accurate cost information. The difference between the treatments refers to the cost information of the competitor (more versus less accurate) and the possibility to cooperate with the competitor (yes versus no).

Experimental Procedures

Participants were master students recruited from a cost accounting course at a large West-European university and have knowledge about cost allocations and pricing decisions. Participants were randomly assigned to one of the experimental treatments and to the role of leader or follower. The experiment was organized during different sessions that have 24 to 36 participants. Communication during the experiment was strictly forbidden and the large number of participants in each experimental session guaranteed that participants cannot determine their competitor[2]. The experiment lasted on average 50 minutes. Participants receive a course credit for participation and the best performing leader and follower of each condition receive a gift coupon of 15 EUR.

In order to maintain similarity with Cardinaels et al. (2008), we used the same business case. Participants had to play the role of a price competitor in the distribution of portable PC's. The case informs participants that clients in market A order slightly less expensive products

[2] Previous research about cooperation between employees also allowed communication between employees by written messages (Zhang 2008; Hannan et al. 2010). As we want to keep the similarity with the design of Cardinaels et al. (2008) as high as possible, we opt to not allow communication by written messages.

(lower cost of goods sold), but require much more support than clients in market B. Less accurate cost information is labeled as 'volume-based costing' and participants are told that overhead costs are allocated based on sales volume. Accurate cost information is labeled as 'activity-based costing' and participants are instructed that overhead costs are first assigned to activities and then to market A or market B. Participants should be able to infer the quality of their cost reports from the labels 'volume-based costing' and 'activity-based costing'. Participants are also instructed that both competitors face the same cost structure.

The sequence of play in each round is as follows. Both leader and follower observe their private cost report during ten seconds. Next, the leader sets his prices for the two markets (followers are instructed to wait). Subsequently, the follower sets his prices while leaders are instructed to wait. Depending on the experimental condition, the follower can observe the prices of the leader before he has to make his price decisions.[3] Markets clear after the price decisions of the follower and both players can observe their private cost report as long as they want. At the end of each round, participants can always observe the total profits of his competitor. The observation of the competitor's prices, however, is dependent on the experimental condition.

Manipulation Checks

An ex-post questionnaire was used to assess whether randomization over experimental conditions was successful and to ensure that participants understand the task and attended to the

[3] Making prices unobservable can alter the sequential model of price competition into a simultaneous model of price competition. However, Huck and Muller (2000) provide experimental evidence for the fact that the physical timing of decisions serves as the most important equilibrium selecting device. Sequential price games without observability of prices are frequently observed in practice when a company knows that another company has done a price offer without having information about the price offer itself. For instance, a supplier that wants to attract a new buyer often knows that the buyer already has a supplier but they do not always know the price that the incumbent supplier charges.

manipulations. The questions were answered on a scale from 0 to 100. The means of questions about the clarity of the experimental procedure (78.92, t=24.25, p<0.001) and clarity of the price setting game (78.68, t=25.84, p<0.001) are significantly larger than the midpoint of 50 and do not differ between experimental conditions (p>0.20) or between leaders and followers (p>0.30). Participants were also highly motivated to participate in this experiment (μ=66.13), enjoyed participating in this experiment (μ=73.53) and attributed a high score on a question about the realism of the experiment (μ=57.34). Again, responses do not differ between experimental conditions (p>0.80) nor between leaders and followers (p>0.70) and were significantly larger than 50. We also assessed knowledge about cost accounting with three questions related to activity based costing. Participants scored significantly higher than 50 on the average of these three questions (μ=72.57, t=21.65, p<0.001) and responses do not differ between experimental conditions (p>0.60) nor between leaders and followers (p>0.90). Average age of the participants was 21.5 years and we found no statistical differences between experimental conditions and between leaders and followers with respect to age (p>0.80) and number of courses in accounting, economics or strategy (p>0.70).

We also assessed the validity of our experimental manipulations with ex-post questions. The questions with respect to cost information are (1) "The costs per unit that were reported in my cost report were an accurate reflection of the real costs per unit" , (2) "The cost report provided me with a clear picture about which market was more costly", and (3) "My cost report provided an accurate estimation of the total costs of each market". Participants with accurate cost information scored significantly higher on these questions than participants that have less accurate cost information at their disposal ($t_{Question1}$=4.25, p<0.01; $t_{Question2}$=6.32, p<0.01; $t_{Question3}$=4.33, p<0.01). For the conditions with asymmetric information, we also found that

leaders (followers) with accurate cost information have a significantly higher score on these questions than followers (leaders) with less accurate cost information ($t_{Question1}$=2.66, p<0.01; $t_{Question2}$=4.43, p<0.01; $t_{Question3}$=1.72, p<0.05 for leaders and $t_{Question1}$=2.60, p<0.01; $t_{Question2}$=4.74, p<0.01; $t_{Question3}$=1.72, p<0.05 for followers). On the other hand, if leaders and followers have both accurate cost information at their disposal, we do not find a significant difference between leaders and followers ($t_{Question1}$=0.07, p>40; $t_{Question2}$=0.99, p>0.15; $t_{Question3}$=0.95, p>0.15). Taken together, we find a significant difference for questions about quality of cost information if players have different types of cost information, while no significant differences are found if both players have accurate cost information.

The questions with respect to ease of cooperation between competitors are as follows (1) "My price strategy was focused on increasing my own profits as much as possible" and (2) "I wanted to obtain higher profits than my competitor". We found that both leaders and followers that can easily cooperate with each other scored significantly lower than leaders and followers that cannot easily cooperate with each other because of unobservable prices ($t_{Question1}$=1.86, p<0.10; $t_{Question2}$=2.10, p<0.05 for leaders and $t_{Question1}$=2.35, p<0.05 and $t_{Question2}$=2.03, p<0.05 for followers) and significantly lower than leaders and followers who are not possible to cooperate because of the absence of starting prices ($t_{Question1}$=1.95, p<0.10; $t_{Question2}$=2.07, p<0.05 for leaders and $t_{Question1}$=2.15, p<0.05 and $t_{Question2}$=2.24, p<0.05 for followers). In summary, the results of our ex-post tests give us some comfort that experimental procedures were understood and that randomization and manipulations were successful.

IV. RESULTS

In this section, we first provide formal tests of our hypothesis by using market profits (i.e. total profits of leader and follower) as well as by using profits of leader and followers separately.

Additional analyses of the price-setting behavior in conditions with cost information symmetry are presented to further unravel the results. We also report the results of a control condition in which both players have less accurate cost information and conclude this section with some robustness checks.

Market Profits

As our primary interest is on the moderating effect of the ease of cooperation without making a distinction between leader and follower, we will first test our hypothesis by using market profits as the dependent variable. Considering the market as a whole implies that we have two conditions with asymmetric cost information: one condition in which only the leader has accurate cost information and one condition in which only the follower has accurate cost information. As a result, we have a 3 (only leader accurate cost information, only follower accurate cost information, leader and follower accurate cost information) x 2 (high ease of cooperation versus low ease of cooperation) experimental design for analyzing the market profits. The results of the ANOVA-analysis support our hypothesis that the effect of cost information symmetry is moderated by the ease of cooperation: we find evidence for a main effect for Ease of Cooperation ($F=9.90$, $p<0.01$ for Experiment 1 and $F=5.52$, $p<0.05$ for Experiment 2) and an interaction effect of Cost Information Symmetry and Ease of Cooperation ($F=4.70$, $p<0.05$ for Experiment 1 and $F=4.16$, $p<0.05$ for Experiment 2) (see Panel B, Table 2). [4] Game-by-game comparisons show that market profits of the conditions with asymmetric cost information are not significantly different from each other, while the profits of the condition where both players have accurate cost information and can cooperate are significantly larger than

[4] Experiment 1 refers to the comparison between the cooperation-conditions and conditions with unobservable prices. Experiment 2 refers to the comparison between the cooperation conditions and conditions without starting prices.

the profits of the condition where both players have accurate cost information but cannot cooperate ($p<0.01$ for Experiment 1 and Experiment 2) (see Panel A, Table 2).

< Insert Table 2 about here >

Total Profits and Profit Margins

Table 2 shows the average realized profits for the 12 rounds of play for leaders and followers. An ANOVA-analysis on the average realized profits of leaders and followers supports our hypothesis: we find a significant interaction term for leaders ($F=3.45$, $p<0.10$ for Experiment 1; $F=5.78$, $p<0.05$ for Experiment 2) as well as for followers ($F=5.25$, $p<0.05$ for Experiment 1; $F=9.86$, $p<0.01$ for Experiment 2) (see Table 3, Panel C and D). Further analysis reveals that profits do not significantly differ between conditions with asymmetric cost information ($p>0.90$ for the leaders of Experiment 1 and Experiment 2 and $p>0.50$ ($p>0.60$) for the followers of Experiment 1 (Experiment 2)) while there is a significant difference in the predicted direction between the conditions with symmetric cost information ($p<0.05$ ($p<0.01$) for the leaders of Experiment 1 (Experiment 2) and $p<0.01$ for the followers of Experiment 1 and Experiment 2).

A simple effects test shows that leaders' profits are not significantly different between the two conditions in which cooperation with the competitor is easy ($p>0.15$ for difference between Game A and Game B for the leaders). For followers that can easily cooperate with their competitor, we observe that total profits are significantly higher with symmetric cost information compared to asymmetric cost information ($p<0.01$). If competitors cannot easily cooperate because of unobservable prices, profits of leaders and followers do not significantly differ between the asymmetric and symmetric cost information condition ($p>0.15$ for the leaders; $p>0.20$ for the followers) (see Table 3, Panel A). If competitors cannot easily cooperate due to the absence of starting prices, profits are significantly lower when cost information is symmetric

compared to when cost information is asymmetric ($p<0.10$ for the leaders, $p<0.05$ for the followers). These results provide evidence for the moderating role of ease of cooperation when both competitors have accurate cost information at their disposal.

< Insert Table 3 about here >

As the profit margin is an important construct in our theoretical reasoning, we also present the results for the profit margins. The results for profit margins confirm our results of the total profits: we find a significant interaction term for leaders ($F=3.17$, $p<0.10$ for Experiment 1; $F=7.09$, $p<0.01$ for Experiment 2) as well as for followers ($F=4.47$, $p<0.05$ for Experiment 1; $F=8,72$, $p<0.01$ for Experiment 2) (see Table 4). The results of the simple effects are similar to those of the total profits.

< Insert Table 4 about here >

Detailed Analysis of Price-Setting Behavior

Although the results for market profits, profits of leaders and followers and profit margins are consistent with our hypotheses, a more detailed analysis of the price-setting behavior is useful to explore how the ease of cooperation between competitors influences the results as well as to investigate the differences between the two manipulations of ease of cooperation. Following our theory, we will focus on the conditions where both players have accurate cost information at their disposal and analyze the price-setting behavior for the three variations of ease of cooperation by means of different metrics. *PriceDifferenceCompetitors* is a first metric and is computed as the absolute value of the price difference between leader and follower. This measure is computed separately for market A and B and reflects the extent to which competitors coordinate their prices (e.g. $|P_{aLeader} - P_{aFollower}|$). Second, price level of market A will be reported. The price level of market A is useful for deriving insights about the prevalence of cooperation as

the optimal price for market A is higher than the starting price and cooperation between competitors is particularly useful for increasing and maintaining high prices. Cooperation between competitors should thus lead to higher prices for market A than prices in the conditions where cooperation is not easy to attain and sustain.[5] Third, *PriceDifferenceMarkets* is computed as the difference between the price for market A and the price for market B for the same subject ($P_a - P_b$) and is a measure for the extent to which differences in indirect costs between both markets are reflected in the prices (Cardinaels et al. 2008). As the price for market A is larger than the price for market B in the equilibrium solution, this measure should be positive if differences in indirect costs are reflected in the prices. Lastly, we also compute metrics for the undercutting and overpricing by leaders and followers. The calculation of these metrics is consistent with the sequence of decisions for leaders and followers. For the leaders, we compare the price of the leader with the price of the follower in the previous round. For the follower, we compare the price of the follower with the price of the leader in the same round. Several measures are computed. A large undercut (overpricing) is a price decrease (increase) of more than 5% compared to the previous price of the competitor. A close undercut (overpricing) is a price decrease (increase) of less than 5% compared to the previous price of the competitor. An imitation implies that the previous price of the competitor is perfectly copied. As competitors cannot observe each other's prices in the condition with unobservable prices, the metrics for undercutting and overpricing are less useful for this condition.

Easy To Cooperate Versus UnobservablePrices

The results for *PriceDifferenceCompetitor* show that differences between prices of leaders and followers are significantly larger in the UnobservablePrices-condition than in the Easy To

[5] The optimal price for market B is lower than the starting price so that price decreases in market A can be due to cooperative intentions or due to competition between competitors. Therefore, we will not report the price levels for market B.

Cooperate-condition ($p<0.01$ for market A and market B, see Panel A and C of Table 5). This indicates that price coordination between leader and follower is hampered if players cannot observe each other's prices. The prevalence of such large price differences between leaders and followers is a first element that can decrease profits. Considering the price level of market A, we observe that the leaders' prices in the UnobservablePrices-condition are not significantly different from those in the Easy To Cooperate-condition ($p>0.10$, see Panel A of Table 6). Followers, on the other hand, set significantly lower prices in market A in the UnobservablePrices-condition than in the Easy To Cooperate-condition ($p<0.01$, see Panel C of Table 6). Followers thus use a more competitive price-setting strategy in the UnobservablePrices-condition than in the Easy To Cooperate-condition, while the price-setting strategy of the leaders does not really differ between both conditions. The competitive price-setting strategy of the followers is confirmed by comparing *PriceDifferenceMarkets* between the both conditions: we observe no significant difference for this metric for the leaders ($p>0.20$, see Panel A of Table 7) while we observe a significant difference for the followers ($p<0.05$, see Panel C of Table 7). As the prices in market B do not really differ between both conditions ($p>0.50$ for the leaders and $p>0.40$ for the followers, see Panel A and C of Table 6), the results for *PriceDifferenceMarkets* are driven by the price level in market A. Taken together, the results for the different metrics show that leaders in the UnobservablePrices-condition have cooperative intentions as their price-setting strategy does not differ between the Easy To Cooperate-condition and UnobservablePrices-condition. Followers, on the other hand, pursue a competitive price-setting strategy if they cannot coordinate their prices with the leader. These results imply that price coordination plays an important role in exploiting the profit-increasing effect of cost information symmetry. Indeed, leaders in the UnobservablePrices-condition have cooperative

intentions but they cannot show these cooperative intentions to the followers, which leads to lower profits for both leader and follower.

< Insert Table 5, 6, and 7 about here >

Easy To Cooperate Versus NoStartingPrices

The results for *PriceDifferenceCompetitor*, our measure for coordinated price-setting, show that differences between prices of leaders and followers for market B are not significantly different between the Easy To Cooperate-condition and NoStartingPrices-condition ($p>0.15$, see Panel C of Table 5). However, *PriceDifferenceCompetitor* for market A is significantly larger in the NoStartingPrices-condition than in the Easy To Cooperate-condition ($p<0.10$, see Panel A of Table 5). Two arguments can be put forward to confirm our expectation that difficulties to coordinate on prices are not the main driver of the low profits in the NoStartingPrices-condition. First, close inspection of the round-by-round results for market A shows that the significant difference is driven by the first periods (i.e. only period 2, 4 and 5 show a significant difference). Second, price coordination difficulties are a smaller issue in the NoStartingPrices-condition than in the UnobservablePrices-condition as *PriceDifferenceCompetitor* is significantly smaller in the NoStartingPrice-condition ($p<0.01$). Inspection of the price level in market A shows that leaders and followers in the NoStartingPrices-condition set significantly lower prices compared to the Easy To Cooperate-condition ($p<0.01$ for the leaders; $p<0.05$ for the followers; see Panel A en C of Table 6). Contrary to the UnobservablePrices-condition, also leaders pursue a competitive price-setting strategy and do not show cooperative intentions. The competitive price-setting strategy of leaders and followers in the NoStartingPrices-condition can be confirmed by close inspection of the data about undercutting and overpricing. Given the sequential nature of our game, followers are assumed to play more competitively and to undercut or imitate the leader

quite often. Leaders thus play a pivotal role in installing and sustaining cooperative price-setting by closely overpricing the followers. As a result, the number of close overpricings by the leader will be used as a measure for the cooperative intentions of the leader. Large undercuts, on the other hand, can be considered as a signal for the competitive intentions.

In general, the data confirm our expectation that followers act more competitively than leaders as followers have more large undercuts than leaders ($p<0.01$, not tabulated) and as followers undercut or imitate the leader in more than 50% of their decisions. Furthermore, follower behavior is qualitatively similar in both conditions. Leader behavior, however, is different. The results in Panel A of Table 8 show that leaders in the Easy To Cooperate-condition are more closely overpricing the follower's price than in the NoStartingPrices-condition ($p<0.05$), while they less use a large undercut of the follower's price than leaders in the NoStartingPrices-condition ($p<0.10$). Taken together, leaders in the Easy To Cooperate-condition are more cooperative, while leaders in the NoStartingPrices-condition act competitively. Although followers in the Easy To Cooperate-condition are still somewhat competitive and often closely undercut the price of the leader, leaders in the Easy To Cooperate-condition take into account this strategy of the followers by more closely overpricing the followers ($p<0.05$) and less imitating the follower's price of the previous period ($p<0.05$) than leaders in the NoStartingPrices-condition. As such, leaders and followers evolve towards higher prices and profits. In the NoStartingPrices-condition, however, competitive leaders are matched with competitive followers which results in low prices and low profits. Taken together, our results show that leaders play a pivotal role in exploiting the profit-increasing effect of cost information symmetry: leaders should have cooperative intentions and they should be able to show these cooperative intentions to the follower.

< Insert Table 8 about here >

Additional Analyses

In this section, we report results of additional tests that both lend robustness and extend the reported results.

Outperforming the Competitor?

Although our evidence provides support for our theory, it could be that the participant's pricing decisions are driven by the relative position against the competitor instead of the absolute level of profits (Armstrong and Huck 2009). As participants are not informed about the optimal profits, concerns about the relative position are not unlikely. If this is the case, then the profits in the different conditions should be interpreted with care. However, analyses show that players with accurate cost information never outperform their competitor with less accurate cost information. Profits of competitors do also not significantly differ if both players have accurate cost information. As a result, satisfaction with a significantly higher profit cannot serve as an explanation for our results.

Control Condition: both Players Less Accurate Cost Information

We have also run a control condition with cost information symmetry of less accurate cost information (i.e. both players less accurate cost information). We have 21 leaders and followers in the Easy To Cooperate-condition, 22 leaders and followers in the UnobservablePrices-condition and 18 leaders and followers in the NoStartingPrices-condition. If cooperation is easy, we observe no significant profit differences between less accurate cost information symmetry – condition and the cost information asymmetry condition ($p>0.15$ for the leaders and $p>0.30$ for the followers, see Panel A of Table 9). This result can be explained by the fact that the low barrier to cooperate makes it possible for competitors to learn to set better prices although both

players have less accurate cost information (Waller et al. 1999). In the UnobservablePrices-condition, leaders significantly improve their profits if only they invest in accurate cost information ($p<0.01$, see Panel A of Table 9). Followers in the UnobservablePrices-condition, on the other hand, cannot improve profits if only he invests in accurate cost information ($p>0.30$, see Panel A of Table 9). Leaders and followers in the NoStartingPrices-condition can significantly improve their profits if they invest in accurate cost information while their competitor does not invest in such information ($p<0.10$ for the leader and $p<0.01$ for the follower, see Panel A of Table 9). In line with our theory, leaders and followers in the Cooperation-condition can significantly increase their profits compared to the control condition if they both invest in accurate cost information($p<0.01$ for leaders and followers). Profits of leaders and followers in the UnobservablePrices- and NoStartingPrices-condition, however, do not significantly differ between the condition where both players have accurate cost information and the condition where both have the less accurate information ($p>0.10$ ($p>0.70$) for leaders (followers) in the UnobservablePrices-condition; $p>0.90$ ($p>0.50$) for leaders (followers) in the NoStartingPrices-condition). Taken together, leaders or followers that invest in accurate cost information will prefer that their competitors do the same if cooperation is possible, while they will prefer that their competitors do not invest in accurate cost information if cooperation is not possible. However, further analysis of the low profits if both competitors have the same cost information (i.e. both less accurate or more accurate cost information) and cannot easily cooperate shows that the condition in which both competitors have accurate cost information is preferable from a welfare perspective. Statistics about *PriceDifferenceMarkets*, for instance, show that the price difference between market A and B is significantly larger if both competitors have accurate cost information then in the condition where both competitors have less accurate

cost information ($p<0.05$ for leaders of Experiment 1; $p<0.10$ for followers of Experiment 1; $p<0.01$ for leaders and followers of Experiment 2). In other words, the low profits if both competitors have accurate cost information are from higher quality because the prices better reflect the cost differences between the markets.

< insert Table 9 about here >

Alternative Econometric Specification

As some players occasionally set ridiculously high or low prices, we delete for each player the round with the lowest and the highest profit and calculate the average profit of the ten remaining rounds. We rerun our analyses and find the same results. Instead of averaging the profits of each player, we also run analyses where each round is considered as an independent observation. We use player-clustered standard errors and control for round-effects by introducing a main term for round an all possible interaction terms between round and the independent variables InformationCompetitor and Collusion. Our results do not change.

V. DISCUSSION

Previous research has shown that the benefits of accurate cost information are diminished in simple settings, due to psychological biases, availability of other information and strategic interactions (Briers et al. 1999; Cardinaels et al. 2008; Dearman and Shields 2005). Our study shifts the focus to characteristics of the competitive environment and starts from the assumption that the competitor's cost information, which generates focal points for price-setting, can influence the profits that a firm can derive from its investment in accurate costing systems. Specifically, our experimental study shows that a firm, which has invested in accurate cost information, will be able to increase its profits if the competitor also invests in accurate cost

information. However, this profit-increasing effect will only be observed if competitors can easily cooperate with each other. More specific, (market) profits increase if competitors can easily cooperate with each other, while (market) profits decrease if cooperation is not easy to attain and to sustain. This disordinal interaction occurs because competitors that both have invested in accurate cost information use that information differently depending on the easiness to which they can cooperate with each other. More specific, accurate cost information is used to set better prices with higher profit margins if competitors can easily cooperate with each other. However, if cooperation between competitors is not easy to initiate and to sustain, competitors use the accurate cost information to undercut each other's prices until the unit cost.

Our additional analyses show that leaders play a pivotal role in the exploitation of the profit-increasing effect if both leader and follower have invested in accurate cost information. More specific, our data suggest that the profit-increasing effect requires that leaders have cooperative intentions, and that they can show these cooperative intentions. Another set of additional analyses shows that profits do not significantly differ between conditions with cost symmetry of accurate cost information and cost symmetry of less accurate cost information but prices better reflect the true costs if both competitors have accurate cost information.

Our results are especially relevant given the empirical and anecdotal evidence suggesting that firms imitate other firms when deciding about implementation of accurate cost systems (Malmi 1999). It is thus not unlikely that firms end up in a situation where all competitors have accurate cost information at their disposal. As our results show, profits in this situation are determined by the easiness to which competitors can cooperate with each other. We let it as a question for future research whether competitors that both have accurate cost information are aware of this unintended consequence and whether they will explicitly search for cooperation in

order to avoid the low profits when cooperation is not a priori possible. Our results also provide (partial) evidence that the first wave of ABC-adopters has made an efficient choice as comparisons with a control condition in which both players have the less accurate cost information show that firms which are the first to invest in accurate cost information can increase their profits, but only if cooperation between competitors is not possible.

More generally, our results imply that firms should be aware of the characteristics of their competitive environment before implementing accurate costing systems. More specific, firms should be aware that results from monopolistic settings cannot be extended to competitive settings without taking into account the complex interactions of such settings. Unfortunately, prior research has shown that people are not good in predicting the effect of competition.

This study has its limitations which provide opportunities for further research. First, our experimental design keeps the price sensitivity of the markets constant across conditions. Further research can examine whether the results change if players compete in markets with higher price sensitivities. Second, our additional analyses have shown that leaders play a pivotal role in exploiting the profit-increasing effects of cost-symmetry. Future research would do well to explore the role of leaders in competitive interactions. One avenue for future research is to investigate how the power assigned to leaders influences their decisions to invest in accurate cost information.

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TABLE 1

Overview of the Experimental Design

Participants act either as leader (first mover) or follower (second mover) and set prices for the two product markets that have different indirect costs. After each round, total profits are made public and participants receive an updated private cost report. Only participants in the NoCollusion-treatment of Experiment 1cannot view each other's prices in the product markets after each round. Given the assumption that indirect costs per product market (equations 3a and 3b) are unobservable, the cost reports use a cost allocation method (see appendix A) to account for differences in the indirect costs per product market. We manipulate these cost reports as either being less accurate (product markets receive per unit of volume an equal amount of indirect costs) or more accurate (product market A is shown to be more costly than market B) in a fully crossed 2x2 design. Panel A shows the unit costs that are shown under a less or more accurate cost report in comparison to the actual costs at the start of the experiment (e.g. for the leader using the initial prices of Experiment 1 $P_{a\ L}$=1650; $P_{b\ L}$=1710; $P_{a\ F}$ =1645; $P_{b\ F}$=1706). Panel B shows our experimental treatments.

Panel A: unit cost shown in high- or low-quality report (at start) vs. actual cost[6]

Type of cost	*Actual Cost* Market A versus B	*Low-quality* cost report Market A versus B	*High-quality* cost report Market A versus B
Direct cost per unit	630.0 < 710.0	630.0 < 710.0	630.0 < 710.0
Indirect cost per unit	**927.8 > 583.9** (Equations 3a and 3b)	**847.0 = 847.0** (Appendix A)	**956.1 > 491.8** (Appendix A)
Total unit cost 'U'	1,557.8 > 1,293.9	1,477.0 < 1,557.0	1,586.1 > 1,201.8

Panel B: overview of the experimental treatments

Experiment 1

	Cost Information Asymmetry	Cost Information Symmetry
Easy To Cooperate	Game A 21 Leaders/21 Followers Focal Player: U(Market A) > U(Market B) Competitor: U(Market A) < U(Market B)	Game B 18 Leaders/18 Followers Focal Player: U(Market A) > U(Market B) Competitor: U(Market A) > U(Market B)
Not Easy To Cooperate (Unobservable Prices)	Game C 22 Leaders/22 Followers Focal Player: U(Market A) > U(Market B) Competitor: U(Market A) < U(Market B)	Game D 21 Leaders/21 Followers Focal Player: U(Market A) > U(Market B) Competitor: U(Market A) > U(Market B)
Not Easy To Cooperate (No Starting Prices)	Game E 18 Leaders/17 Followers Focal Player: U(Market A) > U(Market B) Competitor: U(Market A) < U(Market B)	Game F 17 Leaders/17 Followers Focal Player: U(Market A) > U(Market B) Competitor: U(Market A) > U(Market B)

Control Conditions

Cost Information Asymmetry (Both Players Less Accurate Cost Information)	
Focal Player: U(Market A) < U(Market B) Competitor: U(Market A) < U(Market B)	
Cooperation	21 Leaders/21 Followers
Unobservable Prices	22 Leaders/22 Followers
NoStartingPrices	18 Leaders/18 Followers

[6] Adapted from Cardinaels et al. (2008)

TABLE 2

Market Profits Experiment 1 and 2

Panel A shows the average realized market profits for the 12 rounds of play per experimental treatment. Comparison of the averages is based on a Tukey-Kramer test which controls for the fact that multiple pairwise comparisons are executed. Panel B contains the ANOVA-analysis. Panel C presents a graph of the average realized market profits.

Panel A: Market Profits

	Cost Info Asymmetry (LeaderABC)	Cost Info Asymmetry (FollowerABC)	Cost Info Symmetry			
	Game A	Game B	Game C	Game A-B	Game A-C	Game B-C
Easy To Cooperate	1,030,259.47	1,009,003.15	1,158,641.73	p=0.68	p=0.02	p<0.01
	Game D	Game E	Game F	Game D-E	Game D-F	Game E-F
UnobservablePrices	1,004,258.76	974,095.17	910,566.14	p=0.59	p=0.15	p=0.32
NoStartingPrices	995,640.80	1,011,543.77	799,259.59	p=0.91	p=0.19	p=0.07
Easy To Cooperate Versus	Game A-D	Game B-E	Game C-F			
UnobservablePrices	p=0.64	p=0.51	p<0.01			
NoStartingPrices	p=0.78	p=0.97	p<0.01			

Panel B: ANOVA-results for Market Profits Experiment 1 and 2

	EasyToCooperate Vs. UnobservablePrices		**EasyToCooperate Vs. NoStartingPrices**	
	F-statistic	p-value	F-statistic	p-value
EaseOfCooperation	9.80	<0.01	5.52	0.02
CostInformationSymmetry	0.57	0.58	0.15	0.86
EaseOfCooperation x CostInformationSymmetry	4.70	0.01	4.16	0.02
F-statistic Model	3.82	<0.01	2.71	<0.01
R^2	13.82%		11.33%	

Panel C: Graphical Plots of the Average Realized Market Profits

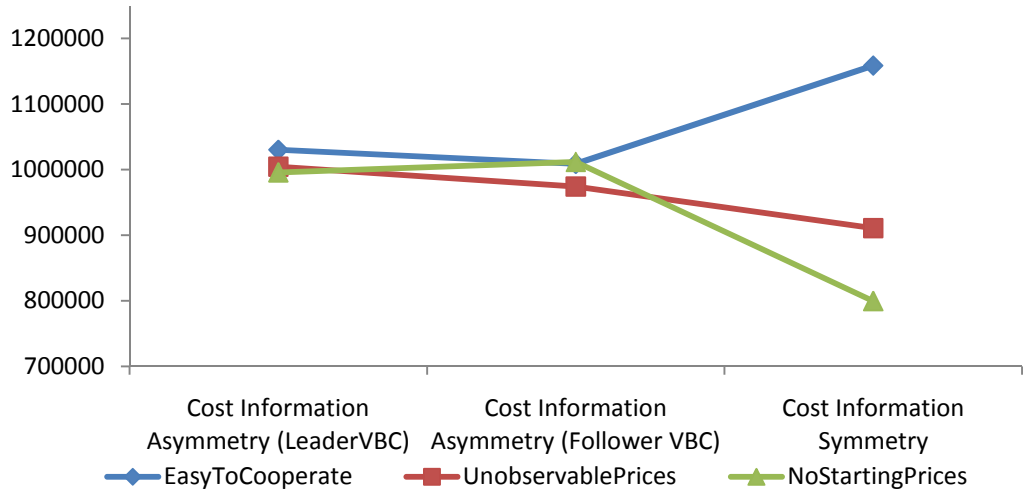


TABLE 3

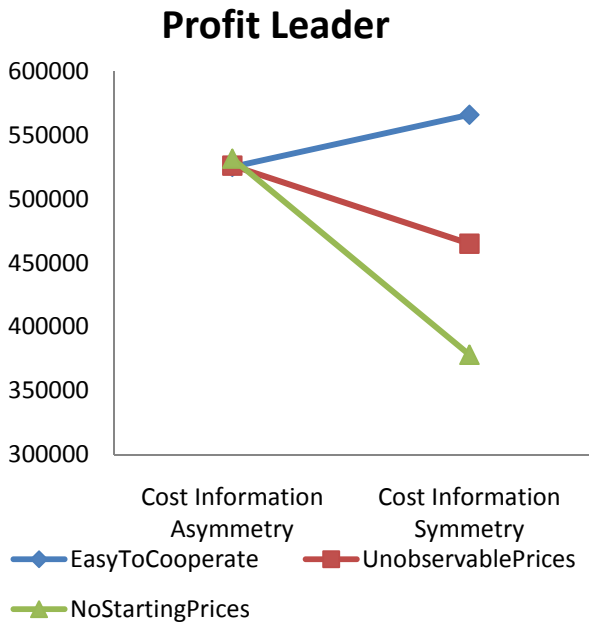
Total Profits

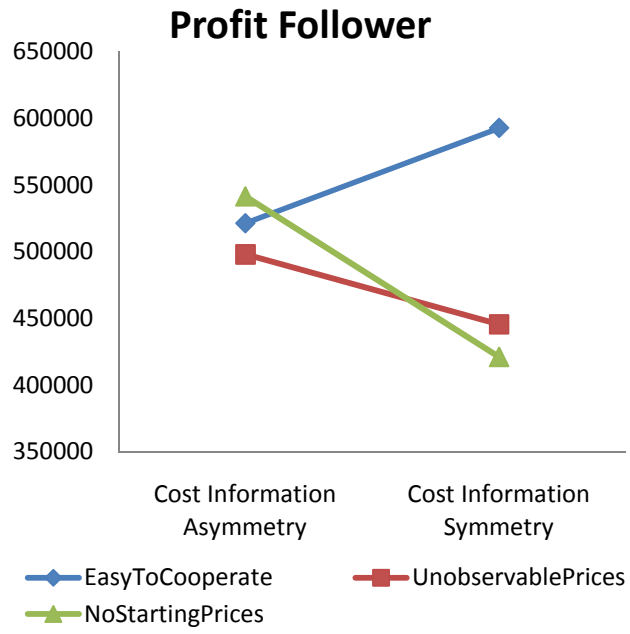
Panel A shows the average realized profits for leaders and followers for the 12 rounds of play per experimental treatment. Comparison of the averages is based on a Tukey-Kramer test which controls for the fact that multiple pairwise comparisons are executed. Panel B presents a graph of the average realized profits for leaders and followers. Panel C and D show the results of the ANOVA-analysis on Total Profits. The dependent variable is the average profit for the 12 rounds of play.

Panel A: Total Profits Leaders and Followers

		Cost Informatyion Asymmetry	Cost Information Symmetry	Effect Cost Information Symmetry
		Game A	Game B	Game A-B
Easy To Cooperate	Leaders	525,237.261	566,040.693	+ 40,803.43 (p=0.18)
	Followers	521,235.831	592,601.036	+ 71,365.21 (p=0.02)
		Game C	Game D	Game C-D
Unobservable Prices	Leaders	526,278.998	465,082.437	- 61,196.56 (p=0.18)
	Followers	497,947.325	445,483.701	- 52,463.62 (p=0.24)
		Game E	Game F	Game E-F
NoStarting Prices	Leaders	531,681.592	378,069.183	-153,612.41 (p=0.06)
	Followers	541,440.229	421,190.406	-120,249.82 (p=0.04)
		Game A-C	Game B-D	
Effect Ease Of Cooperation	Leaders	+ 1,041.74 (p=0.98)	- 100,958.26 (p=0.02)	
	Followers	- 23,288.51 (p=0.55)	-147,117.335 (p<0.01)	
		Game A-E	Game B-F	
	Leaders	+6,444.33 (p=0.92)	-187,971.51 (p<0.01)	
	Followers	+20,204.40 (p=0.64)	-171,410.63 (p<0.01)	

Panel B: Graphical Plots of the Average Realized Total Profits





Panel C: ANOVA-results Total Profits Easy To Cooperate Versus Unobservable Prices

	Leaders		Followers	
	F-statistic	p-value	F-statistic	p-value
Ease Of Cooperation	3.31	0.07	9.95	<0.01
Cost Information Symmetry	0.14	0.71	0.12	0.73
EaseOfCooperation x CostInformationSymmetry	3.45	0.07	5.25	0.03
F-statistic Model	2.23	0.09	4.84	<0.01
R^2	7.9%		15.68%	

Panel D: ANOVA-results Total Profits Easy To Cooperate Versus No Starting Prices

	Leaders		Followers	
	F-statistic	p-value	F-statistic	p-value
Ease Of Cooperation	5.04	0.03	6.14	0.02
Cost Information Symmetry	1.94	0.17	0.64	0.43
EaseOfCooperation x CostInformationSymmetry	5.78	0.02	9.86	<0.01
F-statistic Model	4.01	0.01	5.31	<0.01
R^2	14.67%		18.76%	

TABLE 4

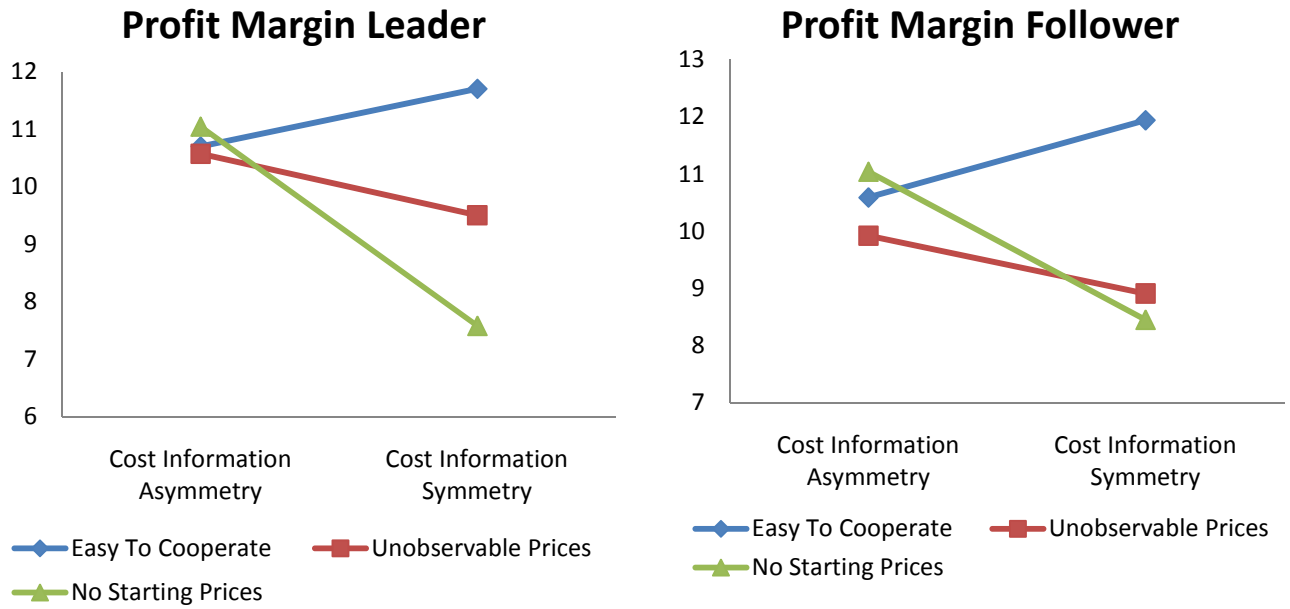
Profit Margins

Panel A shows the average realized profit margins for leaders and followers for the 12 rounds of play per experimental treatment. Comparison of the averages is based on a Tukey-Kramer test which controls for the fact that multiple pairwise comparisons are executed. Panel B presents a graph of the average realized profit margins for leaders and followers. Panel C and D show the results of the ANOVA-analysis on Profit Maring. The dependent variable is the average profit margin for the 12 rounds of play.

Panel A: Profit Margins Leaders and Followers

		Cost Information Asymmetry	Cost Information Symmetry	Effect Cost Information Symmetry
		Game A	Game B	Game A-B
Easy To Cooperate	Leaders	10.70%	11.69%	+0.99%(p=0.14)
	Followers	10.59%	11.95%	+1.36%(p=0.09)
		Game C	Game D	Game C-D
Unobservable Prices	Leaders	10.57%	9.50%	-1.07%(p=0.18)
	Followers	9.92%	8.91%	-1.01%(p=0.20)
		Game E	Game F	Game E-F
NoStarting Prices	Leaders	11.04%	7.58%	-3.46%(p<0.01)
	Followers	11.04%	8.45%	-2.59%(p<0.01)
		Game A-C	Game B-D	
Effect Ease Of Cooperation	Leaders	-0.13%(p=0.87)	-2.19%(p<0.01)	
	Followers	-0.67%(p=0.40)	-3.04%(p<0.01)	
		Game A-E	Game B-F	
	Leaders	+0.34%(p=0.70)	-4.11%(p<0.01)	
	Followers	+0.45%(p=0.63)	-3.50%(p<0.01)	

Panel B: Graphical Plots of the Average Profit Margins



Panel C: ANOVA-results Profit Margins Easy To Cooperate Versus Unobservable Prices

	Leaders		Followers	
	F-statistic	p-value	F-statistic	p-value
Ease Of Cooperation	4.03	0.05	10.89	<0.01
Cost Information Symmetry	0.00	0.95	0.10	0.75
EaseOfCooperation x CostInformationSymmetry	3.17	0.08	4.47	0.03
F-statistic Model	2.30	0.08	4.90	<0.01
R^2	8.12%		15.85%	

Panel D: ANOVA-results Profit Margins Easy To Cooperate Versus No Starting Prices

	Leaders		Followers	
	F-statistic	p-value	F-statistic	p-value
Ease Of Cooperation	5.10	0.03	5.22	0.03
Cost Information Symmetry	2.19	0.14	0.84	0.36
EaseOfCooperation x CostInformationSymmetry	7.09	<0.01	8.72	<0.01
F-statistic Model	4.52	<0.01	4.71	<0.01
R^2	16.22%		17.00%	

TABLE 5

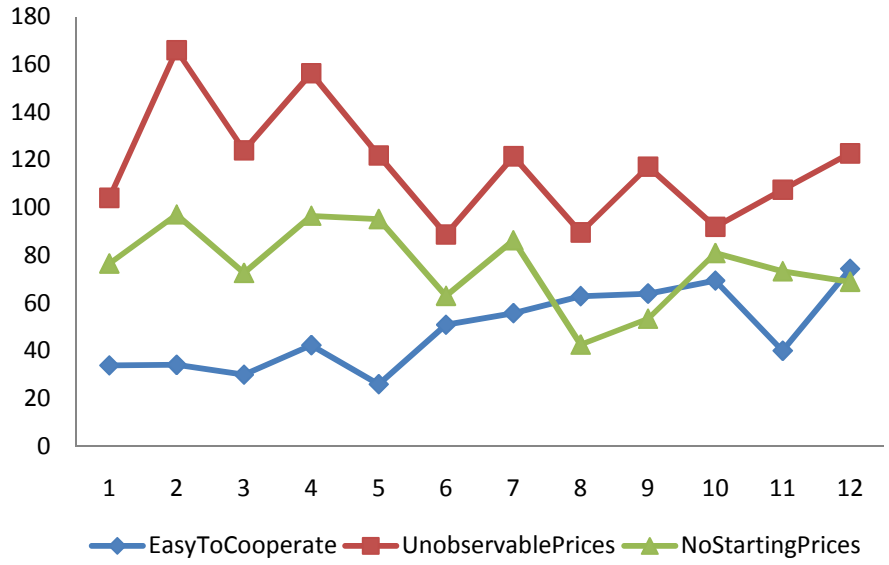
Price Differences Between Leader and Follower (PriceDifferenceCompetitors)

Panel A and Panel C show the average value of PriceDifferenceCompetitors (= $|P_{aLeader} - P_{aFollower}|$) for each round for market A and market B. The differences between the three conditions are expressed in absolute values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. Panel B and Panel D present a graph of PriceDifferenceCompetitors for market A and B.

Panel A: Average Values for PriceDifferenceCompetitor of Market A

Period	Easy To Cooperate	Unobservable Prices	No Starting Prices	Easy To Cooperate Versus Unobservable Prices	Easy To Cooperate Versus No Starting Prices	Unobservable Prices Versus No Starting Prices
1	33,94	104,10	76,59	70,15***	42,64	27,51
2	34,17	165,95	97,12	131,79***	62,95**	68,83
3	30,06	124,05	72,65	93,99***	42,59	51,40
4	42,39	156,33	96,59	113,94***	54,20*	59,75
5	26,06	121,90	95,18	95,85***	69,12**	26,73
6	50,94	88,71	63,06	37,77	12,11	25,66
7	55,78	121,52	86,29	65,75*	30,52	35,23
8	62,89	89,62	42,65	26,73	20,24	46,97*
9	64,00	117,19	53,48	53,19	10,52	63,71*
10	69,39	92,00	80,94	22,61	11,55	11,06
11	40,06	107,52	73,35	67,47***	33,30	34,17
12	74,33	122,76	68,94	48,43*	5,39	53,82*
Average	48,67	117,64	75,57	68,97***	26,90*	42,07**

Panel B: Graphical Plot of PriceDifferenceCompetitor of Market A



Panel C: Average Values for PriceDifferenceCompetitor of Market B

Period	Easy To Cooperate	Unobservable Prices	No Starting Prices	Easy To Cooperate Versus Unobservable Prices	Easy To Cooperate Versus No Starting Prices	Unobservable Prices Versus No Starting Prices
1	42,00	110,95	80,82	68,95**	38,82	30,13
2	48,39	128,14	63,18	79,75**	14,79	64,97*
3	23,83	143,48	102,47	119,64***	78,64*	41,01
4	66,56	171,81	98,24	105,25**	31,68	73,57
5	57,44	191,43	69,24	133,98***	11,79	122,19***
6	56,89	152,90	86,76	96,02***	29,88	66,14
7	53,56	159,38	60,12	105,83**	6,56	99,26**
8	56,72	202,71	76,71	145,99***	19,98	126,01***
9	52,28	204,95	64,82	152,67***	12,55	140,13***
10	40,44	212,90	45,88	172,46***	5,44	167,02***
11	52,17	205,81	87,47	153,64***	35,30	118,34***
12	58,83	187,67	88,00	128,83***	29,17	99,67**
Average	50,76	172,68	76,98	121,92***	26,22	95,70***

Panel D: Graphical Plot of PriceDifferenceCompetitor of Market B

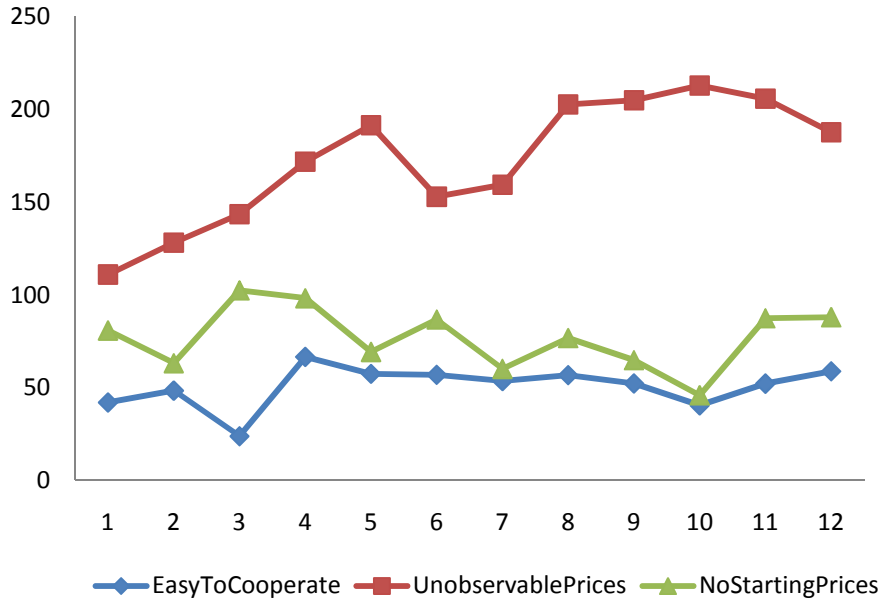


TABLE 6

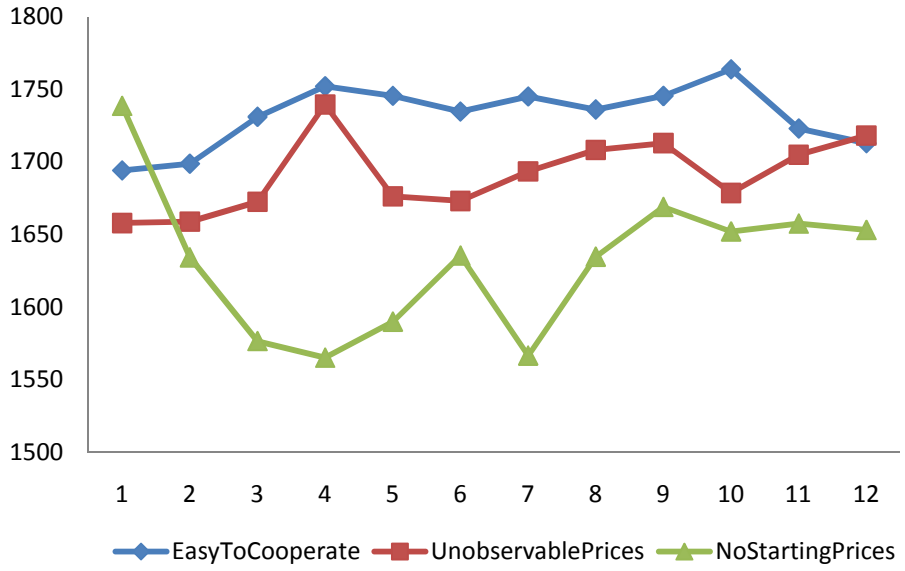
Price Market A

Panel A and Panel C show the average value of the price of market A for each round of leaders and followers. The differences between the three conditions are expressed in absolute values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. Panel B and Panel D present a graph of prices for market for leaders and followers.

Panel A: Average Values for Prices Market A Leaders

Period	Easy To Cooperate	Unobservable Prices	No Starting Prices	Easy To Cooperate Versus Unobservable Prices	Easy To Cooperate Versus No Starting Prices	Unobservable Prices Versus No Starting Prices
1	1694,22	1658,00	1738,76	36,22	44,54	80,76*
2	1698,83	1659,00	1634,35	39,83	64,48	24,65
3	1731,11	1672,67	1576,65	58,44	154,46***	96,02*
4	1752,22	1739,67	1565,24	12,56	186,99***	174,43***
5	1745,61	1676,38	1590,05	69,23	155,56***	86,33
6	1734,72	1673,19	1635,58	61,53*	99,15**	37,61
7	1745,17	1693,52	1566,65	51,64	178,52***	126,88**
8	1736,17	1708,29	1634,82	27,88	101,34**	73,46
9	1745,50	1713,05	1669,12	32,45	76,38	43,93
10	1763,83	1678,71	1652,18	85,12**	111,66*	26,54
11	1723,06	1704,95	1657,65	18,10	65,41	47,31
12	1712,94	1718,24	1653,24	5,29	59,71	65,00
Average	1731,95	1691,31	1631,19	40,64	100,76***	60,12*

Panel B: Graphical Plot of Prices Market A Leaders



Panel C: Average Values for Prices Market A Followers

Period	Easy To Cooperate	Unobservable Prices	No Starting Prices	Easy To Cooperate Versus Unobservable Prices	Easy To Cooperate Versus No Starting Prices	Unobservable Prices Versus No Starting Prices
1	1670,83	1655,52	1721,00	15,31	50,17	65,48
2	1703,67	1603,81	1631,94	99,86**	71,73	28,13
3	1707,72	1623,10	1588,24	84,63**	119,49**	34,86
4	1740,50	1643,43	1639,24	97,07***	101,26*	4,19
5	1738,56	1672,86	1629,69	65,70	108,86**	43,16
6	1730,78	1685,90	1624,99	44,87	105,79*	60,92
7	1758,83	1634,86	1613,88	123,98**	144,95**	20,97
8	1721,17	1643,62	1647,47	77,55**	73,70	3,85
9	1701,61	1636,71	1659,17	64,90**	42,44	22,46
10	1723,56	1644,52	1650,18	79,03**	73,38	5,65
11	1710,67	1657,33	1703,35	53,33*	7,31	46,02
12	1693,28	1675,00	1680,88	18,28	12,40	5,88
Average	1716,76	1648,06	1649,17	68,71***	67,59**	1,11

Panel D: Graphical Plot of Prices Market A Followers

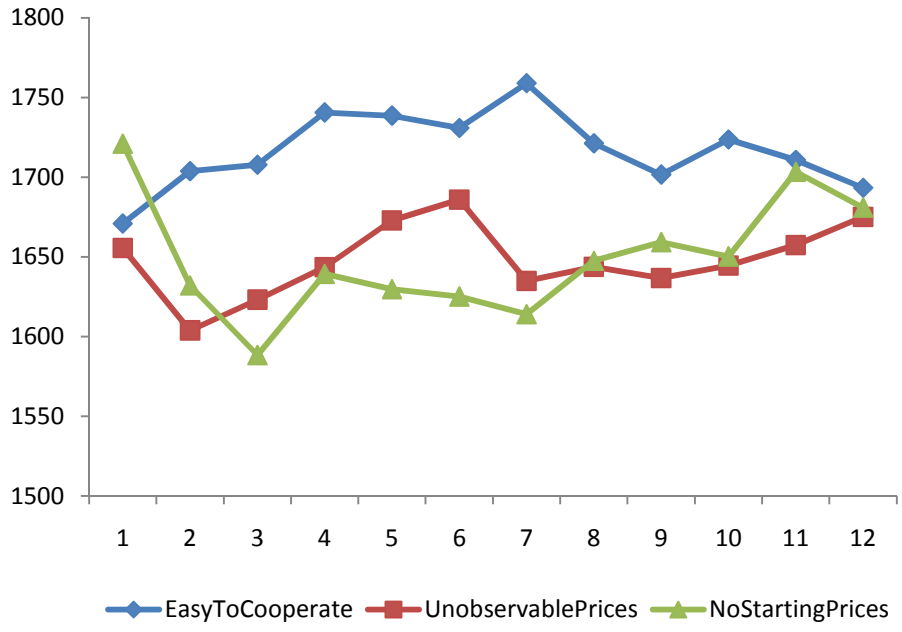


TABLE 7

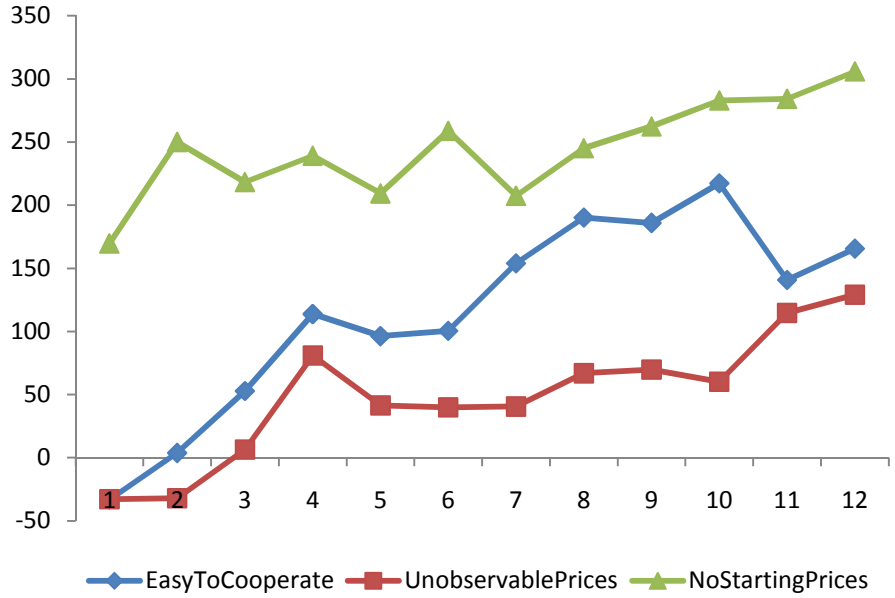
Price Differences Between Market A and Market B (PriceDifferenceMarket)

Panel A and Panel C show the average value of PriceDifferenceMarket (= $|P_{aLeader} - P_{bLeader}|$) for each round for leaders and followers. The differences between the three conditions are expressed in absolute values. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. Panel B and Panel D present a graph of PriceDifferenceMarket for leaders and followers.

Panel A: Average Values for PriceDifferenceMarket of Leaders

Period	Easy To Cooperate	Unobservable Prices	No Starting Prices	Easy To Cooperate Versus Unobservable Prices	Easy To Cooperate Versus No Starting Prices	Unobservable Prices Versus No Starting Prices
1	-33,00	-32,86	169,76	0,14	202,76***	202,62**
2	3,83	-32,14	250,06	35,98	246,23**	282,20***
3	52,83	6,38	218,29	46,45	165,46*	211,91***
4	113,78	80,90	239,18	32,87	125,40*	158,27***
5	96,28	41,48	209,34	54,80	113,06*	167,86**
6	100,50	39,90	258,75	60,60	158,25**	218,85***
7	153,89	40,52	207,47	113,37	53,58	166,95***
8	190,11	66,90	245,06	123,21*	54,95	178,15***
9	185,94	69,76	262,29	116,18*	76,35	192,53***
10	217,22	60,24	282,88	156,98**	65,66	222,64***
11	140,78	114,62	284,12	26,16	143,34**	169,50***
12	165,61	129,05	305,82	36,56	140,21**	176,78***
Average	115,65	48,73	244,42	66,92	128,77**	195,69***

Panel B: Graphical Plot of PriceDifferenceMarket of Leaders



Panel C: Average Values for PriceDifferenceMarket of Followers

Period	Easy To Cooperate	Unobservable Prices	No Starting Prices	Easy To Cooperate Versus Unobservable Prices	Easy To Cooperate Versus No Starting Prices	Unobservable Prices Versus No Starting Prices
1	-15,50	-73,62	206,94	58,12	222,44***	280,56***
2	10,72	-93,10	240,24	103,82	229,51***	333,33***
3	50,94	-51,14	229,88	102,09	178,94***	281,03***
4	71,94	-4,86	277,18	76,80	205,23***	282,03***
5	133,22	8,33	269,99	124,89*	136,77**	261,65***
6	127,11	49,24	243,64	77,87	116,52*	194,40***
7	208,78	63,24	294,82	145,54*	86,05	231,59***
8	209,61	80,10	250,76	129,52**	41,15	170,67***
9	183,22	67,62	285,99	115,60*	102,77*	218,38***
10	195,17	83,33	290,29	111,83*	95,13*	206,96***
11	169,00	92,33	291,18	76,67	122,18**	198,84***
12	198,11	93,29	316,18	104,83	118,07**	222,89***
Average	128,53	26,23	266,42	102,30**	137,90***	240,19***

Panel D: Graphical Plot of PriceDifferenceMarket of Followers

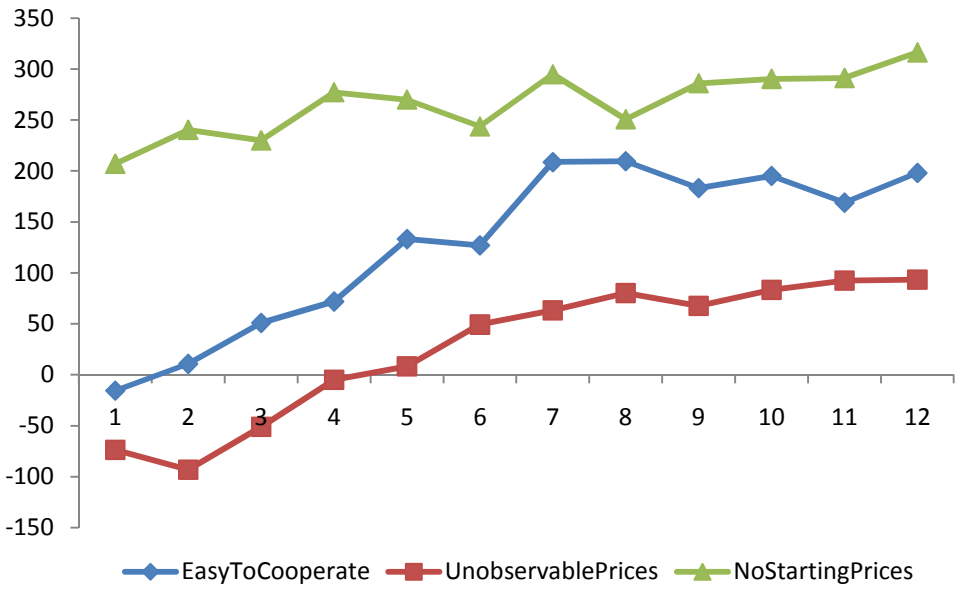


TABLE 8

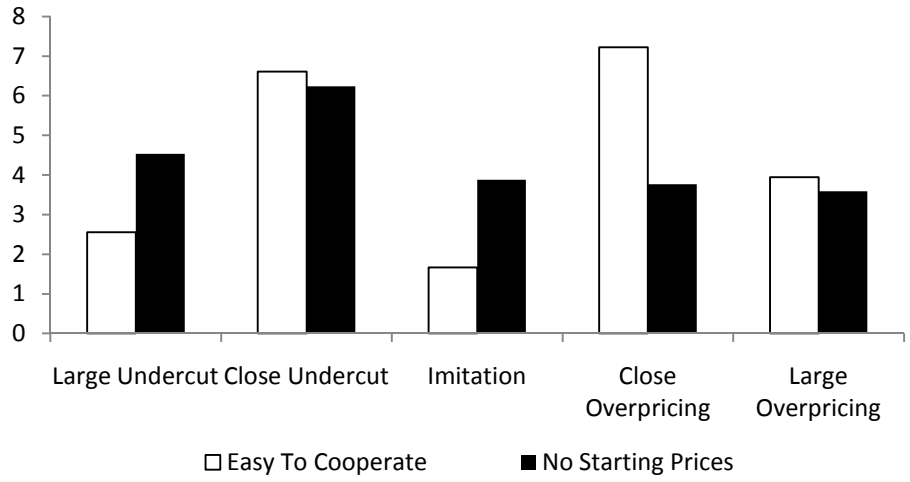
Overpricing and Undercutting

Panel A shows the average number of total undercuts, large undercuts, close undercuts, imitations, close overpricings, large overpricings, and total overpricings for leaders and followers. *, **, and *** denote significance levels of 10%, 5%, and 1%, respectively. Panel B and Panel C presents a graph of the average number of overpricings and undercuttings for leaders and followers.

Panel A: Overpricing and Undercutting Leaders and Followers

		Easy To Cooperate	No Starting Prices	Cooperation Versus No Starting Prices
Total Undercuts	Leaders	9,17	10,76	1,60
	Followers	17,61	10,94	6,67***
	Leaders Versus Followers	8.44***	0.18	
Large Undercuts	Leaders	2,56	4,53	1,97*
	Followers	3,33	3,82	0,49
	Leaders Versus Followers	0.77	0.71	
Close Undercuts	Leaders	6,61	6,24	0,38
	Followers	14,28	7,12	7,16***
	Leaders Versus Followers	7.67***	0.88	
Imitation	Leaders	1,67	3,88	2,22**
	Followers	2,33	4,94	2,61*
	Leaders Versus Followers	0.66	1.06	
Close Overpricings	Leaders	7,22	3,76	3,46**
	Followers	2,61	4,00	1,39
	Leaders Versus Followers	4.61***	0.24	
Large Overpricings	Leaders	3,94	3,59	0,36
	Followers	1,44	4,12	2,67**
	Leaders Versus Followers	2.5*	0.53	
Total Overpricings	Leaders	11,17	7,35	3,81**
	Followers	4,06	8,12	4,06**
	Leaders Versus Followers	7.11***	0.77	

Panel B: Graphical Plots of Leader's Overpricing and Undercutting



Panel C: Graphical Plots of Follower's Overpricing and Undercutting

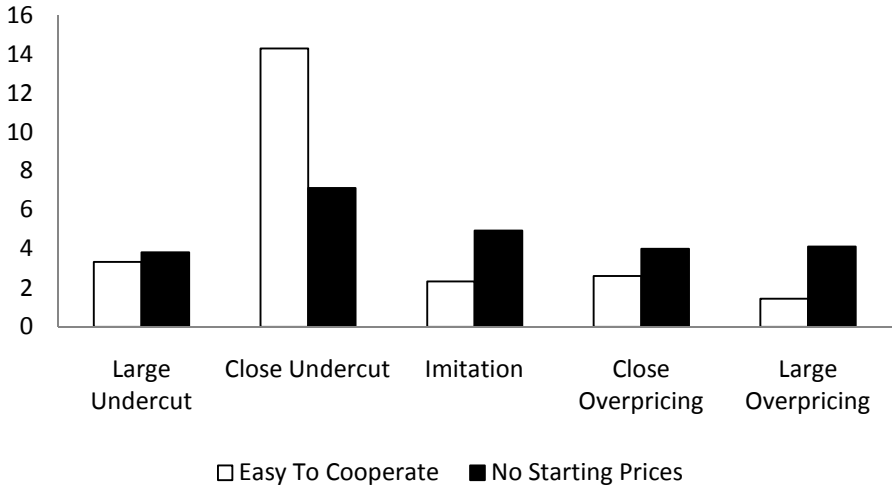


TABLE 9

Comparisons with Control Condition

Panel A shows, for Experiment 1, the average realized profits for leaders and followers for the 12 rounds of play with the control treatment included. Panel B contains the same statistics for Experiment 2. Comparison of the averages is based on a Tukey-Kramer test which controls for the fact that multiple pairwise comparisons are executed. Panel C and D present a graph of the average realized profits for leaders and followers with the control condition included.

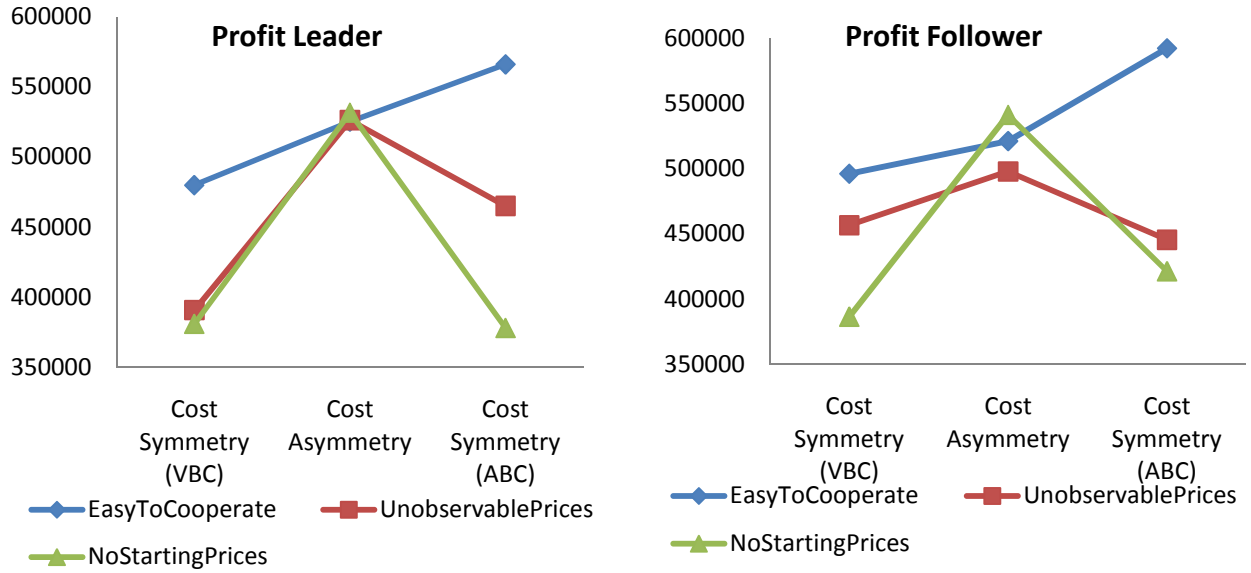
Panel A: Total Profits Leaders and Followers with Control Condition

	CostSymmetry (VBC)	Cost Asymmetry	CostSymmetry (ABC)			
EasyToCooperate	Game A	Game B	Game C	Game A-B	Game A-C	Game B-C
Leaders	479,942.675	525,237.261	566,040.693	p=0.15	p<0.01	p=0.18
Followers	496,191.829	521,235.831	592,601.036	p=0.36	p<0.01	p=0.01
UnobservablePrices	Game D	Game E	Game F	Game D-E	Game D-F	Game E-F
Leaders	390,803.179	526,278.998	465,082.437	p<0.01	p=0.12	p=0.18
Follower	456,640.260	497,947.325	445,483.702	p=0.33	p=0.78	p=0.24
NoStartingPrices	Game G	Game H	Game I	Game G-H	Game G-I	Game H-I
Leaders	380,978.7	531,681.6	378,069.2	p=0.07	p=0.96	p=0.06
Followers	386,267.4	541,440.2	421,190.4	p<0.01	p=0.55	p=0.04

EasyToCooperate Vs. UnobservablePrices			
	Game A-D	Game B-E	Game C-F
Leaders	p=0.03	p=0.98	p=0.02
Followers	p=0.22	p=0.55	p<0.01

EasyToCooperate Vs. NoStartingPrices			
	Game A-G	Game B-H	Game C-I
Leaders	p=0.11	p=0.92	p<0.01
Followers	p=0.02	p=0.64	p<0.01

Panel C:Graphical Representation of the Average Realized Profit (with Control Condition)



APPENDIX A[7]

Allocation Method for Accurate and Less Accurate Cost Reports

We allocate the costs for the leader using the initial prices of Experiment 1 ($P_{a\,L}$=1650; $P_{b\,L}$=1710 for the leader and $P_{a\,F}$ =1645; $P_{b\,F}$=1706 for the follower). The total indirect cost, calculated via equation 3c, is then equal to 2,521,118. A less accurate cost report uses sales volume (Qa and Qb, calculated via equations 1a and 1b) to allocate this total indirect cost to the two product markets. Accordingly, the two product markets have the same amount of indirect costs per unit of volume. A more accurate cost report divides this overhead into three categories, which represent respectively 35%, 40% and 25% of the total indirect cost. Overhead in these categories are then assigned by assuming cost drivers, in which market A always uses more of the cost driver per unit of sales volume than market B. As a result, the cost per unit volume is higher for market A than for market B.

Low-quality cost report

Total indirect cost = 2,521,118	Cost driver market A		Cost driver market B	
	Qa: 2,277.25		Qb: 699.3	
Indirect costs allocated to markets	$\frac{2{,}277.25*2{,}521{,}118}{2{,}277.25+699.3}$	1,928,815	$\frac{699.3 \times 2{,}521{,}118}{2{,}277.25+699.3}$	592,302
	Per unit of volume:	**847.0**	=	**847.0**

High-quality cost report

Total indirect cost = 2,521,118	Cost drivers market A	Cost drivers market B
Split up: 882,391.3 (35% of tot. indir. cost)	0.15 x Qa: 341.6	0.07 x Qb: 49.0
1,008,447.2 (40% of tot. indir. cost)	2.30 x Qa: 5237.7	1.20 x Qb: 839.2
630,279.5 (25% of tot. Indir. cost)	0.07 x Qa: 159.4	0.04 x Qb: 28.0

Indirect Costs Allocated to Markets				
	$\frac{341.6 \times 882{,}391.3}{341.6 + 49.0}$	771,790	$\frac{49.0 \times 882{,}391.3}{341.6 + 49.0}$	110,601
	$\frac{5{,}237.7 \times 1{,}008{,}477.2}{5237.7 + 839.2}$	869,189	$\frac{839.2 \times 1{,}008{,}477.2}{5237.7 + 839.2}$	139,258
	$\frac{159.4 \times 630{,}279.5}{159.4+28.0}$	536,191	$\frac{28.0 \times 630{,}279.5}{159.4+28.0}$	94,088
		2,177,171		343,947
	Per Unit of Volume	**956.1**		**491.8**

[7] Adapted from Cardinaels et al. (2008)

APPENDIX B[8]

Screenshot of Private Cost Report and Information about the Competitor

The tables show what participants can observe during each round. They can always observe information about the previous six rounds of play. Only players in de UnobservablePrices-treatment do not observe the prices of the competitor in the two markets. The figures are calculated based on the initial prices of Experiment 1($P_{a\,L}$=1650; $P_{b\,L}$=1710 for the leader and $P_{a\,F}$ =1645; $P_{b\,F}$=1706 for the follower). A less accurate cost report is introduced as 'volume based costing' while a more accurate cost report is introduced as 'activity based costing'. For the latter costing method, we identify three activities (order processing, software installations and delivery). The costs of these activities are allocated to the markets by three activity drivers (number of orders, installations and deliveries).

Historical Information

	Round 1	Round 2	Round 3	Round 4	Round 5	Round 6
Price Market A						
Price Market B						
Total Profits						
Price Market A (Competitor)						
Price Market B (Competitor)						
Total Profits (Competitor)						

VBC [***ABC***] Report

	market A	margin	market B	margin	Total	Margin
Price	1650		1710			
Sales Volume	2277		699		2977	
Revenues	3757463		1195803		4953266	
Cost of goods sold	1434668	38.2%	496503	41.5%	1931171	39.0%
Indirect costs*	1928815	51.3%	592302	49.5%	2521118	50.9%
Indirect costs*	***2177171***	***57.9%***	***343947***	***28.8%***		
	#	***costs***	***#***	***costs***		
Order processing	***341.6***	***771790***	***49.0***	***110601***		
Software installation	**5237.7**	**869189**	**839.2**	**139258**		
Delivery	**159.4**	**536191**	**28.0**	**94088**		
Profits	*393980*	*10.5%*	*106988*	*8.9%*	500977	10.1%
Profits	***145624***	***3.9%***	***355353***	***29.7%***		
Unit cost	1477.0		1557.0			
Unit cost	***1586.1***		***1201.8***			

* are allocated using sales volume as a cost driver

[#: respectively the number of orders, software installations and deliveries]

Report about your competitor

Price market A	1645
Price market B	1706
Total profit	500639

[8] Adapted from Cardinaels et al. (2008)