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**THE VALUE OF MORE ACCURATE CUSTOMER PROFITABILITY REPORTS: DOES COST COMPLEXITY MATTER?**

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# The value of more accurate customer profitability reports: Does cost complexity matter?

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## ABSTRACT

This paper reports experimental evidence on the potential benefits of reporting different levels of customer-related information in a pricing decision context. The paper mainly focuses on the influence of the complexity of the cost environment -measured by the degree of heterogeneity across customers- on the value of more accurate customer profitability systems. Contrary to the findings of Gupta & King (1997) our results indicate that the value of more accurate cost reports increases, as the cost environment becomes more complex. In addition we find that, compared to a situation where decision makers receive only general profit feedback, reports based on traditional costing systems improve the quality of the pricing decision only in a complex cost environment.

**Keywords:** Activity based costing, Decision making, Cost complexity, Price setting

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## 1. INTRODUCTION

This paper reports the results of an experiment designed to study the effect of cost complexity on the value of more refined customer profitability reports in a pricing decision task. Many articles indeed emphasize that customers differ in absolute or relative profitability because each dollar of revenue does not contribute equally to net income (Foster, Gupta & Sjoblom, 1996). In some companies no attempt is made to relate revenues and costs to customers or customer groups. In other companies the assignment of marketing, selling and administrative costs is based on traditional cost systems using arbitrarily cost drivers such as sales dollars (Kaplan & Cooper, 1998). Finally, more refined customer profitability reports based on activity based costing information can be used to identify customers that are more or less expensive to serve.

Research as to in which environments these more refined customer profitability reports enhance managerial decision making is practical non-existing (Foster & Gupta, 1994). The management accounting literature has developed some general practitioner's rules concerning environments that require more refined cost information. One of the most cited rules relates to increased heterogeneity in resource usage among customers (Cooper, 1988; Foster & Gupta, 1990; Anderson, 1995). It is argued that the cost environment becomes increasingly complex when customers make different use of the firm's various kinds of support functions like delivery, order processing, etc...(Kaplan & Cooper, 1998). Simple forms of feedback on customers then fail to reveal hidden cost and profits for each customer. Firms may therefore require a more accurate cost system. While cost complexity and heterogeneity are indeed important drivers for firms to adopt ABC (Krumwiede, 1998), the question whether ABC in fact enhances decision making and resulting profitability in these more complex cost settings remains largely unanswered.

Our central research question relates to this point of view. In a price differentiation task across customers, we investigate whether the benefits of accurate customer profitability reports depend on the level of **cost complexity**, which is manipulated by the degree of heterogeneity in resource usage across customers. Contrary to prior findings (Gupta & King, 1997), our results show that more accurate profitability reports based on ABC compared to other report types allow for better price

differentiation and improved profits in a complex cost environment where customers place heterogeneous demands on the firms support functions. In simple cost settings a much smaller benefit of cost system accuracy was obtained. In addition, we find that compared to a situation in which participants received aggregated feedback on customers, a traditional cost report only performs better in a complex cost setting.

## 2. THEORETICAL BACKGROUND

An important debate in today's accounting literature relates to the typology of environments where more accurate information will lead to higher decision quality. The main reason is that managers making decisions have other types of information or cues available for improving these decisions (Malmi, 1997; Bruns & Mckinnon, 1993). Briers, Chow, Hwang & Luckett (1999) for example show that in simple settings decision makers with biased cost data can already make close-to-optimal pricing and output decisions when other types of feedback such as information on past performance (outcome feedback) and resource usage (process feedback) are available. This may strongly reduce the effect of more accurate cost data.

In more complex environments the use of this existing information is assumed to be more difficult (Bonner & Walker, 1994; Brehmer, 1980). Bonner (1994) studied the effect of audit task complexity on audit judgment performance. She found that an increase in task complexity resulted in a less optimal usage of existing knowledge and corresponding performance decreased. McIntyre & Ryans (1983) studied the effect of complexity on decision quality in traveling salesperson problems. In their experiment, subjects in a more complex environment were found to perform less well on the decision task. On the other hand, Busemeyer, Swenson & Lazarte (1986) argued that when it becomes more difficult to learn from existing cues, providing additional and relevant feedback may facilitate learning again. Accurate cost data that reveals actual cost differences across customers can be considered as such feedback, which may improve the quality of the decision again in a more complex environment.

In addition to different kinds of profitability reports, subjects received in our experiment also other types of feedback, like rank information on the resource usage of customers and general profit feedback. When applying the previous arguments to

cost complexity, we expect that in simple cost settings characterized by homogeneous resource usage, subjects can use other available information like feedback on resource usage to improve pricing decisions and resulting profitability, making an accurate profitability report highly redundant. However when resource usage across customers becomes more heterogeneous and more complex it is more difficult to use these other types of information (Bonner & Walker, 1994) to improve pricing decisions. Here we expect that more refined profitability reports will strongly enhance pricing decisions and resulting profitability compared to other report types, because they provide more relevant feedback on profit and cost differences across customers. To summarize, our first and main research question tests whether a more refined customer profitability report as opposed to other report types has more value in a complex cost environment.

As far as we know, Gupta & King (1997) have been the only authors to study the effect of environmental complexity on the value of more accurate cost reports accompanied by outcome feedback and rank information on resource usage. They however did not find evidence to support the hypothesis that a more refined cost system would have more value in a complex cost setting. Our experimental task differs from theirs. We introduced a more dynamic price setting task which in itself was more complex (Busemeyer et al., 1986). In addition we gave updates of the customer reports after each period, since in reality managers also make pricing decisions using continuously updated cost reports.

The second research question examines whether traditional profitability reports, displaying additional customer data based on arbitrary drivers, have any value compared to reports in which no data on customers is received (aggregated feedback). Because we already stated that existing cues might improve decisions in a simple environment, our analysis concentrates on the difference in value of both report types in a complex cost setting. Regarding the effect of additional accounting data on the quality of managerial decisions, Iselin (1988, 1996) argues that accounting info influences decision quality via information load and data load. Information load is the number of cues relevant to the decision to be made and will normally improve the quality of the decision. Data load refers to the cues in the accounting report that are not relevant to the decision and will normally reduce decision quality, since decision makers must learn to recognize and filter out these irrelevant cues (Iselin, 1996).

Following this reasoning, it is difficult to predict whether profitability reports using arbitrary cost drivers would have any value compared to aggregated feedback, since the additional feedback is the result of both relevant and irrelevant cues. The displayed "accounting profit" on customers contains indeed relevant components such as sales and revenues. On the other hand, it also contains highly irrelevant components, since arbitrary cost drivers cause a biased and irrelevant cost picture on customer level[1].

## 3. EXPERIMENT

### 3.1. Experimental setting

This section provides an overview of the functions that are used in the experimental setting. Since we have two different cost environments (see 3.2. experimental factors) appendix A shows the parameters of the functions both for a simple and complex cost environment. The experimental setting had three different customers denoted by A, B and C. For each customer, demand was a downward sloping function of prices:

$$Q_i = a_i - b_i P_i \qquad \text{(with i = customers A, B and C and } Q_i \geq 0) \qquad (1)$$

Participants, acting as price setters, had to differentiate prices among these customers based on their cost of serving. The cost of goods sold (COS) for each customer is calculated by using formula (2). Parameters (appendix A) are chosen in such a way that the cost of goods sold barely differs across customers.

$$COS_i = c_i \; Q_i \qquad \text{(i = customers A, B and C)} \qquad (2)$$

Variations in cost-to-serve mainly stem from customers consuming various amounts of resources in four different sales activities. Table 1 displays the names of each of the four activities, together with the kind of resources consumed in each activity. The more resources (e.g. the number of orders generated) a customer consumes, the more

[1] Note: One could also compare profitability reports based on ABC with aggregated feedback. ABC is assumed to improve performance since it provides more accurate and relevant cost data on customers.

costs this customer will incur for this activity. The relation between the cost of a sales activity ($CSA_{ij}$) and a customer's resource usage is characterized by formula (3):

$$CSA_{ij} = (1/1000)(ru_{ij}\ dr_j)\ Q_i \qquad (3)$$

with i = customers A, B, C and j = sales activity 1, 2, 3 and 4

$ru_{ij}$ = customer i's resource usage of sales activity j (per 1000 units sold)

$dr_j$ = Driver rate for one unit of resource j

Table 1: The four sales activities and resources used by customers

| **Sales Activity (SA)** | **Resources Used (ru)** |
|---|---|
| SA1: Sales generation | # sales calls |
| SA2: Order processing | # orders |
| SA3: Internal logistics | # stock pickings |
| SA4: Delivery | # deliveries |

The actual cost incurred for each customer is calculated as the sum of the cost of goods sold and the cost of the four sales activities. In general, customer B was per unit the most costly customer to serve, followed by A and C (Appendix A). The participant's goal was to set prices -given different cost information- that would maximize profits[2]. The optimal price for each customer ($P_i^*$) is determined by solving the first order condition for the firms profit function[3]:

$$P_i^* = \frac{a_i + b_i\ (c_i + \Sigma_{i=1}^{4}(1/1000)\ ru_{ij}\ dr_j)}{2\ b_i} \qquad (4)$$

Since our primary focus is on costs, parameters (appendix A) were set in a manner that actual unit cost differences between customers were reflected in the optimal price pattern (Pb>Pa>Pc).

[2] In our experiment subjects act as managers of firms with complete discretion on prices which is similar to the setting of Hilton, Swieringa & Turner (1989). A competitive element by including competitors in the experiment (Waller, Shapiro & Sevcik, 1999) was not considered.

[3] This price maximizes profits since the second derivative of the firms profit function is < 0 (second order condition for a maximum).

### 3.2. Experimental factors

Two factors were manipulated between subjects. The first factor was the **accounting report type**. Subjects did not receive actual cost data, but received various profitability reports as shown in appendix B. The accounting report type could have three values:

1. *No information on customers (NO_INFO):* This report type only displays aggregated sales, revenues, cost and profit information. Participants did not receive any profitability data on individual customers.
2. *Traditional accounting information (TRAD):* Next to aggregated data, profitability reports for each single customer are shown. The costs of the four sales activities are gathered into a single cost pool which is allocated to customers using 'sales' as single volume driver. Since 'sales' does not capture differences in resource usage among customers, participants receive highly biased cost cues on customer level, which may adversely affect their decision performance. However, compared to the no-info case, extra cues received on customers may have some incremental benefit.
3. *Activity Based Costing (ABC):* In this profitability report, the costs of the sales activities are assigned to customers according to their resource usage. This cost report makes a small aggregation error (Datar & Gupta, 1994) since the cost of the sales activities sales generation (SA1) and order processing (SA2) are gathered into a single cost pool, which is then allocated to customers on the basis of the number of orders[4]. Regardless this error, ABC provides the most accurate cost picture for each individual customer (see ABC-report in appendix B).

The second factor was **cost complexity**. Subjects are assigned to either a simple or a more complex cost environment. The cost structure was made more complex by increasing the heterogeneity in resource usage among customers (Gupta & King, 1997). Due to increased heterogeneity customers behave differently for each sales activity which increases processing load making the task more complex (McIntyre & Ryans, 1983; Bonner, 1994). Since managers often have a fairly good idea of the

[4] Since resource usage of SA1 strongly resembles resource consumption patterns in SA2, the aggregation error is rather small.

resource consumption pattern of their customers (Malmi, 1997; Briers, Chow, Hwang & Luckett, 1999), participants in both cost environments received rank ordering data on the different resources that customers consume (table 2). This information is derived from the actual resource information in appendix A. Rank information on "sales calls" is omitted, since the most elaborated cost report (ABC) does not use this driver either.

Table 2: Rank ordering information on resource usage

Panel A: Displayed table on rank information in the simple cost environment

| Resources | A | B | C |
|---|---|---|---|
| Orders | 2 | 1 | 3 |
| Stock Pickings | 2 | 1 | 3 |
| Deliveries | 2 | 1 | 3 |

**Homogeneous resource usage**
Compared to other customers, Customer B uses the most resources in each sales activity

Panel B: Displayed table on rank information in the complex cost environment

| Resources | A | B | C |
|---|---|---|---|
| Orders | 2 | 3 | 1 |
| Stock Pickings | 1 | 2 | 3 |
| Deliveries | 3 | 1 | 2 |

**Heterogeneous resource usage**
Customer B needs the most deliveries but requires the lowest number of orders

In the simple environment (panel A of table 2) the resource usage across customers was homogeneous. Customer B always used the most resources in every single sales activity (needed the highest number of orders, stock pickings and deliveries) while customer A and C were always ranked second and third. Customer B was hence the most costly customer followed by A and C. Rank ordering data already identified potential cost differences across customers, which may reduce the value of accurate cost accounting cues (ABC). Although in the complex environment, customers incurred almost the same cost as in the simple environment (see appendix A), the rank ordering of resource usage for each sales activity was highly heterogeneous across customers (panel B of table 2). For example, Customer B used the highest number of deliveries, but at the same time he required the least number of orders. Increased heterogeneity in resource usage makes rank information less useful for identifying the most costly customer. Therefore, the value of extra accounting cues on customers, especially cost data that more accurately identify cost differences across customers (ABC) is expected to increase as cost complexity increases.

### 3.3. Participants and procedures

Participants -on average 22 years old - were recruited from an MA-level cost accounting course at a large West European university. The course had dealt with traditional accounting methods, ABC and customer profitability analyses. A total of 170 students completed the task on a computer. Participants were randomly assigned to one of the six experimental cells when entering the PC-room. Each session lasted one hour. To induce motivation, subjects were notified in advance that the best six players - with the highest average profit realized over all experimental trials - would receive a 20 € gift coupon exchangeable against CD's or books[5].

At the start of the experiment subjects received a few pages of instructions describing the case company and their task. Participants were instructed to improve profitability by differentiating prices across customers. An initial cost report (see appendix B) and the product rank information of table 2 were also provided at the start. In order to introduce prior knowledge on cost, participants were expressly told that cost varied across customers due to the fact that customers used different amounts of resources (orders, stock pickings and deliveries) in the distribution process.

Participants had 10 trials to improve the firm's profitability. A price bracket of between €100 and €160 was established for each customer. Because prices at the start were not in line with the actual cost-to-serve (see table B1, appendix B), there was ample opportunity to improve. After each decision on prices, the rank ordering information of a customer's resource usage (for either the simple or complex environment) and an updated cost report (NO_INFO, TRAD, ABC) were issued to participants. The prices and the realized total profit for the last five trials always remained on screen. After the last trial, the experimental task automatically finished and subjects had to fill in an exit questionnaire containing several items (on a five point scale) checking for motivation among other things. Participants were highly motivated (average: 4.25) and importantly no significant differences were detected for accounting report type ($F_{(2,164)} < 1$, ns) and for cost complexity ($F_{(1,164)} < 1$, ns).

[5] In reality we rewarded the best player in each of the six experimental cells with a coupon. Average profit was taken as a reward, in order to restrict people from taking risky decisions for one of the trials. McIntyre & Ryans (1983) use a similar compensation scheme.

## 4. RESULTS

### 4.1. Manipulation checks

Items in the post questionnaire tested subject's perceived value of the supplementary rank information and their perceived benefit of cost data on customers. Concerning the role of rank information, items revealed that participants in the simple cost setting indeed considered the rank information more useful for identifying the costly customer ($F_{(1,164)} = 34.85$, $p<.01$) and considered it as more relevant for the pricing decisions ($F_{(1,164)} = 34.55$, $p<.01$) compared to people in the complex setting. A main effect of accounting report type was not detected for these items. These analyses indicate that the perceived complexity was lower in the simple cost setting. Analysis on the perceived use of additional cost data[6] on customers indicated that for both cost environments people with ABC took cost data on customers more into consideration when making decisions ($F_{(1,110)} = 3.35$, $p<.07$). More importantly, subjects receiving traditional information had a feeling that their reported unit cost was more biased ($F_{(1,110)} = 6.99$, $p<.01$) compared to participants receiving ABC. We have thus created a strong test for the value of ABC in a complex environment. If additional test would indicate that people receiving ABC would still outperform those receiving traditional information, we can argue that knowing your cost system is biased is not enough to improve performance[7].

### 4.2. The effect on profit performance

This section reports the results of an Anova analysis with the mean relative distance against optimal profit (%dev.$\pi_i$*) over the 10 trials as a dependent variable[8] and accounting report type (TYPE) and cost environment complexity (ENVIR) as between subjects factors. The lower the %dev.$\pi_i$*, the closer one is to optimal profit:

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[6] Analysis were only run for traditional and ABC cost data, since in the no information condition participants did not receive additional cost data on customers.

[7] Managers often call into question the wisdom of investing in ABC systems (Malmi, 1997; Narayanan & Sarkar, 2002), since they are able to debias distortions introduced in their existing cost systems by means of experience (Dearman & Shields, 2001). Our test can indicate whether ABC still provides incremental value even if decision makers know their cost system is producing biased cost data.

[8] %dev.$\pi_i$* = ($\pi$*- $\pi_i$)/$\pi$* where $\pi$* is the optimal profit and $\pi_i$ is the average realised profit over the 10 trials for each participant i. The optimal profit $\pi$* can be found in appendix A.

$$\%dev.\pi_i^* = b_0 + b_1\ TYPE + b_2\ ENVIR + b_3\ TYPE*ENVIR$$

Table 3: Anova analysis on the variable $\%dev.\pi_i^*$ and reported means per experimental cell.

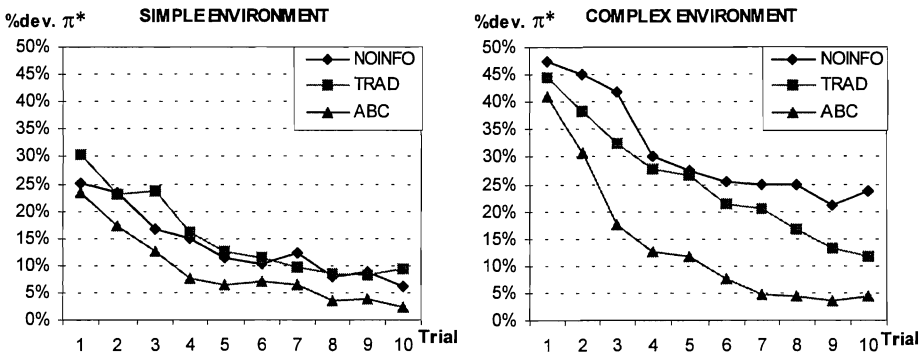
| *Source of variation* | *P-value* |
|---|---|
| TYPE | 0.0001 |
| ENVIR | 0.0001 |
| TYPE*ENVIR | 0.0142 |
| MODEL | 0.0001 |

| | NOINFO | TRAD | ABC |
|---|---|---|---|
| **Simple Cost** | | | |
| mean % dev. $\pi$ | 13.67% | 14.90% | 9.00% |
| # subjects (n) | 28 | 29 | 29 |
| **Complex Cost** | | | |
| mean % dev. $\pi$ | 31.18% | 25.33% | 13.75% |
| # subjects (n) | 28 | 28 | 28 |

Results of this Anova analysis are summarized in table 3. Both main effects 'TYPE' and 'ENVIR' are significant. More importantly, our significant interaction term shows that the effect of the report type becomes more pronounced in a complex cost setting. The means indicate that the difference between ABC and TRAD information in the simple environment is smaller (5.9%) compared to the complex environment (11.58%). In a similar way, the difference between ABC and NO_INFO increases as complexity of the environment increases (from 4.67% to 17.43%). Another interesting effect is that while there is almost no difference in performance between TRAD and NO_INFO in the simple environment, people with traditional information are closer to optimal profit when cost complexity has raised. Overall, we can conclude that the value of extra cues on customer increases as cost complexity increases. Even more, the value of more accurate profitability data on customers (ABC) increases as the resource usage among customers is more complex.

To further understand the effects of the different accounting report types on profits, we have tested some additional models. Since subjects naturally gain experience in the task, these models take into account an overall learning effect captured by trial number (T). The factors accounting report type (TYPE) and complexity of the cost environment (ENVIR) have to be seen as deviations from this overall learning effect. These effects are displayed by figure 1. A linear-log relationship between realized profits and trial number is expected, since improvements in profits during the initial trials are larger compared to latter trials.

Figure 1: trial by trial relative distance from optimal $\pi^*$ for each experimental cell




Three separated models were tested since we compare the performance of the accounting report types one by one. Because of evidence of first order serial correlation, parameters of the models were estimated using the Yule-Walker method to correct for serial correlation in the data:

$$\%dev.\pi_{it}^* = b_0 + b_1\ TYPE + b_2\ ENVIR + b_3\ TYPE*ENVIR + b_4\ log(T)$$

with $\%dev.\pi_{it}^*$ = the deviation from optimal profit for participant i in trial t;
ENVIR is 0 for simple and 1 for complex cost; T = trial 1, 2, …, 10;
Model 1 → NOINFO vs. ABC; Type is 0 for NOINFO and 1 for ABC;
Model 2 → TRAD vs. ABC; Type is 0 for TRAD and 1 for ABC;
Model 3 → NOINFO vs. TRAD; Type is 0 for NOINFO and 1 for TRAD.

The results of the three models are presented in panel A of table 4. In each model the trial effect is significant, indicating that people move towards optimum because of accumulated experience (Gupta & King, 1997). Consistent with arguments in the literature (Bonner, 1994; McIntyre & Ryans, 1983), participants in complex cost environments are further removed from optimal profit.

In model 1, the variable 'TYPE' is marginally significant indicating that the value of ABC over NO_INFO is small in a simple environment. However the interaction term, which is significant at the 1% level, indicates that the profit advantage of ABC over NO_INFO is higher in a complex cost environment. Similarly, because 'TYPE' and

the interaction with environment are significant in model 2, one can conclude that the value of ABC over traditional accounting data increases as cost complexity has raised. Similar inferences can be made from figure 1 and the analysis by environment in panel B of table 4. Since, in a simple environment the rank ordering data are highly informative, the profit effect of ABC over other report types is marginal significant. However, cost accuracy matters more in a complex cost scenario since the effect on profit of an ABC report compared to other report types is larger and highly significant. Regarding the first research question the following conclusion can be made: In a complex cost setting with heterogeneous customers a more accurate ABC report provides **increased benefit** for decision making since it is more difficult to use other types of feedback (such as data on resource usage) for improving decisions.

Table 4: Regression results of the three models

Panel A: Regression estimates and significance levels for the three models

| Variable | Model 1 NOINFO/ABC | Model 2 TRAD/ABC | Model 3 NOINFO/TRAD |
|---|---|---|---|
| Intercept | 0.2997*** | 0.3275*** | 0.2933*** |
| TYPE | -0.0393* | -0.0503** | 0.0124 |
| ENVIR | 0.1865*** | 0.1103*** | 0.1869*** |
| TYPE*ENVIR | -0.1487*** | -0.0675** | -0.0908** |
| log (T) | -0.1108*** | -0.1213*** | -0.1046*** |
| R-square | 0.5714*** | 0.5902*** | 0.6073*** |

Panel B: The effect of accounting report type analyzed by environment;
Model: $\%dev.\pi^* = b_0 + b_1 \text{ TYPE} + b_2 \log (T)$

| Parameter estimate | **Simple Cost** | **Complex Cost** |
|---|---|---|
| TYPE (NOINFO/TRAD) | 0.0148 | -0.0765*** |
| TYPE (TRAD/ABC) | -0.0437* | -0.1165*** |
| TYPE (NOINFO/ABC) | -0.0372* | -0.1855*** |

Significance: * p<.10 level; ** p <.05 level; *** p < .01 level

Regarding the second research question, model 3 does not show a significant effect of accounting report type. However, the interaction term is significant at the 1% level, indicating that a traditional cost report outperforms the no information scenario only in the complex cost condition. Figure 1 and the analysis in panel B of table 4 reinforce

these results. Apparently, only when rank information is not informative, the extra cues on customers that decision makers receive in a traditional report seem to add value, even if some cues like the reported unit cost are highly irrelevant (Iselin, 1996).

### 4.3. Additional analysis

In order to explain why the profit effect occurred we identified price differences that are responsible for the deviations in profits. The relative deviation from optimal prices for each customer was taken as a dependent variable[9]. The following three regression models[10] were ran separately for each cost setting. Since log(T) was always significant, panel A of table 5 only displays the results for 'accounting report type':

$\%dev.PA_{it} = b0 + b1\ TYPE + b2\ log(T)$

$\%dev.PB_{it} = b0 + b1\ TYPE + b2\ log(T)$

$\%dev.PC_{it} = b0 + b1\ TYPE + b2\ log(T)$

Table 5: Analysis on prices charged

Panel A: parameter estimates and significance levels of 'report type' in the auto-regression models on prices

| | Simple Cost (envir=0) | | | Complex Cost (envir=1) | | |
|---|---|---|---|---|---|---|
| Parameter estimate | PA | PB | PC | PA | PB | PC |
| type (noinfo_trad) | -0.0086 | 0.0130 | 0.0055 | 0.0003 | -0.0143 | -0.0501*** |
| type (trad_abc) | -0.0015 | -0.0307*** | -0.0203** | -0.0217*** | -0.0413*** | -0.0290*** |
| type (noinfo_abc) | -0.0100 | -0.0201** | -0.0171** | -0.0220*** | -0.0559*** | -0.0805*** |

Significance: * p<.10 level; ** p <.05 level; *** p < .01 level

Panel B: % observations with PC ≤ € 104 or PC ≥ € 144 for each experimental cell.

| | Simple Cost | Complex Cost |
|---|---|---|
| NO INFO | 5.36% | 20.36% |
| TRAD | 2.76% | 3.21% |
| ABC | 5.17% | 6.43% |

[9] $\%dev.PA_{it}^* = abs(PA^* - PA_{it})/PA^*$ with $PA^*$ the optimal price for customer A (see appendix A) and $PA_{it}$ the price charged for participant i in trial t. The absolute value is taken because prices above and below optimum are possible. Similar formula for PB and PC.

[10] Parameters were again estimated using the Yule-Walker method to correct for first order correlation in the data.

*4.3.1. ABC versus other accounting reports*

Results show that in a simple environment, the marginal effect of ABC on profits compared to other report types is due to significant price differences for customer B and customer C (high and low cost-to-serve customers) and not for customer A. Although in a simple cost setting rank information is highly informative, ABC apparently still adds some value by indicating how far one can go for the least and most costly customer to serve. As resource usage becomes however more complex the effect of accurate profitability reports compared to other report types strongly increases due to the fact that ABC is much closer to optimal prices for all three customers (see panel A).

*4.3.2. Traditional accounting reports versus no information*

Previous analysis on profits showed that a traditional profitability report outperformed no information only in a complex cost setting. Apparently only for customer C in a complex cost environment, participants receiving a traditional report are closer to optimal prices (see panel A of table 5). Hence, compared to no info, the extra cues received on customer C seem to provide some value. Decision makers with traditional cost data actually learned to avoid to extreme prices for customer C which positively affected their performance. When PC was set to high (PC $\geq$ € 144) or to low (PC $\leq$ € 104), a biased cost report would produce an 'accounting loss' for this customer. To avoid such an unfavorable outcome in future (Tversky & Kahneman, 1991), subjects quickly refrained from charging these extreme prices. This general preference to avoid losses is labeled by Tversky & Kahneman (1991) as "loss aversion". On the other hand, subjects receiving no additional customer cues longer continued to charge prices far below or above optimum for customer C in a complex cost scenario[11]. From panel B in table 5 it is clear that only the cell 'NO_INFO/Complex cost' has a very high percentage of observations with PC $\geq$ €144 or PC $\leq$ €104. In a simple cost setting this effect did not occur since participants of both report types avoided highly sub-optimal prices for customer C due to informative rank ordering data on the resource usage of each customer.

[11] For customers A and B this effect did not play, since a traditional accounting report displays these customers still as profitable at high price levels. At low prices the system shows indeed a loss for these customers. However participants did not test low prices for customer A and B.

*4.3.3. Testing the "loss aversion" hypothesis*

In order to test whether the phenomenon of "loss aversion" explained the differences in profits between traditional and no information in a complex condition a new variable "LOSS" (with LOSS is 1 if PC ≥ 144 or PC ≤ 104 and 0 otherwise) was created. We want to explore whether "LOSS" is a 'mediating' variable between the dependent variable "%dev.π" and the independent variables "TYPE(noinfo_trad)" and "LOG(T)" in the complex cost setting. We therefore examined the three criteria proposed by Baron & Kenny (1986). First, the independent variable(s) should have a significant effect on the dependent variable. Second the independent variable(s) should have a significant effect on the presumed mediator. Third when both the independent variable(s) and the mediator are included in the model, the mediator should have an effect on the dependent variable but the effect of the independent variable(s) should be reduced. The test strongly supported the mediational hypothesis. When "LOSS" was added to the model the significant effect of "TYPE(noinfo_trad)" on profits (see panel B of table 4) was reduced to nonsignificance ($t=1.55$, $p>0.1$) while the effect of "LOSS" remained highly significant ($t=11.21$, $p<.001$). To conclude, only when rank information is not informative (complex cost) participants with a traditional report outperform people with no information, because the specific cues (profit) on customer C restrained them from charging prices far below or above optimum, to avoid "accounting losses" for this particular customer.

## 5. DISCUSSION

Our experiment investigated the effect of different customer profitability reports on pricing decisions. In contrast to prior evidence (Gupta & King, 1997), our results demonstrated that cost complexity (resource usage among customers is highly heterogeneous) indeed has a value enhancing effect on the benefits of more accurate profitability reports (using ABC) compared to other accounting report types. As cost becomes more complex, the more difficult it is to learn from existing information cues (e.g. rank information on resource usage) in the decision environment and the more advantaged is then the decision maker which has access to more accurate and relevant cost accounting cues (ABC).

If we compare our results with those of Gupta & King (1997) we can argue that a dynamic decision task in which subsequent decisions are based on a sequence of updated cost reports is necessary for investigating the value enhancing effects of cost report accuracy in complex cost scenario's. In the setting of Gupta & King (1997) subjects only received a cost report at the start of the experiment while in the following periods only profit feedback was available. This rather static decision setting made it difficult to detect any incremental value of cost system refinement in a complex cost setting. Moreover, in real life, managerial decision making is typically assisted with continuously updated cost reports.

Additionally, our results showed that traditional profitability reports provided incremental value over displaying no information on customers only in a complex cost setting. We advance important evidence on the debate whether highly biased cost systems do provide any benefit at all. Although traditional profitability reports report irrelevant cues (e.g. reported unit cost), our analysis showed that they have some value in a sense that decision makers learned to avoid "accounting losses" for one particular customer. This aversion to accounting losses (Tversky & Kahneman, 1991) was beneficial since it prevented the decision maker from testing prices that were far away from the optimal price. Additional research should also explore scenarios where accounting losses produced by garbled cost systems may hinder profit improvement.

While we raised complexity by making resource usage among customers more heterogeneous, many other sources can increase cost complexity. The use of non-linear cost functions and random cost shocks further raises cost complexity (Bonner, 1994; Busemeyer et al. 1986). This opens an interesting avenue for future research. It provides a direct test for investigating if growing levels of cost complexity will set certain limits to the benefits of cost system accuracy. A second path to further explore the value of ABC is to add a competitive element by introducing other market players with different levels of cost information to the setting. In this way managers receive information from the market. However this market feedback can sometimes be highly incorrect (e.g. competitor is less informed). Managers should weigh the validity of their own accounting cues against the market feedback received. A fascinating question is whether managers are able to filter out the information that is most relevant for the decision they are faced with.

## APPENDIX A

TABLE A1: Parameters of the simple and complex cost environment

| | | SIMPLE | | | COMPLEX | | |
|---|---|---|---|---|---|---|---|
| | | **A** | **B** | **C** | **A** | **B** | **C** |
| Demand | a | 200000 | 330000 | 295000 | 200000 | 330000 | 295000 |
| | b | 1240 | 1790 | 2050 | 1240 | 1790 | 2050 |
| Cost of goods sold | c | 55 | 54.5 | 56 | 55 | 54.5 | 56 |
| Cost sales activities | | | | | | | |
| dr1 = 3000 | ru1 | ***3.4*** | ***4*** | ***3*** | ***3*** | ***2*** | ***3*** |
| dr2 = 1500 | ru2 | ***3*** | ***5*** | ***2.5*** | ***4*** | ***3*** | ***5*** |
| dr3 = 2000 | ru3 | ***8*** | ***11*** | ***6*** | ***13*** | ***11*** | ***2*** |
| dr4 = 1500 | ru4 | ***9*** | ***13*** | ***5.75*** | ***4*** | ***17.5*** | ***5*** |
| Cost per unit $= c_i+\Sigma_{j=1}^{4}(1/1000)*ru_{ij}*dr_j$ | | 99.1 | 118 | 88.5 | 99 | 118 | 88.5 |
| Optimal Price | P* | 130.2 | 151.2 | 116.2 | 130.1 | 151.2 | 116.2 |
| Maximum profit | π* | 4742537 | | | 4746396 | | |

## APPENDIX B

This appendix displays the different accounting report types subjects receive at the start of the experiment. These reports are automatically updated and issued after each pricing decision. We only show analysis for a simple cost environment. Analysis for the complex environment is similar. Since we want to have an idea how closely each cost report approximates actual cost, table B1 displays the actual figures using the formulas of section 3.1. together with the parameters of appendix A.

Table B1: Profitability report using actual cost information

| | **A** | **B** | **C** | **TOT** |
|---|---|---|---|---|
| Selling price | 119 | 117 | 131 | |
| Sales | 52440 | 120570 | 26450 | 199460 |
| Revenues | 6240360 | 14106690 | 3464950 | 23812000 |
| Cost of goods sold | 2884200 | 6571065 | 1481200 | 10936465 |
| Cost sales activities | 2312604 | 7656195 | 859625 | 10828424 |
| *Sales calling (SA1)* | *267444* | *723420* | *119025* | *1109889* |
| *Order processing (SA2)* | *471960* | *1808550* | *198375* | *2478885* |
| *Internal logistic (SA3)* | *629280* | *1989405* | *238050* | *2856735* |
| *Delivery (SA4)* | *943920* | *3134820* | *304175* | *4382915* |
| **Profit** | **1043556** | **-120570** | **1124125** | **2047111** |
| **Unit Cost** | **99.1** | **118.0** | **88.5** | |

From table B1 it is clear that prices are not in line with actual cost-to-serve (customer B has a high cost-to-serve but receives the lowest price). Participants need to differentiate prices among customers using imperfect cost reports. Participants receiving **no information** on customers receive only the last column with aggregated profit feedback. They do not receive any information on customers (see table B2).

Table B2: Displayed figures in the 'no information on customers' condition

| | **TOT** |
|---|---|
| Sales | 199460 |
| Revenues | 23812000 |
| Cost of goods sold | 10936465 |
| Cost sales activities* | 10828424 |
| **Profit** | **2047111** |

* cost of order processing, internal logistics and deliveries

In the **traditional accounting report** (see table B3) the cost of all four sales activities (cost of sales activities=10.828.424) are gathered into a single cost pool. This cost pool is allocated to customers via the driver 'sales' which does not reflect the actual resource consumption pattern of customers. Compared to actual cost information (Table B1), traditional accounting cues produce a highly biased cost picture. By fixating on these biased figures, participants may perform worse than in the no info scenario were such figures are not available. On the other hand, the extra info on customers contains also relevant components, which may enhance performance.

Table B3: information received in a traditional accounting report.

| | **A** | **B** | **C** | **TOT** |
|---|---|---|---|---|
| Selling price | 119 | 117 | 131 | |
| Sales | 52440 | 120570 | 26450 | 199460 |
| Revenues | 6240360 | 14106690 | 3464950 | 23812000 |
| Cost of goods sold | 2884200 | 6571065 | 1481200 | 10936465 |
| Cost sales activities* | 2846899 | 6545588 | 1435936 | 10828424 |
| **Profit** | **509261** | **990037** | **547814** | **2047111** |
| **Unit Cost** | **109.3** | **108.8** | **110.3** | |

* Order processing costs, internal logistic costs and delivery costs. Allocated to customers using **sales volume** as a driver.

In the **ABC condition** subjects receive a cost report as is displayed in table B5. Table B4 shows that cost are allocated to customers according to the resource usage. The ABC system however makes a small aggregation error since the cost of sales activity

"SA1: sales generation" and "SA2: order processing" are aggregated into a single cost pool which is allocated to customers using the number of orders as cost driver. Since the aggregation error is small, the cost per unit and the profitability per customer using an ABC report (see Table B5) strongly resembles actual figures (see table B1). Participants using this accurate ABC data for price differentiation should outperform subjects receiving other report types, especially in scenarios were it is more difficult to learn from existing information.

Table B4: Cost calculation details under ABC (were not shown to participants)

**POOL 1 (SA1 +SA2)** → Cost driver: # orders

Total cost to be assigned = 1109889 +2478885 = 3588774 (actual cost report → table B1)

↳(info appendix A)

| | | |
|---|---|---|
| *A: (3/1000)*52440* | *= 157.32 orders* | *→(157.32/826.295)*3588774 = 683274* |
| *B: (5/1000)*120570* | *= 602.85 orders* | *→(602.85/826.295)*3588774 = 2618305* |
| *C: (2.5/1000)* 26450* | *= 66.125 orders* | *→(66.125/826.295)*3588774 = 287194* |
| *TOT:* | *= 826.295 orders* | |

**POOL 2 (SA3)** → Cost driver: # stock pickings → similar analysis as for pool 1

**POOL 3 (SA4)** → Cost driver: # deliveries → similar analysis as for pool 1

| | A | B | C | TOT |
|---|---|---|---|---|
| Cost assigned from pool 1 | *683274* | *2618305* | *287195* | *3588774* |
| Cost assigned from pool 2 | *629280* | *1989405* | *238050* | *2856735* |
| Cost assigned from pool 3 | *943920* | *3134820* | *304175* | *4382915* |
| **Cost Sales activities** | **2256474** | **7742530** | **829420** | **10828424** |

Table B5: Information received in the ABC condition

| | **A** | **B** | **C** | **TOT** |
|---|---|---|---|---|
| Selling price | 119 | 117 | 131 | |
| Sales | 52440 | 120570 | 26450 | 199460 |
| Revenues | 6240360 | 14106690 | 3464950 | 23812000 |
| Cost of goods sold | 2884200 | 6571065 | 1481200 | 10936465 |
| **Cost sales activities*** | 2256474 | 7742530 | 829420 | 10828424 |
| **Profit** | **1099686** | **-206905** | **1154330** | **2047111** |
| **Unit Cost** | **98.0** | **118.7** | **87.4** | |

* Order processing costs, internal logistic costs and delivery costs. Allocated to customers **according to their actual resource consumption** pattern (e.g. number of orders, stock pickings and deliveries).

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