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DIAGNOSTIC MARKET FEEDBACK ATTENUATES THE BENEFITS OF ABC FOR COMPETITIVE PRICE SETTING IN A HETEROGENEOUS MARKET

by

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Diagnostic market feedback attenuates the benefits of ABC for competitive price setting in a heterogeneous market.

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ABSTRACT

Activity-Based Costing (ABC) is intended to assist managers to make better pricing decisions than those taken using traditional volume-based cost methods. The added value of ABC should be assessed against that of signals emanating from the competitive environment in which the firm operates. Prior research has often shown market-based information to be overwhelming, thereby calling into question the wisdom of investing in cost systems to better approximate actual costs. We compare experimentally the pricing decisions of decision makers in a price-competitive duopoly market, characterized by considerable heterogeneity in customer-serving costs. Our results show that the incremental value of ABC depends on the quality of market signals. Decision makers receiving uninformative feedback revert to costing data and ABC outperforms volume-based costing. The presence of a well-informed competitor attenuates but does not completely eliminate the value of ABC.

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1. Introduction

Price setting is a crucial but complex task for managers (Gijsbrechts, 1993). Managers are less than perfectly informed about future demand and need to rely on some form of cost-plus pricing, for which good accounting information is indispensable (Drury, 1997). One of the major problems to be solved is the allocation of marketing costs and other fixed costs to units. The still prevalent (Innes and Mitchel, 1995) volume-based cost allocation methods ignore cost heterogeneity across products and customers or segments. The resulting cost reports are biased, unreliable in terms of pricing decisions (Kaplan and Atkinson, 1998) and prone to cause dissatisfaction amount users (Foster and Gupta, 1994). Traditional systems produce biased cost figures because they use sales as the single volume driver. They will lead companies to charge similar prices for all types of customers (Shapiro, Rangan, Moriarty and Ross, 1987), even if some are served at a loss. High volume, standardized products (or easy to serve customers) are relatively overcosted, while low-volume, complex products (or difficult-to-serve customers) are relatively undercosted, leading to unsuitable pricing strategies (Cooper, 1988).

One important debate currently taking place relates to whether Activity-Based Costing (ABC) systems provide incremental benefits compared with traditional accounting practices in managerial decision-making (Briers, Luckett and Chow, 1997). ABC assumes that product costs are caused by activities. By using activity drivers as a basis for allocation, the actual resource consumption of different products within a firm is more accurately reflected in the product cost (Kaplan and Cooper, 1998). This more accurate cost information should result in superior product pricing strategies. Similarly, Customer Profitability Analysis (CPA) can assist managers to set appropriately differentiated prices among customers or market segments that are heterogeneous in terms of serving costs (Goebel, Marshall and Locander, 1998).

Recent evidence suggests that the benefits of ABC or CPA may have been overstated. Managers do not only have costing information to rely on. The business environment in which the firm and the decision maker operate offers potentially useful information (Waller, Shapiro and Sevcik, 1999). By observing competitors it is possible to learn about their pricing behavior and results (Briers, Chow, Hwang and

Luckett, 1999). Interacting with and observing customers makes it possible to identify the more costly products or market segments (Malmi, 1997). It has been argued that these natural sources of information may to a certain extent substitute for accounting information (Bruns and McKinnon, 1993). To the extent that there are alternatives for learning about costs and best managerial practice, the importance of the choice of an information system may be sharply reduced.

A limited number of experimental accounting studies have contrasted costing systems with contextual information. The value-enhancing effects of ABC depend on a firm's reward structure (Drake, Haka and Ravenscroft, 1999), on the complexity of the environment (Gupta and King, 1997; Cardinaels, Roodhooft and Warlop, 2000), and on the nature of the competition. Callahan and Gabriel (1998) proved that more accurate cost signals do not have any benefit when duopoly firms compete on the basis of price competition. We will build on their findings and investigate whether and when value-enhancing effects of ABC are obtained in a competitive environment in which decision makers have to differentiate prices across market segments.

2. Price strategies and the role of accounting information and market feedback.

With limited information about the parameters of cost and demand functions available to the decision maker, cost-plus pricing is procedurally rational (Noble and Gruca, 1999) and it is widespread in business practice (Drury & Tayles 2000; Shim and Sudit, 1995; Noble and Gruca, 1999). There has been a long line of accounting experiments investigating the effects of traditional absorption compared with variable costing information on pricing decisions (Ashton, 1976; Barnes and Webb, 1986; Dyckman, Hoskin and Swieringa, 1982; Hilton, Swieringa & Turner, 1988; Waller, Shapiro & Sevcik, 1999). The major limitation of this research is that only one product was considered and cost allocation was therefore not an issue. Given that cost-plus pricing is typically applied to full costs and firms have several products in different markets (Shim and Sudit, 1995), the question of how different full costing methods such as ABC and traditional systems affect pricing decisions seems opportune but has not received much attention (Foster and Gupta, 1994). The accuracy of the costing system would be especially important if the decision maker had no other information available. Managers may learn from experience if they receive feedback on the outcomes of their decisions, but such learning is known to be difficult and slow (Brehmer 1980). An illustrative experiment was reported by Briers et al. (1997). Participants in their study made production quantity decisions for two products. Those provided with garbled traditional cost information tended to fixate on unit costs and obtained poor results. Participants in the ABC group were provided with actual cost figures and made close to optimal decisions. Both groups received performance feedback and performance based rewards. Regardless of this, both groups relied heavily on the costing information and the differences between traditional information and ABC persisted.

If decision makers were to continue to rely solely on costing information to make decisions, even in the face of other available and diagnostic information, adaptability would degenerate to 'functional fixation' (Ashton 1976). In reality, the cost-plus price derived from the cost allocation system is rarely adopted without amendments (Drury, 1997). In the Briers et al. study (1997), little information was available in the environment. Real pricing decisions usually occur in competitive markets providing the decision maker with cues that can substitute for accounting data (Waller et al., 1999). Monitoring the actions and the performance of these best performing firms provides relevant cues for decision-making.

Briers et al. (1999) showed that participants receiving benchmark feedback (a trade association report about three best performing firms) together with a traditional distorted cost report and outcome feedback made closer to optimal product and pricing decisions compared with a control group receiving only outcome feedback and distorted cost data. They were able to incorporate the competitor data and did not merely fixate on biased cost numbers. Waller et al. (1999) studied whether differences between absorption and variable costing persisted in a competitive price setting market. Low performance sellers apparently learned from the pricing choices of other sellers. Given this opportunity to learn from market feedback, sellers revised their price offers towards an optimal level in a manner that compensated for absorption vs. variable costing.

Christensen and Demski (1995) stated that if the purpose of the costing exercise is to improve the function of a less than completely specified cost expression, the exercise is based on a cost-benefit test. Both the Briers et al. (1999) and the Waller et al. (1999) studies seem to suggest that the contribution of a costing system is limited: market feedback may to a large extent replace costly accounting information as a basis for pricing decisions. However, Briers et al. (1999) did not compare cost accounting systems. In addition, participants received benchmark feedback (report of best practice of other players that played the game), but they did not engage in a market setting involving any interaction between competitors. Waller et al. (1999) did consider an environment with several competing sellers, but they considered just one product and consequently cost allocation was not an issue. In both studies feedback about competitors was always informative. Briers et al. (1997) introduced information about hypothetical superior competitors. Waller et al. included enough sellers to guarantee superior pricing decisions of at least a few players. In both studies accounting information was redundant.

Both studies suggest not only that decision makers can learn from experience, but also that it may be hard to avoid using competitors' data in one's own pricing decisions if they are available. Salient competitor information tends to be used as a model and as a basis for comparison (Ferris and Mitchel, 1987, Frederickson, 1992). Frequently, feedback from competitors is not informative because they, too, have little knowledge of market conditions. Evidence in real and laboratory markets seems to suggest that competitors do indeed act with limited information and rationality (Coughlan and Mantrala, 1992). We will study the incremental value of more accurate but less than perfect accounting (ABC) information compared with traditional accounting information in competitive environment, by manipulating the information value of market feedback. Better accounting information may still be of help when competitor behavior has low signal value.

3. Experimental setting and predictions

We investigate a pricing decision task in a laboratory market consisting of decision makers playing against one competitor (duopoly) in two market segments. We add to the realism of the task by giving every subject customer descriptions and total profit feedback. The two market segments are heterogeneous in terms of costs, while the demand and cost functions in each are assumed to be stable. Participants undertake multiple trials and receive market feedback on each trial. Starting prices reflect an ecologically common distorted policy in which the market segment with the highest (lowest) cost-to-serve is often assigned the lowest (highest) price (Kaplan and Cooper 1998). We are deliberately starting from such a distorted pricing policy because this gives the decision maker ample room to improve. It also gives us the opportunity to study how market feedback and cost data can signal that the current distorted pricing policy needs adjustment. The value of information coming from the market is manipulated by contrasting a fully informed with a fully uninformed competitor.

In a competitive environment, participants may be faced with a competitor who does not have any superior knowledge of market demand and cost parameters. An uninformed competitor like this may therefore follow the subject's price choice within a random range. The market is unable to provide the decision maker with relevant information. Fixating on accounting numbers (Briers et al., 1997) then gives an advantage to the decision maker provided with more accurate cost data. Although it ignores demand, ABC provides the decision maker with cost data corresponding to actual cost behavior in both market segments. Participants can discover that the current distorted price policy is not in line with the cost of serving and learn much sooner to reverse the price pattern by charging higher (lower) prices for the high (low) cost-to-serve market. This should bring them closer to optimal profit performance. Participants with traditional information receive biased cost-to-serve data, suggesting that the actual low cost-to-serve market is in fact more costly. Fixating on biased costs slows down learning, leading to similar price distortions as the pricing policy initially adopted in subsequent decision making. This leads to following hypothesis:

H1: When the market is uninformative, providing decision makers with ABC data will result in closer to optimal price setting and higher performance levels.

In a competitive environment, decision makers can also be faced with a competitor informed about market parameters. Such a competitor has knowledge of both demand and cost parameters which enables him to set optimal prices, taking into account the participants' price choices. Due to the presence of a salient competitor, participants are more likely to engage in social learning in which they successfully imitate their competitor (Frederickson, 1992). This should result in superior performance. Learning occurs here by comparing decisions with available signals from competitors. Accounting information is therefore made redundant (Briers et al., 1999; Waller et al., 1999) because dominant cues available from the competition inform both participants with ABC and traditional information that the current pricing policy should be changed. This in turn has a positive effect on attaining the optimal state. The following hypothesis is formulated:

H2: When the market is informative, the cost accounting system does not contribute to the setting of prices and the resultant performance will be similar.

When decision makers are faced with an informed competitor, performance in terms of learning to reverse the distorted price pattern and closeness to optimal performance levels should be better. An informed competitor applies economic theory taking into consideration all market parameters. Decision makers imitating this price model incorporate demand and cost parameters into their price choices. Benchmark feedback therefore provides more relevant information, leading subjects to higher levels of performance (Iselin, 1996). When market feedback is uninformative, participants rely on accounting feedback. The performance may be expected to be much lower. First of all, an accounting report only contains information on costs (in the traditional case this is even a biased insight) and nothing on demand. It provides fewer relevant signals, leading to lower performance (Iselin, 1996). Secondly, the competitor provides irrelevant information, which may adversely affect the quality of the decision taken. This leads us to following hypothesis:

H3: Participants operating in an informative market learn to reverse the distorted price pattern more effectively and achieve closer to optimal performance compared with participants working in an uninformative market.

4. Experiment

4.1. Experimental market environment

Subjects compete against one competitor (modeled by the computer) on the basis of prices in an experimentally defined environment consisting of two market segments, A and B. A typical Bertrand demand function for differentiated products - e.g. products with differing brand names - was defined for each market segment[1] (Callahan & Gabriel, 1998):

$$Q_{is} = u_s - v_s P_{is} + w_s P_{js} \qquad \text{for } s = A,B \qquad (1)$$

where Q_{is} is the quantity of the product demanded for firm i, P_{is} is the price choice by firm i in market segment s (subject), P_{js} is the price choice by firm j (computer), u_s ($u_s>0$) is the demand in segment s when both firms charge zero prices and v_s, w_s (v_s, $w_s > 0$ and $v_s > w_s$) are fixed parameters for each segment s derived from the inverse demand function[2]. Table 1 shows parameter u, defined in such a way that market segment A is a high volume market while B is a low volume market. An important assumption for learning from benchmark feedback is that the situations being compared are similar (Frederickson, 1992). Therefore both firms face the same non-linear cost function within each market segment. The cost is defined as a second-degree function of output:

$$C(Q_{is}) = f_s + y_s Q_{is} + z_s Q_{is}^2 \qquad \text{for } s = A,B \qquad (2)$$

where f_s is the fixed cost for market segment s, and where y_s and z_s are fixed slope parameters. The parameters of the cost function are chosen such that the market segments are **heterogeneous** in terms of cost. Table 1 shows that market A is a high cost-to-serve market because it has a much higher fixed cost (parameter f) and

[1] We assume that parallel trade from market segment A to B is not possible (markets are separated).

[2] We set $v_s > w_s$ to make the firm's own price demand effect stronger than the competitor's cross-price demand effect. In our Bertrand demand function $v = 1/b(1-s^2)$ en $w = s/b(1-s^2)$; where b is the slope and s is the degree of substitutability between the products of firm i and j of the inverse demand function: $P_i = a - bQ_i - sbQ_j$ (Callahan & Gabriel, 1998). Given the values of v and w (see Table 1), we can derive s and b. In our example, market A has a higher degree of substitutability. ($s_A=0.367 > s_B=0.25$) and a shallower slope of the inverse demand function ($b_A=0.385 < b_B=0.888$).

because costs increase with larger amounts as output increases (parameters y and z). Consequently, market A incurs more costs than market B per unit of production. As market A has a high cost-to-serve, it requires higher prices in order to recover its costs. Market B allows for lower prices because its cost per unit of production is lower. However, at the beginning of the experiment, as matter of deliberate **distortion**, a slightly higher price for market B was charged compared with market A which was not in line with the actual cost of serving. This enabled us to test whether participants are able to learn that the current price policy needs adjustment.

Table 1: Parameters for the demand and cost functions in each market segment

	DEMAND			COST	
	Segment A	Segment B		Segment A	Segment B
u	5500	2250	f	1750000	700000
v	3.0	1.2	y	220	195
w	1.1	0.3	z	0.22	0.14

In this market environment, prices determine the quantity demanded which in turn determines costs. Therefore the firm's profit objective function can be written in terms of price choices and takes the following form:

$$\pi_{is} = P_{is}\,(u_s - v_s P_{is} + w_s\,P_{js}) - y_s(u_s - v_s P_{is} + w_s\,P_{js}) - z_s(u_s - v_s P_{is} + w_s\,P_{js})^2 - f_s \qquad s=A,B \qquad (3)$$

4.2. Experimental Design

Two factors were manipulated orthogonally and between subjects. The first factor was the value of information available from the market. After each trial, participants received a report from the competitor, who was facing similar market conditions, in which his price choices and corresponding total profit were indicated. Half of the subjects received **informative** market feedback from a superior competitor, fully informed about market demand and cost parameters, while the other half were provided with **uninformative** market feedback, modeled as a competitor with no knowledge of market parameters. The competitor (programmed by the computer) always moved second after participants had made their price choice. The competitor with complete insight into demand and cost parameters relating to the market is programmed to set an optimal price following economic theory, given a subject's price choice. Such a strategy results in superior performance because the competitor maximizes profits at the expense of a participant's profit. The competitor's optimal price reaction given the subject's price choice can be calculated by solving the first order condition (maximizing firm j's profit given P_i):

$$\mathbf{P_{js}} = \frac{(2\, u_s v_s z_s + u_s + v_s y_s) + (2\, v_s w_s z_s + w_s)\, \mathbf{P_{is}}}{2(v_s + v_s^2\, z_s)} \qquad (4)$$

The feedback from the market is informative because it provides the decision maker with cues regarding optimal behavior incorporating demand and cost effects. Learning occurs here by comparing own profits against the superior competitor benchmark.

The uninformed competitor was programmed to follow a participant's price choice within a random range. The overall performance of such a strategy is not superior to the performance achieved by the participant imitated. The competitor's random price reaction is calculated as an equation (5), with the parameter 'a' set at 2%, which means that the competitor's price lies somewhere between 98% and 102% of a subject's price choice:

$$\mathbf{P_{js}} = [(1 \pm a)\%\ \mathbf{P_{is}}] \qquad (5)$$

Due to random responses, the feedback received from the market is uninformative. Given the fact that decision makers' knowledge of market parameters is also limited, they are more likely to apply cost-plus pricing strategies. Here more accurate cost figures can make a difference because they reveal accounting numbers closely representing the actual cost to serve.

The second factor was the cost report. Half of the participants received **ABC information** (containing activity drivers) showing unit cost figures closely approximating actual cost-to-serve differences among market segments. The system used a two-stage procedure (Kaplan and Atkinson, 1998) in which the total real cost was first allocated to three marketing activity drivers, namely ordering, delivery and custom set-up. In the second stage the cost of each activity was allocated across the two market segments using these activity drivers. Market A required a lot more of these activities than market B, rendering it more costly to serve per unit. This corresponds to our assumed underlying reality. The other half received **traditional accounting numbers** allocating fixed costs based on overall sales volume across segments. In a **traditional cost report**, total actual costs are allocated to the two market segments using sales-volume as a driver. This driver is unable to differentiate effectively between the cost of servicing both market segments, resulting in a biased cost picture on market segment level. Appendix B shows how both ABC and traditional systems allocate real cost incurred to the two market segments. The unit cost information in the ABC system is a better approximation of the actual cost per unit of servicing each market.

4.3. Experimental procedures

Participants were recruited from an undergraduate cost accounting course at a large West European university. The course had covered the differences between ABC and traditional systems and had dealt with some Activity-Based Management issues such as applying ABC for customer or segment profitability analysis. A total of 131 students[3] completed the task on the computer. Subjects were randomly assigned to the four experimental conditions when entering the PC room. Each session lasted one hour. To increase motivation, subjects were notified in advance that the four best players would receive a gift coupon[4] for books or CDs worth the equivalent of approximately € 20.

Before beginning the experimental task, the participants saw a few computer screens describing the target company and their task. The target company was described as an importer of portable computers of a particular brand. The PCs were bought directly from the manufacturer and distributed by the company in two market segments. Market A consists of small PC shops, while market B covers business clients. In order to induce prior cost knowledge, participants were expressly told that both markets had different cost structures. The cost of goods sold in market A was

[3] The cell with traditional information and uninformative market feedback contained 32 participants, the three other cells each consisted of 33 participants.
[4] In reality, we rewarded the best player in each of our four experimental conditions with a coupon.

lower than in market B, but customers in market A ordered more frequently, and were more demanding with respect to service and delivery than the customers in market B. Participants were told that they were playing against a competing distributor of a different brand, operating in the same markets and facing similar cost structures. In case of uninformative market feedback, this competitor was described as a new market player, while in the other scenario he was introduced as an established market player.

The purpose of the task was to set selling prices for PCs within each market segment in order to maximize profitability. A price bracket[5] of between € 1100 and € 2200 was established. The target company's current price strategy was € 1650 for market A and €1710 for market B, which was not in line with the actual cost of serving the two market segments. Each subject had ten trials at their disposal to decide on prices in order to improve performance. After each decision, a cost report (ABC versus traditional) and a report on the competitor's price choices and his profit performance (random versus optimal price strategy) were issued to participants. The subject's price choices and total profits recorded for the last five trials, together with those of the competitor, remained on the screen. After the tenth trial, the task automatically finished and subjects received an exit questionnaire containing several items (on a five-point scale), checking motivation amongst other things. Participants were all highly motivated (average: 4.22) and more importantly, no difference was detected between the accounting report type ($F_{(1,127)}$: 0.01; $p > .92$) and the competitor's price strategy ($F_{(1,127)}$: 0.72; $p > .40$).

5. Results

A small number of participants experimented in a limited number of trials with the upper and lower limits of our constraints. For example, they would charge the lowest possible price (1100) for market A and the highest possible price (2200) for market B. Testing these extreme values resulted in profits far from the general trend. Neither the accounting systems, nor the different market feedback conditions, nor the starting values, indicate that these extremes would be appropriate as a pricing policy.

[5] This was done in order to ensure that quantities demanded remained positive at all times, given the competitor's price choice.

In 17 (1.3%) of the 1310 trial/participants observations (10 trials for 131 participants), an upper or lower limit was charged to one or two market segments. These data points are considered as outliers and are left out of subsequent analyses. In the first part of the results section we analyze whether the experimental factors influenced the learning process of the decision makers. In the second part we look at the consequences for performance.

5.1. Learning to reverse the price pattern

We introduced a biased price policy at the beginning of the experiment in the sense that prices were not in line with the cost of serving. Although market A incurred far more costs than market B, the initial price for market A was lower than for market B (Pa < Pb). Reaching the optimal state required a reversal in the pricing policy (Pa > Pb). For market A, a significant upward price adjustment was needed, while market B required a considerable downward adjustment. We tested whether participant learning was influenced by the nature of market feedback and the cost report. The following logistic regression was estimated:

$$LEARN_n = b_0 + b_1\,A + b_2\,M + B_3\,AM + B_4\,T,$$

where LEARN was 0 if the price for market A was lower than for market B (Pa < Pb) and 1 otherwise (Pa > Pb), for each trial/participant observation n (n=1293). Besides the influence of accounting system A (0 for traditional and 1 for ABC), market feedback M (0 for uninformative and 1 for informative) and their interaction AM on learning, we also expected that reversing the price pattern would become more likely as a decision maker gained experience with the experimental task. Therefore we added cumulative experience reflected by the trial number T (T=1, 2, …, 10) to the model (Gupta & King, 1997).

Table 2 shows the results of the logistic regression. Panel A shows that when market feedback was uninformative, participants provided with ABC were more likely to reverse the price pattern compared with participants with traditional information (H1). When the market feedback was informative, accounting information made no difference as regards learning, as was predicted by H2. However in this situation, people were much more like to reverse the initial price pattern, compared with participants receiving uninformative market feedback (H3), due to the more relevant nature of the cues from the competitor as opposed to accounting data.

Table 2: Results of the logistic regression

Panel A: Summary statistics

	TRAD	ABC
Market Uninformative		
% of observations where Pa > Pb	20.75%	51.26%
trial/participant observations (n)	318	318
Market Informative		
% of observations where Pa > Pb	96.96%	96.34%
trial/participant observations (n)	329	328

Panel B: logistic regression results

	All observations (n=1293)		Market uninformative (n=636)		Market informative (n=657)	
	estimate	p-value	estimate	p-value	estimate	p-value
Intercept	-2.9123	0.0001	-2.7423	0.0001	1.5932	0.0004
Account. System (A)	1.5478	0.0001	1.5185	0.0001	-0.1963	0.6594
Market Feedback (M)	5.1972	0.0001	-	-	-	-
Interaction (AM)	-1.7415	0.0003	-	-	-	-
Trial (T)	0.2580	0.0001	-0.2322	0.0001	0.4767	0.0001
p-value model		0.0001		0.0001		0.0001

Participants also gained experience during the task. As the number of trials increased, a subject was more likely to charge higher prices for market A compared with market B. The model with all observations in Panel B of Table 2 indicates that the effects are all significant, thereby confirming our hypotheses. Simple effects tests indicated that the effect of the 'accounting system' was indeed significant in the 'uninformative market feedback' condition, thereby reinforcing H1. However, the variable accounting system was not significant when the subset 'informative market feedback' only was taken into consideration, thereby confirming H2.

5.2. The effect on profit performance

In this section we analyze how the different experimental factors affect profit performance. We take the relative distance from optimal profit (%dev.π*) as the dependent variable[6]. Besides the main effects of accounting system (A), market feedback (M) and their interaction (AM), we expect people to improve over time. Again cumulative experience reflected by trial number T was added to our model. The following regression was tested:

$$\%dev.\pi^*_n = b_0 + b_1 A + b_2 M + B_3 AM + B_4 T$$

Table 3 shows the results of this regression. The model with all observations in panel B shows that the variable 'accounting system' is significant while the interaction term (AM) is not. This indicates that ABC has additional value when market feedback is both informative and uninformative. However, our hypothesis maintained that better accounting information would only have additional benefit (in terms of closeness to optimal profit) when market feedback was uninformative (H1) and not when it was informative (H2). Further analysis on each of the subsets indicates that the accounting system is less significant when playing against an informed competitor compared with playing against an uninformed competitor, indicating that here ABC seems to have less value[7]. The figure in panel A also seems to indicate that the value of ABC is much smaller when the informative market feedback is available. However, this type of feedback is not a complete substitute for better accounting data, as H2 had predicted.

The 'market feedback' factor is highly significant in our profit model. When market feedback is informative, all participants are much closer to optimal profit (H3). An informed competitor is able to apply economic theory incorporating demand and cost effects. Participants applying this benchmark to their own firm will therefore achieve a better profit performance. In the case of uninformative feedback, finding the optimal state is much more difficult because only cost information is available and the irrelevant behavior of the competitor might adversely affect profit performance.

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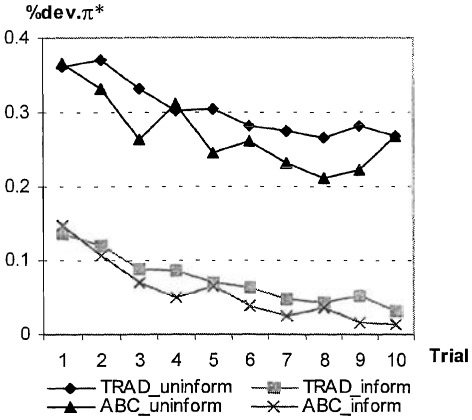
[6] $\%dev.\pi^*_n = (\pi^* - \pi_n)/\pi^*$ where π^* is the optimal profit and π_n is the profit recorded for each trial/ participant observation n. Given the fact that maximum achievable profitability fluctuates within an interval due to the random responses of the competitor in the case of uninformative market feedback (see appendix A), we take the upper limit of this interval as π^*.

[7] Similar inferences can be made from the semi-partial correlation r^2 as a measure of effect size. It indicates that the variable accounting system (A) explains more of the variance in profits when market feedback is uninformative ($r^2_{Acc.\ syst.} = 0.01253$) compared with the case where market feedback is informative ($r^2_{Acc.syst.} = 0.00693$).

Finally, the trial number is highly significant in all our models. Even in the worst-case scenario, adjustments are apparently not random. Subjects still move closer to optimal profit indicating that they improve with experience. Learning also occurs via total profit feedback.

Table 3: OLS regression results on the dependent variable %dev. π^*

Panel A: trial by trial relative distance to optimal π^* in each experimental condition



Panel B: OLS regression results on the model with dependent variable %dev.π^*

	All observations (n=1293)		Market uninformative (n=636)		Market informative (n=657)	
	Estimate	p-value	estimate	p-value	estimate	p-value
Intercept	0.3705	0.0001	0.3718	0.0001	0.1386	0.0001
Account. System (A)	-0.0332	0.0006	-0.0332	0.0038	-0.0165	0.0235
Market Feedback (M)	-0.2306	0.0001	-	-	-	-
Interaction (AM)	0.0167	0.2156	-	-	-	-
Trial (T)	-0.0120	0.0001	-0.0122	0.0001	-0.0118	0.0001
p-value model		0.0001		0.0001		0.0001
R-square	0.4852		0.0677		0.1222	

We also analyzed the relative distance against optimal prices as a dependent variable in each market segment. In this way, we were able to identify which price differences are responsible for the differences in profits obtained. The following additional explanatory regression models were tested:

$\%dev.Pa^*_n$[8] $= b_0 + b_1 A + b_2 M + B_3 AM + B_4 T$

$\%dev.Pb^*_n = b_0 + b_1 A + b_2 M + B_3 AM + B_4 T$

When the market feedback was **uninformative**, incremental benefits of ABC can be explained by price differences in both markets. The figure in panel A of Table 4 indicates that prices in both market A and B were closer to optimal prices. Analysis of the 'uninformative market feedback' subset indicated that accounting system had a significant impact for both price models (see panel B and C of Table 4). More accurate cost data provided the decision maker with additional information resulting in closer to optimal prices in both market segments.

ABC also proved a slight advantage when **informative market feedback** was presented. The figure in panel A of Table 4 shows that this small additional benefit can only be explained by price differences in market B. In fact, the accounting report type was not significant in the model with Pa (see panel B of Table 4). Here all decision makers improved by following the dominant benchmark provided by the competitor, regardless of the quality of the accounting information. However, the report type is significant in the price model Pb. People with traditional information are further away from the optimal price for market B compared with participants receiving ABC. The reason why participants with traditional information perform worse only in this market can be found in the displayed unit cost. The traditional scenario displayed a unit cost of around € 1450 in segment B. Although they followed the competitor by lowering the price for market B, participants did not completely ignore their cost data. They did not want to go below the 'psychological' cost limit of €1450, because then their accounting system would display a loss. In reality market B is at this level still profitable, and the optimal price was even considerably lower (€ 1362). Participants with ABC received a more accurate and lower unit cost for market B and continued to follow their competitor in market B, thereby moving much closer to the optimal price level[9]. We infer that if a traditional system had produced a

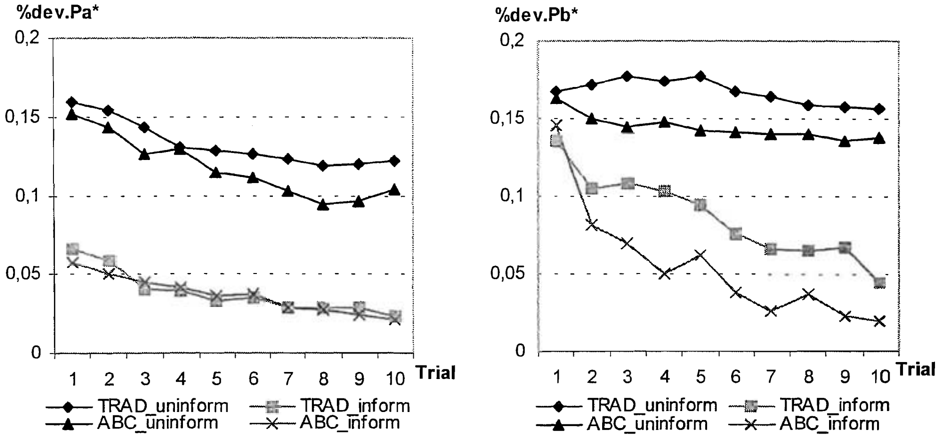
[8] $\%dev.Pa^*_n = abs(Pa^* - Pa_n)/Pa^*$ and $\%dev.Pb^*_n = abs(Pb^* - Pb_n)/Pb^*$ where Pa* and Pb* are the optimal prices and Pa_n and Pb_n are the prices actually charged for each trial/ participant observation n. The absolute value is taken because prices higher or lower than optimal are possible.

[9] The average Pb over the 10 trials for participants receiving traditional information is €1473.7, indicating that many participants did not go below their biased cost figure. Participants receiving ABC had an average Pb of €1396.9. They therefore achieved higher profits because they moved closer to the optimal price in market B.

smaller unit cost figure in market B, differences in the accounting report type for this market would have disappeared.

Table 4: Regression results for the dependent variables %dev.Pa* and %dev.Pb*

Panel A: trial by trial relative distance from optimal Pa and Pb in each experimental condition



Panel B: OLS regression results for the model with dependent variable %dev.Pa*

	All observations (n=1293)		Market uninformative (n=636)		Market informative (n=657)	
	estimate	p-value	estimate	p-value	estimate	p-value
Intercept	0.1578	0.0001	0.1613	0.0001	0.0602	0.0001
Account. System (A)	-0.0153	0.0001	-0.0152	0.0002	-0.0014	0.4906
Market Feedback (M)	-0.0941	0.0001	-	-	-	-
Interaction (AM)	0.0138	0.0021	-	-	-	-
Trial (T)	-0.0046	0.0001	-0.0052	0.0001	-0.0040	0.0001
p-value model		0.0001		0.0001		0.0001
R-square	0.5635		0.0978		0.0158	

Panel C: OLS regression results on the dependent variable %dev.Pb*

	All observations (n=1293)		Market uninformative (n=636)		Market informative (n=657)	
	estimate	p-value	estimate	p-value	estimate	p-value
Intercept	0.1992	0.0001	0.1785	0.0001	0.1397	0.0001
Account. System (A)	-0.0226	0.0001	-0.0226	0.0001	-0.0326	0.0001
Market Feedback (M)	-0.0793	0.0001	-	-	-	-
Interaction (AM)	-0.0100	0.2269	-	-	-	-
Trial (T)	-0.0058	0.0001	-0.0021	0.0406	-0.0094	0.0001
p-value model		0.0001		0.0001		0.0001
R-square	0.2887		0.0298		0.1528	

6. Discussion

Our experiment demonstrated that the benefits of ABC compared with traditional volume-based cost methods depend on the information value of market feedback. ABC had incremental value when market feedback was uninformative. ABC provided the decision maker with more accurate cost figures, which positively affected his or her learning and performance in terms of adjusting the decision process in the appropriate direction. Pricing decisions for participants receiving ABC were closer to optimal price levels, resulting in higher profitability compared with decision makers basing their price choices on biased cost information. In the case of informative market feedback, the benefits of ABC became mostly redundant. Although ABC still resulted in a profit advantage in one market segment, participants with biased cost data performed as well as people with ABC in terms of adjusting a distorted decision-making process in the right direction. The pricing choices of a well-informed competitor provided the necessary diagnostic information suitable for achieving performance improvement. Informative market feedback acted as a substitute for more accurate cost. What is more, when market feedback was informative, a decision maker's performance was much closer to optimal performance.

In our current design, the competitor was either fully informed or uninformed about the characteristics of the market environment. Follow-up studies could model competitors applying cost plus pricing. Improving the accuracy of one's own cost information would be less interesting if the decision maker were to compete against a competitor who has access to more accurate cost data. This better informed competitor might be considered as a benchmark for the decision maker's own firm. On the other hand, improving the cost system might still generate a competitive advantage when competitors use biased cost figures for price setting. Here ABC would provide the decision maker with more accurate insights into the market environment, leading to improvements in decision-making.

In this study, participants played against a competitor whose behavior was pre-programmed. It would be interesting for future research to increase the dynamics by playing subjects off against each other. A player with biased or more accurate cost information can be faced with one (or multiple) player(s) having biased or ABC information. Human competitors might often use irrational strategies, which do not occur when facing a programmed and thus consistent competitor. This makes learning from market feedback much more difficult. Investigating the role of ABC in these multi-period competitive environments is indeed an unexplored research area in accounting (Callahan & Gabriel, 1998) and deserves further investigation.

Although the current study did not incorporate the cost of implementing ABC, it still provides useful results for managers considering adopting ABC. Given the costly implementation procedure, it is more worthwhile undertaking an ABC exercise when competitors are known to be less informed. As the market becomes increasingly informative (e.g. more players that implement cost system refinements), investing in an expensive cost system seems less useful because one has the opportunity to compare performance against better-informed competitors. Future research should continue to investigate when, how and why the benefits of ABC occur in the light of alternative sources of information. Besides informative feedback from superior competitors, other factors may moderate the value of ABC.

Managers often have informal knowledge on the market environment in which they operate via interaction with customers, daily informal reports, feedback about the production process, their personal management experience, or mere intuition. Managers may consider these sources of information highly diagnostic and substitute them for accurate accounting information as well as for garbled cost information. However, just like formal accounting sources, these informal sources of information about customers or products are often incomplete or even incorrect. Rational managers should weigh the validity of cost accounting information and various informal sources, and base their decisions on the most valid source. A fascinating subject for future research is whether and when they actually do.

APPENDIX A

In this appendix we derive the best response for a participant in each market feedback condition. In this way we can derive the maximum achievable profit level for each condition. The profit function is expressed as follows:

$$\pi_{is} = Pi\ (u_s - v_s Pj + w_s\ Pi) - y_s(u_s - v_s Pj + w_s Pi) - z_s(u_s - v_s Pj + w_s Pi)^2 - f_s \tag{A1}$$

If market feedback is informative, the competitor sets following competitive price:

$$\mathbf{P_{js}} = \frac{(2\ u_s v_s z_s + u_s + v_s y_s\ ) + (2\ v_s w_s z_s + w_s)\ \mathbf{P_{is}}}{2(v_s + v_s^2\ z_s)} \tag{A2}$$

Substituting (A2) for (A1) results in a profit function written entirely in terms of P_i. Subsequently solving the first order equation, the following optimal best response is obtained for firm i, which maximizes the participant's profits.

$$\mathbf{P_{is}} = \frac{m_s - n_s\ y_s - 2\ z_s\ m_s\ n_s}{2n_s\ (z_s\ n_s - 1)} \qquad m_s = \left[u_s + \frac{w_s(2\ u_s v_s z_s + u_s + v_s y_s)}{2(v_s + v_s^2 z_s)}\right] \text{ and } n_s = \left[\frac{w_s^2(2v_s z_s + 1) - v_s}{2(v_s + v_s^2 z_s)}\right] \tag{A3}$$

When market feedback is uninformative, the competitor sets following random price:

$$\mathbf{P_{js}} = [(1 \pm a)\%\ \mathbf{P_{is}}] \qquad \text{On average: } \sum_{n=1}^{\infty} \frac{P_{js}}{n} = \mathbf{P_{is}} \tag{A4}$$

This competitor actually follows the participant. Substituting (A4) for (A1), the profit function can be written entirely in terms of P_i. Subsequently solving the first order equation, the following best response will maximize profitability:

$$\mathbf{P_{is}} = \frac{u_s + v_s\ y_s - w_s y_s + 2u_s v_s z_s - 2u_s w_s z_s}{2\ (v_s - w_s + v_s^2 z_s - 2v_s w_s z_s + z_s w_s^2)} \tag{A5}$$

Table A1 displays the optimal prices and corresponding maximum profits for each market feedback condition. The competitor's arbitrary responses if the market is uninformative cause fluctuation in the subject's maximum profits.

Table A1: optimal prices and maximum profitability

	Market Informative	**Market Uninformative**
Pa_i	1833.8	1951.6
Pb_i	1362.4	1476.5
$Profits_i$	941184	[958194, 1057318]

APPENDIX B

This appendix shows how costs actually incurred over both market segments are allocated to the different market segments using ABC or traditional accounting information. We only show the analysis for the setting in which market feedback is uninformative. The analysis of the setting with informative feedback is similar. At the beginning of the experiment, the target firm charged a price of € 1650 for market A and € 1710 for market B. Table A1 shows a random response of the competitor and the actual results in terms of the profit achieved by the decision maker's own firm. The price pattern charged by the decision maker's own firm is not in line with the cost of serving, in the sense that market A is actually more costly to serve than market B, which is not reflected in the prices (see Table B1):

Table B1: The initial price policy and corresponding actual results

	Firm i	Competitor
Pa	1650	1635
Pb	1710	1740

Profits and actual unit costs for firm i

	Segment A	margin	Segment B	margin	Total	margin
Sales Volume	2349		720		3069	
Price	**1650**		**1710**			
Revenue	3875850		1231200		5107050	
Cost	3480696	89.8%	912976	74.2%	4393672	86.0%
Profit	395154	10.2%	318224	25.8%	**713378**	**14.0%**
Cost/unit	**1481.78**		**1268.02**			

We assume that part of the actual cost incurred over the two markets (4393672, see shaded area in Table B1) is in fact the cost of goods sold. Products are imported at a fixed price and each imported product is in fact also sold. In our setting, the import price for market B is slightly higher than that for market A:

Cost of goods sold (COS) $= 659.35 * Qa + 694.8 * Qb$
$= 659.35 * 2349 + 694.8 * 720 = 2049069$

The remaining part of total actual cost incurred (4393672 – 2049069 = 2344603), defined here as customer costs, is allocated to the two market segments using different cost accounting systems. An ABC system uses a two-stage procedure to allocate this customer cost to market segments (see Table B2). In the first stage, costs are spread over three cost-to-serve activities - ordering, delivery and software installation – on the basis of the time that each activity takes. In the second stage, the cost of each activity is allocated to the market segments on the basis of activity drivers. As Table B2 indicates, market A requires more activities (more orders, deliveries and custom design) in our experiment than market B. Hence, market A incurs more costs per unit, corresponding to economic reality (see unit cost in panel B of Table B2).

Table B2: Underlying assumptions in the ABC condition and the ABC report

Panel A: assumptions of the ABC system

Stage 1: Allocating cost to activities		**Stage 2: Activity drivers for each market segment**		
	% of time		**Activity level per 100 units**	
			Segment A	**Segment B**
Order processing	35 %	No Orders	15	6
Software installation	40 %	No licenses	230	120
Delivery	25 %			

Panel B: ABC report

		Segment A	margin	Segment B	margin	Total	Margin
Sales Volume		2349		720		3069	
Price		1650		1710			
Revenues		3875850		1231200		5107050	
Cost of goods sold		1548813	40.0%	500256	40.6%	2049069	40.1%
Customer Costs		2038315	52.6%	306288	24.9%	2344603	45.9%
	Driver rate	*Drivervol.*	*Costs*	*Drivervol.*	*Costs*	*Drivervol.*	*Costs*
Order process.	*2075*	*352*	*730988*	*43*	*89623*	*395*	*820611*
Softw. Install.	*150*	*5403*	*808540*	*864*	*129302*	*6267*	*937841*
Delivery	*3033*	*164*	*498788*	*29*	*87363*	*193*	*586151*
Profits		288722	7.4%	424656	34.5%	713378	14.0%
Unit Costs		**1527.09**		**1120.20**			

In a traditional accounting report, customer costs are allocated to the two market segments using sales volume as a driver. By using this driver, it can be seen from Table B3, that market B is a high cost-to-serve market per unit, which is due to the fact that the cost of the goods sold on market B is slightly higher. Sales as a cost driver is unable to differentiate between the cost of servicing the two market segments.

Table B3: Traditional cost report

	Segment A	margin	Segment B	margin	Total	Margin
Sales Volume	2349		720		3069	
Price	1650		1710			
Revenues	3875850		1231200		5107050	
Cost of goods sold	1548813	40.0%	500256	40.6%	2049069	40.1%
Customer Costs	1794550	46.3%	550053	44.7%	2344603	45.9%
Profits	532487	13.7%	180891	14.7%	713378	14.0%
Unit Costs	**1423.31**		**1458.76**			

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