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# Time estimates as cost drivers

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### Preface

The academic paper that forms the basis for this research executive summary is published in *The Accounting Review*, for which the American Accounting Association holds the copyright. The full reference for that paper is Cardinaels, E. and E. Labro (2008). *On the Determinants of Measurement Error in Time-Driven Costing*. *The Accounting Review*, 83(3), pp. 735-756. The academic paper can be found on: <http://dx.doi.org/10.2308/accr.2008.83.3.735>

### Methodology and overview

It is difficult to carry out research into costing because an observable true cost benchmark that can assess the error in a costing system<sup>1</sup> is not available. In this project, a unique experimental design overcomes this difficulty. Firstly, participants perform a series of activities for which they provide time estimates afterwards. Secondly, a computer accurately measures the time spent on each activity, providing a true benchmark against which the participants' time estimates are compared. Researchers then calculate the error in their time estimates.

All participants perform the same subset of 20 tasks, for which they provide the time estimates in percentages as well as in absolute time units (minutes), to study the effect of response mode. The experiment produces results for three variants:

1. The level of aggregation on which time estimates have to be provided.
2. How the participants' jobs are structured (task coherence).

3. The timing of notification that time estimates are required.

To study aggregation levels, the 20 tasks are either grouped into three major activities (machine set ups, price quotes or material requests) or into six subsets of activities (machine set ups disaggregated into L-shaped and special shaped set ups, price quotes for single and multiple products, and material requests for wood and paint). More aggregation requires estimates on three major activities, while less aggregation requires estimates on the six subsets of activities<sup>2</sup>.

To examine the impact of task coherence, the tasks are presented in a coherent way where the participants first perform the machine set ups. This is followed by price quotes and then material requests. Alternatively, they are performed in an incoherent way, in which the tasks arrive in random order.

The timing of notification about the time estimate requirement was varied to be prospective or retrospective. Participants who were notified prospectively knew that time estimates would be required before they performed the tasks. In retrospective cases, participants were only notified about the requirement after they had completed their tasks. Figure 1 summarises how the various factors in the experimental design are manipulated.

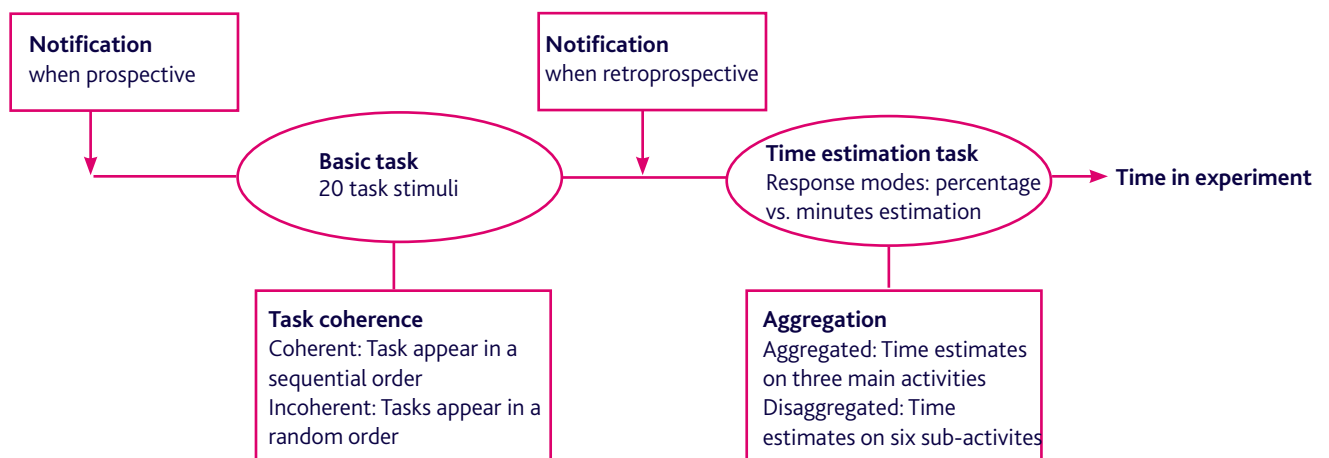


Figure 1: Overview of the research design

<sup>1</sup>Indeed, it is the management accountant's job to come up with a good approximation of what that unobservable true cost may be.

<sup>2</sup>This falls within the usual range of number of activities (two to nine) for which time estimates are requested of one staff member when designing a costing system. Of course, combined over all staff, the costing system can include many more activities in its activity dictionary.

Students from the London School of Economics were randomly assigned to these variations (2x2x2 between subjects design). The use of students did not limit the general results, because the simple clerical tasks required no specific expertise. In practice, anybody can be asked to provide time estimates which require limited skill. All participants received a fee for taking part.

To boost motivation, the students were further rewarded for both the speed with which they completed their tasks to an excellent standard and the accuracy of their time estimates. The study aimed to focus on the cognitive limitations to providing accurate estimates. In this way, the explicit incentives offered for accuracy should have ruled out any potential errors resulting from strategic gaming behaviour. Such behaviour included deliberately over or under reporting the time spent on a certain activity<sup>3</sup>.

### Objectives and contributions

Managers make major decisions such as product pricing, customer discounts, product mix, cost reductions, capacity acquisition and re-engineering based on data reported by product costing systems. Accurate cost information can prevent managers from making the wrong decisions. However, both academics and practitioners know that costing systems contain error, and often managers feel their costing system is not delivering the required level of accuracy to support their decision making. Despite this, relatively little academic research has been done to look into the determinants of costing error and how to improve accuracy of cost systems<sup>4</sup>.

This research focuses on the accuracy of the time estimates provided by employees on their various activities, as time estimates are present throughout cost systems. These time estimates are used as duration drivers to allocate resource costs to activities and cost objects. As the service industry grows in importance, the use of duration drivers is expected to increase further, as the cost of staff time spent becomes the most important resource.

Additionally, a new variant of activity based costing (ABC), known as time driven ABC (Kaplan and Anderson, 2004) has emerged that uses time estimates as the sole type of cost driver. Experience suggests, however, that employees' time estimates on their activities are often inaccurate (Ittner, 1999). Despite the widespread use of time estimates in costing and a general sentiment that time estimates may be prone to error, there has been little research into what causes this error. The issues

of how time estimates impact on the accuracy of the reported product costs and what managers can do to solve this problem have also not been addressed.

This project's objective is to study prevalent costing system design parameters and task environment (job design) parameters which determine the measurement error in time estimates. It also looks for solutions that management accountants can implement to reduce errors.

The first part of the study looks at the level of aggregation in the cost system's definition of activities. The level of aggregation is determined by the cost system designer, who often further refines the costing system by disaggregating the activity dictionaries. Nevertheless, some authors have pointed out that less aggregation may impact the measurement error with which these activities are measured (Datar and Gupta, 1994). This potential trade off has not yet been investigated empirically.

The second part of the study examines different task environments (job design) where tasks present themselves in a coherent or incoherent order. How do different task environments impact on a staff member's ability to estimate accurately the time spent on the various aspects of their job?

The third part of the study looks at the notification that participants will need to provide time estimates after performing a set of activities. This can be issued prospectively (before they start their activities) or retrospectively (after they have finished their activities). For example, for recurring revisions of costing systems, employees are notified that they will have to provide time estimates in advance. However, when a new information system is installed or when consultants update existing costing data, employees may be asked to provide time estimates after the fact. Timing of the notification is a parameter under the management accountant's control. The research investigates whether early notification may be used as a device to reduce the measurement error of employees' time estimates.

Finally, the research studies whether providing time estimates in percentages versus in absolute time units (e.g. minutes) has an effect on accuracy. The aim is to make managers aware of situations where measurement error on time estimates is likely to be high, and offer ways to help reduce such error.

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<sup>3</sup> Survey questions in the exit questionnaire filled out by the participants indeed indicate that they were focusing on being accurate, and no such gaming behaviour was present.

<sup>4</sup> Some notable exceptions are Datar and Gupta (1994), Christensen and Demski (1997), and Labro and Vanhoucke (2007; 2008).

## Findings and practical implications

### Trade off between aggregation and measurement error

New costing systems such as ABC are often devised to increase accuracy by reducing aggregation and specification error. More cost pools (less aggregation) are defined to increase homogeneity within a cost pool. The cost drivers of each pool can be chosen to better reflect cause and effect relationships. All of this is done to try to increase the accuracy of the reported product costs. Where hard data from software systems such as time clocks or activity time logs are unavailable, staff are asked to fill out time surveys to provide input.

This experiment shows that disaggregating a costing system by defining more activities may also lead to more measurement error. Even when accuracy is the sole underlying purpose and people have no incentive to bias their estimates, the results show significant errors in the estimates. This is because of the cognitive limitations to the process, where perception of durations is encoded in, and retrieved from, memory.

When people are asked about the time they spend on a limited number of activities, their estimates will be fairly accurate. For example, a secretary can estimate fairly well the percentage of the time spent on three activities: client reception, typing and booking orders. However, when the same secretary is asked for time estimates across six activities ranging from making coffee, over making managers' travel arrangements, to typing up minutes from the product management team meeting, she cannot estimate as accurately the time spent on each. This is due to cognitive restrictions.

Caution should be taken in disaggregating costing systems because of this trade off between measurement and aggregation error. Management accountants know that a costing refinement exercise, for example, the implementation of an ABC system, has high consulting, systems and software costs. What this research indicates is that, even if such systems came at zero cost, there is an endogenous trade off between aggregation and measurement error that may result in less accuracy overall when disaggregated systems are used.

### The effect of coherence of the job or task environment

Tasks can be coherent or incoherent. When the task environment is coherent, the activities are presented and performed in a structured and systematic sequence. When a task is incoherent, activities are addressed as they come in. For example, a labourer may work at a specific task on a particular machine for several hours and only move on to another activity after a lunch break (coherent). Alternatively, a secretary may take phone calls, type an invoice, reply to a manager's query and continue to type the invoice, among other activities (incoherent). Another example is an assembly line (coherent) versus a flexible manufacturing cell (incoherent).

The costing system designer does not determine task coherence because it is driven by the underlying production technology. However, task coherence has an important impact on the workings of the costing system design parameters and tools. These include the level of aggregation and notification that are under the management accountant's control.

There is no main effect of task coherence on the level of measurement error. However, the results indicate that the interplay of high disaggregation and low task coherence (many incoherent activities) results in the highest measurement error levels. Management accountants are advised to focus investments in improved measurement systems on such cases, as there is the highest potential gain for accuracy.

### The effect of notification

It has been found that early notification can be used as a tool to mitigate the problem of inaccurate time estimation. Often people are asked for time estimates after the fact. At a certain point in time, a consultant comes in and starts interviewing people about their activities and the time they spent on them.

However, time estimate errors will be reduced if staff know beforehand that their time estimates will be required<sup>5</sup>. Cognitively, prospective notification makes the encoding of temporal information easier, because participants can allocate mental resources to conscious cognitive timing.

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<sup>5</sup>Other tools such as challenging time estimates of employees by superiors or by peers might also be worthwhile to improve the accuracy of time estimates, but their effectiveness has, to our knowledge, not been empirically tested.

As notification has such a strong impact on reducing measurement error, the research looks at whether it can be safely applied as a management accounting tool. When staff are allocating mental resources to conscious timing, there may be reduced performance in the main task. We do not find an intrusive notification effect on basic task performance in our setting that uses fairly simple clerical tasks.

The on the job performance of those prospectively notified is not statistically different from the performance of those only retrospectively notified. Literature indicates that this result is likely to extend to a variety of other settings and job contexts, except perhaps those that require high level mathematical thinking. The overall conclusion is that it is best to warn employees upfront that their time estimates will be required.

### **3.4. Effects of notification in relation to the task environment and aggregation**

Our results also show that prospective notification works better in reducing time estimate errors where tasks present themselves in an incoherent order. When tasks follow an incoherent order, reconstructing time durations is very difficult if you are only retrospectively notified. This is because there are many changes in the task stimuli leading to serious misperceptions in a human's cognitive timer. People who are prospectively notified can keep track of time more consciously and can do a reasonable job in reconstructing time durations, even when tasks are presented in an incoherent order. Advantages of prospective notification are smaller when tasks are presented in a coherent order. Even without prospective notification, people can make good time judgments because of few changes in the task stimuli, so the benefit of keeping track of time more consciously is smaller <sup>6</sup>.

Nevertheless, the effect of prospective notification has its limits, especially for longer activity dictionaries (low aggregation). It is then so difficult for staff to keep track of time that the estimation's accuracy only improves slightly, even with prospective notification. In short, it is best to warn people upfront that time estimates will be required, as measurement error always reduces. Stronger reductions are, however, to be expected when the tasks present themselves in an incoherent order, and when activities are defined on a more aggregated level.

### **3.5. Percentage versus absolute estimation and the problem with estimating practical capacity in time driven ABC**

While all the above findings are relevant for both 'traditional' costing systems that use duration drivers and time driven ABC, we identified a particular problem with the accuracy of the recently proposed time driven ABC method. Kaplan and Anderson (2004) advise that companies that haven't previously adopted an ABC system or struggle with its complexity should use this simpler version of ABC where time is the sole cost driver. Time driven ABC uses duration drivers instead of transaction drivers. For example, a product that requires an easy set up for a machine will take up less time than a product requiring a more complex set up, whereas this is not captured by number of set ups as a transaction driver <sup>7</sup>.

In addition, time spent inactive is not taken into account, in an attempt to allocate only practical capacity. Kaplan and Anderson (2004) argue that this overcomes a problem identified with 'traditional' ABC systems that often allocate full capacity to cost objects. They claim that this results from the traditional use of a percentage response mode. Staff surveyed tend to allocate 100% of their time over a set of activities, as few admit to spending some of their time idle. By estimating in minutes rather than in percentages, the time driven costing method aims to overcome the problem of allocating unused capacity to products. As a result, it makes costing figures more relevant.

However, our experimental evidence suggests that people tend to over estimate dramatically the time they work when they are asked to estimate in absolute time units like minutes or hours. More than 77% of our participants consistently over estimate the time they spent by 37% on average. Such overestimation increases cost figures to an extent that is likely to undo the intended effect of not including idle capacity in their calculation.

In the exit questionnaire, participants also indicated a much higher level of confidence in the accuracy of their percentage estimates than in their absolute (minutes) estimates. A lack of confidence in the accuracy of figures could lead to staff questioning the costing data they are provided with. Ultimately, they could refuse to use the data in decision making or performance evaluation.

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<sup>6</sup>This also suggests that if there are concerns that prospective notification may lead to more 'gaming of the system' behaviour (an aspect we deliberately excluded from our laboratory setting to allow us to focus on pure cognitive effects), the costs in terms of accuracy reduction of not prospectively notifying are smallest in environments with coherent job design.

<sup>7</sup>A detailed example of the methodology and a comparison with the 'traditional approach' of ABC is described in Barrett (2005).

#### 4. Conclusion

We use an experimental setting to study the determinants of measurement error in time driven costing. Our results are as follows. Firstly, we document empirically that there is an important trade off between aggregation and measurement error – reduced aggregation leads to increased measurement error. This trade off needs to be carefully considered when making costing system design choices. Even when costing system refinements are introduced, an endogenously caused increase in measurement error may make reported product costs less accurate.

Secondly, we show that prospective notification can reduce measurement error. This is not at the expense of worse performance on the main tasks that a staff member performs. Therefore, prospective notification is a useful device in reducing measurement error. The job setting in which people operate (performing an incoherently or coherently ordered set of tasks), does not impact on measurement error directly. However, when tasks present themselves incoherently, the notification has a stronger impact on reducing the measurement error. We would suggest that management accountants introduce prospective notification, particularly in this context.

We also demonstrate that the minutes-based response mode is associated with a large overestimation bias. This highlights the need for caution when using time driven ABC. Advocates of time driven ABC argue that a minutes based response mode is superior to the percentage mode, because only the practical capacity cost is allocated, rather than the full capacity cost (Kaplan and Anderson 2004). Few employees report a percentage of their time

as idle when they submit percentage estimates. However, a large overestimation bias in the minutes' estimation is likely to undo the intended benefit of moving away from a percentage based response mode.

Our results have direct implications for costing practice. Service based economies rely heavily on time estimation in their cost allocations, with many areas such as billing, tendering, and project accounting tracking activities' time estimates. Given this widespread use, decision makers who use costing systems figures should know how measurement error affects the accuracy of the costing figures, so that they avoid making flawed decisions.

The results also highlight the need for costing system designers to reduce error size in a costing system's design. There are suggestions that can be used, such as aggregation, prospective notification and percentage response modes. It has been established that the highest error in time estimates occurs when tasks are incoherent and activities are disaggregated – these cases would benefit most from increased accuracy. In such cases, firms may want to invest in an automatic (online) time measurement system.

Our study also opens up areas which are worth investigating further. For example, our study is done in a single person context. This enables us not to confuse the effect of cognitive aspects on accuracy of time estimates with strategic gaming behaviour. A multi-person setting can be introduced to study strategic over and under estimation. Here, the use of peers or supervisors to assess (and possibly challenge) the accuracy of time estimates could be studied, as sometimes happens in practice.

## References

- Barrett, R. Time-driven costing: the bottom line on the new ABC. *Business Performance Management Magazine*, March 2005 Supplement, Volume 11, pp 35-39
- Cardinaels, E. and Labro, E. On the determinants of measurement error in time-driven costing. *Accounting Review*, May 2008, Volume 83, Issue 3, pp 735-756
- Christensen, J. and Demski, J. Product costing in the presence of endogenous sub-cost functions. *Review of Accounting Studies*, March 1997, Volume 2, Issue 1, pp 65-87
- Datar, S.M. and Gupta, M. Aggregation, specification and measurement errors in product costing. *Accounting Review*, October 1994, Volume 69, Issue 4, pp 567-591
- Ittner, C.D. Activity-based costing concepts for quality improvement. *European Management Journal*, 1999, Volume 17, Issue 5, pp 492-500
- Kaplan, R.S. and Anderson, S.R. Time-driven activity-based costing. *Harvard Business Review*, November 2004, Volume 82, Issue 11, pp 131-138
- Labro, E. and Vanhoucke, M. A simulation analysis of interactions among errors in costing systems. *Accounting Review*, July 2007, Volume 82, Issue 4, pp 939-962
- Labro, E. and Vanhoucke, M. 2008 Diversity in resource consumption patterns and costing system robustness to errors. *Management Science*. 54 (10), pp. 1715-1730

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