PERFORMANCE MEASUREMENT SYSTEM PROPERTIES AND MANAGERIAL TIME ORIENTATION: SURVEY AND EXPERIMENTAL EVIDENCE

Marcel van Rinsum and Frank Hartmann
RSM Erasmus University

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Corresponding author: Marcel van Rinsum, RSM Erasmus University, Burgemeester Oudlaan 50, 3062 PA Rotterdam, The Netherlands. E-mail: mrinsum@rsm.nl

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I. INTRODUCTION

A crucial attribute of managerial decision making is the adoption of an appropriate time horizon for investment decisions (National Academy of Engineering 1992). Managers adopting a horizon that is too short may take decisions that destroy long-term firm value (Merchant 1990; Mannix and Loewenstein 1993). Managers adopting a horizon that is too long may cause short-term performance risks instead (Merchant and Manzoni 1989, p.552). The organization's performance measurement system (PMS) is generally considered an important determinant of managerial time orientation (Chow et al. 1996; Van der Stede 2000). In particular has dysfunctional managerial short-termism, myopia, been associated with PMS that rely on accounting metrics for managerial performance evaluation and compensation (Ittner et al. 2003; Merchant 1998). As a consequence, there is great practical and academic interest in finding performance management policies that could lengthen managers' time horizons. One possible policy would involve lengthening the period taken into consideration when evaluating and rewarding managerial performance, to capture the long-term financial consequences of managerial behavior better. However, this solution has limits because extending evaluation periods may negatively affect managerial performance, since long-term goal-setting is less effective than short-term goal-setting (Locke and Latham 1990). A second strategy would be to lower the emphasis on accounting targets altogether and increase the reliance on non-financial performance or subjective judgments, which allow superiors to consider their longer-term performance effects (cf. Gibbs et al. 2004). However, this cure's drawback is that these alternative performance evaluations are costly and subject to various judgment and measurement biases (Moers 2005). A third strategy that has been suggested to reduce myopia is to supplement accounting metrics with additional, non-financial, performance indicators which would encourage managers to 'balance' their focus on the organization's short-term and long-term performance (e.g., Luft and Shields 2002; Sliwka 2002; Farell et al. 2005). The balanced scorecard philosophy in particular has spurred firms to supplement their traditional set of accounting performance indicators with *leading* performance indicators that have predictive value for future *lagging* accounting results (Kaplan and Norton 1996).

An example is incorporating customer satisfaction metrics in the PMS which should help managers recognize the future profit effects of current (investments in) customer satisfaction. Such recognition can be implicit and explicit. Implicit recognition means that managers who optimize the leading indicator at the same time optimize its lagging, causal, consequence. In this paper we explore the effects of PMS design on managers' explicit recognition of leading-lagging effects. In particular, we demonstrate that this recognition is contingent on two PMS design characteristics; the time-lag between leading and lagging indicator (*lead-time*), and the reporting frequency of results (*evaluation period*).

Extending traditional economic analyses with insights from cognitive psychology we develop hypotheses about the direct and interactive effects of lead-time and evaluation period length on managerial time orientation along the arguments outlined. We subsequently test these hypotheses using evidence from both a cross-sectional survey study and a laboratory experiment which involved a pay-for-performance investment task. We find positive main effects of lead-time and evaluation period on managerial time orientation, as well as a positive interaction between these two independent variables in our survey study, and a positive main effect of evaluation period in our experimental study. Overall, we conclude that these studies provide support for our expectations.

Our analysis departs from, the small number of, existing time orientation studies in three ways. First and foremost, our analysis aims to explain managerial time orientation from a cognitive perspective, as the managerial perception of causality is a central explanatory variable in our study. Studies on time orientation have, so far, not distinguished such cognitive effects from incentive effects associated with multi-period performance measurement, and thus have not been able to explain whether a certain time orientation was the result of cognitive biases or, simply, multi-period optimization. Second, our study does not focus on a single broad type of leading performance metrics (i.e. non-financial), but explores the underlying time-lag dimension which we argue to be a more fundamental characteristic. We therefore acknowledge that the financial-nonfinancial distinction is too crude as a proxy for this underlying PMS property (cf. Ittner and Larcker 1998; Ittner and Larcker 2002). Third, we address managerial time orientation as a continuous variable, thus extending the focus in previous research on the (specific) issue of myopia to the (general) issue of managing managerial time orientation through PMS design. Thus, we avoid taking normative stances on the general desirability of a certain time orientation.

Our study makes at least three contributions to the performance evaluation and compensation literature, in line with its distinct features vis-à-vis previous studies. First, we extend cross-sectional studies on managerial myopia (e.g. Merchant 1990, Hoskisson et al 1993, Van der Stede 2000) in several ways. We explore more fundamental PMS characteristics that determine time orientation, thus allowing a more detailed advice on building such systems than studies that merely explore the effects of non-financials (cf. Malina and Selto 2004). In addition, our broad focus on time orientation allows a direct assessment of the potential benefits of balanced scorecard type PMS, than studies that focus on myopia as a consequence of accounting-based performance evaluation. Second, our study is not only concerned with the main effect of the two PMS characteristics that we investigate, but also in their interaction. Research evidence on the interactive effects of PMS properties is very scarce thus far, and the fragmented attention to PMS design limits our understanding of actual PMS in practice. Third, our study contributes to the methodological development of this field of enquiry by combining a survey and an experiment to test one single set of hypotheses. The survey study provides an initial cross-sectional test of the hypotheses, to establish patterns of potential causation. The added value of the experiment lies in isolating the effects of separate properties of the PMS on managerial time orientation, which may be confounded with other variables in the cross-sectional survey study, and by demonstrating causality (Shadish et al. 2002). Together, this multi-methods approach enhances reliability (McGrath et al. 1982; Birnberg et al. 1990), as it allows triangulating and optimizing external and internal validity (cf. McGrath et al. 1982). Moreover, since the literature we build on is mainly survey based (e.g., Merchant 1990; Van der Stede 2000), our extension using experimental evidence may provide an important bridge to the wider experimental compensation literature (cf. Sprinkle 2003).

The remainder of the paper is organized as follows: In section II we review the relevant literature and develop hypotheses. In section III we describe the survey methodology and results of the survey. In Section IV we describe the experimental methodology and results of the experiment. Section V concludes this paper and discusses the implications of the study.

II. LITERATURE REVIEW AND HYPOTHESES

We define managerial time orientation (MTO) as the time window that managers consider for maximizing the expected returns from their investment decisions. Managers with a short MTO will look for immediate return on investment. When confronted with a portfolio of investment opportunities, they will select projects in which the benefits will accrue immediately. Managers with a long MTO consider both short-term and long-term effects of their investment behavior. When confronted with a portfolio of investment opportunities, they will consider projects in which the benefits accrue over a longer time period. In the accounting and performance measurement literature, most attention has been paid to myopia, which refers to the situation in which managers' orientations to the short-term become so excessive that managers are more concerned with short-term profits than entity value Merchant (1998, p.460). Myopia has typically been related to the use of accounting metrics for performance measurement and rewarding. At least three categories of arguments exist that have addressed the relationship between accounting metrics and myopia.

A first line of argumentation emphasizes that myopia is the consequence of the intrinsic nature of accounting, formed by institutions and conventions. Typically, such behavior is regarded the consequence of managers optimizing the pay-off based on short-term accounting results (Ittner et al. 2003). Accounting rules are generally conservative, which means that performance reported in accounting metrics is negatively biased. This provides an incentive to focus on the short-run (i.e. be cautious) because long-term (i.e. risky) gains are recognized late (e.g., Merchant 1989; Bushee 1998, p. 306). Accounting metrics are also typically aggregated. As such, they provide only noisy signals of managerial effort since managerial actions will very imperfectly reflect in accounting results (Fisher 1992; Singleton-Green 1993). This stimulates short-termism because it allows managers to engage in behaviors that increase accounting numbers, without value creation (Merchant, 1998).

A second set of explanations regards managers' general incentives to optimize short-term instead of long-term behavior. A recognized strong driver of short-termism is managers' (expected) employment horizon. Managers will adapt their optimizing behaviors to this horizon, which may result in short-termism if the expected employment horizon is shorter than the investment horizon (e.g. Dechow and Sloan 1991; Mannix and Loewenstein 1993, 1994; Sliwka 2002). A second cause is related to managers' general inclination to adjust reported accounting numbers in order to maximize their periodic bonuses (e.g., Merchant 1990; Hoskisson et al. 1993; Narayanan 1985; Healy and Wahlen 1999). The use of non-linear annual bonus schemes, in which small differences in effort result in large differences in bonus, may evoke or aggravate this tendency (e.g., Healy 1985; Holthausen et al. 1995; Guidry et al. 1999).

A third set of studies tests the viability of proposed solutions for managerial short-termism. They provide indirect evidence of the incidence of short-termism. Several studies focus on the use of non-financial measures as a complement to traditional accounting measures, investigating the claim that non-financial metrics provide immediate performance feedback and predict longer-term performance effects (Kaplan and Norton 1996). In short, this philosophy argues that so called leading measures should be used that act as indicators of future (lagging) accounting performance (Fisher 1992; Singleton-Green 1993). Indeed, some evidence exist that firms use more non-financials when they have adopted more long-term oriented strategies (i.e. innovation or prospector; Ittner et al. 1997; Said et al. 2003; HassabElnaby et al. 2005). Firms with a longer product life cycle also make more use of non-financial measures (Said et al. 2003; HassabElnaby et al. (2005). The combination of these firm characteristics and the use of non-financials has been shown to affect performance positively (Said et al. 2003). In contrast, situations of financial distress lead companies to abandon the use of non-financial measures (HassabElnaby et al. 2005). Although these studies provide some evidence on the fit between non-financial measures and time orientation for the given (production) strategies, there is little direct evidence on the effects of leading indicators on MTO.

Although these studies have covered several aspects of dysfunctional short-termism, they seem to hint upon, rather than explicate, the essential causes of myopia. In particular, studies seem to confuse short-termism as a consequence of incentivizing short-term performance and short-termism that is the result of cognitive limitations of any decision taker. Indeed, if the incentive effect of the PMS was the only source of myopia, its cure would simply involve choosing an evaluation horizon that matches the pay-back period that is optimal for the firm. The problem associated with this cure, however, is that since managers' rationality is bounded, longer pay-back periods will reduce managerial effort intensity. Indeed, the leading-lagging philosophy seems to be grounded on an alternative analysis of the myopia problem. At least implicitly, it points out that MTO is determined by managers' cognitive abilities as well. Managers have cognitive limitations that hinder their understanding of the longer-term consequences of their actions. These cognitive limitations also explain why longer evaluation horizons may come at the cost of lower managerial performance, and explain why the time periods that managers consider for optimizing pay-offs are not infinite. Our hypotheses will address this cognitive effect and aim to explain how the design of the PMS affects managerial cognitions of MTO.

Lead-time and MTO

We define lead-time as the time-lag between a leading indicator and the lagging accounting result. When lead-time is short, changes in the leading indicator will have a more or less immediate effect on the lagging accounting result. When lead-time is long, changes in the leading indicator are indicative of accounting results which will reveal themselves later. Figure 1 provides a graphical illustration of lead-time. A change in a leading indicator affects accounting results with a time lag. The length of this time lag determines the degree to which the performance measure is leading (lead-time). The figure depicts customer satisfaction as a performance measure with a larger lead-time than customer retention, assuming that the time until accounting performance is affected exceeds the lead-time of customer satisfaction.

---Figure 1 about here---

There are two reasons to expect that the use of leading indicators will affect MTO, consistent with available evidence. First, and generally, managers tend to optimize measured dimensions of performance (e.g., Kerr 1975; Jenkins et al. 1998; Courty and Marschke 2004). Optimization of a leading performance measure in order to obtain a favorable performance evaluation may be achieved by investing more in long-term projects if the lead-time is long (Merchant 1989; Sliwka 2002). For example, increasing customer satisfaction may require an investment in employee training, with longer term effects on profits. This effect is driven by the incentive of optimizing the leading indicator, and does not require that managers explicitly consider longer term effects on accounting results. Their behavior, however, will be consistent with such broadening of the time period they consider in evaluating investment pay-offs.

Second, the use of leading performance measures has a cognitive effect on MTO. Individuals have a natural tendency to look for causes of outcomes in the near past, but the use of leading indicators may reduce this myopic focus by providing a temporal bridge (Luft and Shields 2002). The expectation is that when managers are forced to think about past causal factors of current financial performance, they obtain knowledge about causality which they project into the future (Bluedorn and Denhardt 1988, p.308). Thus, when confronted with leading indicators in the current period, they will better understand future positive consequences of current actions, which extends their planning horizon (Das 1987, p.207). This is why leading measures are associated with larger future orientation (AAA Financial Accounting Standards Committee 2002; Luft and Shields 2002). By identifying causal effects, they also facilitate the identification of the optimal long-term strategy (Farrell et al. 2005). Thus, managers will not only have a better understanding of apparent causality, but will also be more inclined to understand the mechanics behind the relationship. These arguments point at a positive effect of lead-time on MTO. This means, consistent with available evidence, that larger lead-times will be associated with larger MTO. We therefore propose to test the following hypothesis.

Hypothesis 1: Evaluations based on a performance measure with a longer lead-time are positively associated with MTO.

Evaluation period and MTO

We define evaluation period as the period that is taken into consideration in accounting-based managerial performance evaluation. This definition implies that weekly accounting cycles are shorter than yearly accounting cycles. Two arguments support a direct effect of the length of the evaluation period on MTO. The first argument relates to two essential features of accounting measures, which is its use of the conservativeness principles in combination with its limited ability to express economic returns. The conservativeness principle warns against recognizing uncertain gains, and thus biases behavior towards achieving immediate returns. In the long run, accounting performance approaches economic performance, because all results from an investment are realized and recognized in accounting performance (Merchant and Bruns 1986). In the short-run, however, accounting can only provide a noisy proxy of ultimate performance. Managers will seek immediate returns instead (see Merchant 1989; Bushee 1998, p.306). We expect that MTO varies with the length of the period that is taken into consideration in managerial performance evaluation based on accounting measures. As this period gets longer, accounting performance will approach economic performance, which reduces the myopic bias. The second argument is based on the managerial inclination to evaluate investments myopically because of their loss aversion. Loss aversion means that the disutility attached to losses of X exceeds the positive utility of a gain of X. Studies on *myopic loss aversion* suggest that managerial investment myopia can be reduced by evaluating performance over a longer period. Longer evaluation periods make loss-averse managers more likely to consider a specific investment opportunity as part of a long-term set of investment opportunities. Consequently, they will perceive the risk of a loss attached to an investment as lower, and are thus inclined to invest more. In case of a short evaluation period, individuals will tend to view the investment as a one-shot deal, even when it is part of a sequence. Studies show that a short evaluation period causes individuals to invest significantly less than the expected value would suggest as optimal, thus leading to myopic behavior (Benartzi and Thaler 1995; Gneezy and Potters 1997; Thaler et al. 1997; Gneezy et al. 2003; Langer and Weber 2003; Bellemare et al. 2005; Langer and Weber 2005). Figure 2 provides a mathematical illustration. Assuming a manager attaches 3 times more value to a loss than to a gain, which means that the manager is loss-averse, investment opportunity IO_1 will be rejected due to a negative value of –$2.5. This is also true when IO_1 is part of a sequence of subsequent similar investment opportunities, because they are evaluated period wise. If the evaluation period is extended, however, managers tend to aggregate the investment opportunities over multiple periods, increasing the likeliness that they will invest. An aggregation of two times IO_1, displayed as IO_2 in Figure 2, is likely to be accepted as its value equals +$5.

---Figure 2 about here---

In sum, we expect that a shorter evaluation period decreases MTO (Bluedorn and Denhardt 1988, p.312), and vice versa. This is consistent with existing empirical evidence, although the limited number of studies has mixed effects of evaluation period length with effects of the type of measure (e.g., Merchant 1990). We propose to test the following hypothesis.

Hypothesis 2: Evaluation period length is positively associated with MTO.

Lead-time, evaluation period and MTO

We expect that lead-time and evaluation period do not only have main effects on MTO, but that they also have an interactive effect. In particular, we expect that the positive effect of lead-time on MTO interacts with the length of the evaluation period. The arguments are as follows. The expectation that larger lead-times will result in larger MTO (hypothesis 1) assumes that the signal that leading indicators provide about lagging accounting results are undisturbed by intervening accounting-based evaluations. If, however, during the lead-time an evaluation moment occurs, we expect that the effect of lead-time is shortened since it is overruled by the incentives that the accounting-based rewards will provide (cf. Healy 1985; Merchant 1990; Holthausen et al. 1995). Such an evaluation during the lead-time will thus make the leading measures relatively less salient, which will limit the cognitive effect of lead-time (cf. Luft and Shields 2002).

Figure 3 provides a graphical illustration. and figure 4 presents a graph of the form of the interaction.

---Figures 3 & 4 about here---

Based on these arguments, we propose to test the following hypothesis (figure 4 presents a graph of the form of the interaction).

Hypothesis 3: Evaluation period length has a positive effect on the relationship between lead-time and MTO.

The tests of these hypotheses using evidence from a survey study and an experimental study are described next.

III. SURVEY STUDY

We conducted a survey study amongst middle-level managers involved in management decisions and investment decisions. We used a database of managers from the Dutch Controller Institute (CI), which consists of managers with a background in accounting and control. The sample thus consisted of respondents from a single country, preventing national or cultural biases. We selected respondents from companies with more than 250 employees, as we expected that MTO related issues are typically prevalent in larger firms. A survey instrument was developed using guidelines by Dillman (2000). The questionnaire was pre-tested with six management accounting academics, three business controllers, and with a group of financial directors. We approached respondents using an article published in a Dutch management magazine that broadly described the project, and sent the questionnaire with a hand-signed letter and a high-quality pen. The procedure further involved sending a follow-up postcard, a replacement questionnaire and a final follow-up by telephone and e-mail. The total sample consisted of 297 potential respondents, of whom 151 returned the questionnaire, resulting in a satisfactory 52.3% response rate to the survey. From these respondents we selected managers who were evaluated on both an accounting and a leading measure of performance, based on questions in the questionnaire, to enable testing of hypotheses 1 and 3, which required the establishment of lead-time. We thus used 52 observations for the analysis of our hypotheses, which corresponds with a 17.5% response rate. On average, respondents were 38.3 years old and had been working for their current company for 6.3 years. They had been working for 3.5 years for the same organizational unit, and for 3.0 years in a similar type of function on average. Male respondents comprised 88% of the sample. Importantly, for effects of performance measurement for evaluations are likely to be stronger in case of stronger pay-sensitivity, a significant part of the respondents' reward is variable (17,4% on average). It is also noteworthy that respondents received negligible proportions of their reward in stock-based form – which demonstrates that effects of stock-based rewards on MTO, if any, are not likely to taint results. In fact, 72% of respondents received no such rewards whatsoever.

Respondents reported that they were working for an organizational unit that employed 2577 employees on average, within a company that employed 37960 people. The companies were active in the industries of production (32%), trade (16%), financial services (20%) or other services (32%). Respondents further reported that they were actively involved in management.

We measured the following constructs, relying as much as possible on available instruments.

Managerial Time Orientation (MTO) was measured by an instrument originating in Lawrence and Lorsch (1967) and used by Merchant (1990), Van der Stede (2000), and Moers (2001). This instrument asks the respondent to indicate the percent of time spent on activities that will show up in the profit and loss statement after (a) one month or less, (b) between one month and one quarter, (c) between one quarter and one year, and (d) between one and five years. We added a category (e) longer than five years, to reflect our neutral approach to MTO, rather than a focus on myopia as in previous studies. Percentages should sum up to a total of 100%. Percentages allocated to items (d) and (e) were summed to provide a measure of the length of managerial time orientation for the analysis of the hypotheses. A higher score thus indicated a longer time orientation.

Lead-time was measured with a question asking the average number of months it would take for a change in the level of the most important operational measure to affect profit levels. Usable responses were carefully determined based on the most important nonfinancial measure that respondents had provided. Only those respondents that were evaluated based on measures related to the business process (such as product quality) were considered viable responses.

The *evaluation period* length for accounting results was determined by asking respondents an open question to indicate how often a report was made regarding the most important accounting measure they were evaluated on ("..once per _____").

Descriptive statistics for the measurement instruments can be found in Table 1.

---Table 1 about here---

Survey results

We applied linear and moderated regression analysis (Hartmann & Moers, 1999) to test the hypotheses. Table 2 reports on the outcomes of a test of the two main effects we predicted in hypotheses 1 and 2. The data in this table confirms our predictions.

---Table 2 about here---

We proceeded to incorporate the predicted interactive effect into our analysis – see Table 3 for results. Consistent with hypothesis 3, we found a significant interaction between lead-time and evaluation period. The regressions were re-run including organizational size, strategy, and industry as control variables, with no effect on significance or direction of relationships. We also included propensity to leave, which measures the managerial inclination to quit. Including this variable to correct for possible job horizon effects also yields inferentially identical results. See Table 4 for measurement details and for a regression analysis including all control variables.

---Tables 3 and 4 about here---

To enable a further exploration of the nature of the interaction, the two independent variables were dichotomized. Lead-time was split at the median (6.00). Evaluation period was split at the semi-annual score. Table 5 shows that, consistent with the expectation in hypothesis 3, correlation coefficients between lead-time and MTO are higher in case of a long evaluation period than in case of a short evaluation period. The form of the interaction is further confirmed by ANOVA-analyses. A full-factorial ANOVA confirmed the interactive effect. A significant one-way ANOVA (F=6.803, p=0.001) indicated that there are differences in the mean value for MTO between the four subgroups that were formed based on the two dichotomized variables. The value for MTO was highest for the group with a long evaluation period and a long lead-time (see Table 6). This mean is significantly different from the other means at the 0.05 confidence level, both in post-hoc LSD and Bonferroni analyses.

---Tables 5 and 6 about here---

These results all support hypothesis 3 and indicate that the positive effect of lead-time on MTO is stronger in case of a longer evaluation period. Nonparametric Spearman correlations corroborate the interactive effect (see Table 5).

IV. EXPERIMENTAL STUDY

We conducted a 2x2 between-subjects computerized experiment in which we manipulated the two central independent variables (lead-time and evaluation period length). The experiment involved an individual investment task, with sixteen rounds of investment opportunities in a long-term project. The subjects were 188 students enrolled in a third-year academic accounting course, who participated on a voluntary basis. They were offered a course-credit as well as a financial reward based on their investment performance for their participation. We considered this sample appropriate for the following reasons. The direction of investment decision effects for this type of subjects is similar to that of practitioners (cf. Ashton and Kramer 1980; Liyanarachchi and Milne 2005). Furthermore, using student subjects averts any noisy influence from biases induced by individual practical experiences (cf. Libby et al. 2002).

The experiment was programmed in Authorware. It utilized only video-taped and computerized instructions, thus preventing any experimenter effect. The duration of the entire experimental session was approximately one hour. Subjects were first taken through five instruction screens (see experimental materials in appendix A) and a set of comprehension set questions before the actual investment task started. The dependent variable (DV), MTO, was operationalized by the amounts invested in an investment project that had long-term pay-offs. Any amount invested yielded a 10% positive return in the future. Higher invested amounts signaled a longer managerial time orientation (cf. Mannix and Loewenstein 1993; 1994). Invested amounts also affected two non-financial leading indicators positively. Figure 5 provides an example and illustrates the lagged effects on the performance indicators of an investment of 10,000 at the end of period three. This figure was *not* included in the experimental materials. Instead, the lagged effects could be detected by subjects with some effort from a table which provided examples of the causal effects of similar investments on all three performance measures (see instruction screen 3 in appendix A).

---Figure 5 about here---

The experimental materials signalled that there was a 5% independent chance that an investment made in a specific period would not yield any *financial* return or payback. This was included in the experimental design because risk is normally part of investment decisions. Moreover, the theory of myopic loss aversion predicts effects of evaluation period length on MTO specifically in the presence of risks.

The amounts invested affected subjects' bonus. If low amounts were invested, the current profit level and bonus were high, but profits and attached bonus in later periods were lower. Similarly, investing high amounts decreased current but increased later performance and bonuses.

The manipulation of the independent variables was achieved through different incentive schemes. The *evaluation period* length for accounting measures was manipulated by evaluating subjects' profit and determining their profit-based reward either every period (short evaluation period) or only twice during the experiment, after 8 and after 16 periods (long evaluation period). In the latter case, subjects were rewarded based on the cumulative profits over the previous 8 periods (cf. Gneezy and Potters 1997). The reward paid was €0.06 (approx. $0.08) per 1000 profit. Actual profit-based rewards paid to subjects varied from $8.63 to $13.06, with a mean of $11.50.

Lead-time was manipulated by rewarding subjects (every period) based on a different non-financial leading indicator. In the long lead-time conditions, the non-financial indicator used for bonus determination increased almost immediately after an investment, i.e. the next period. In the short lead-time conditions, non-financial performance increased after a longer time lag, i.e. only one period before the profit increase[i]. The leading indicator was included in the incentive scheme to make it salient. The hypothesized effect of lead-time was based on cognitive effects, i.e. increased attention to causal effects. This was measured by recording the use of a table that contained all lagged causal effects of example investments (see instruction screen 3 in appendix A).[ii]

Additionally, it was necessary to ensure that subjects would not just invest more because they wanted to maximize their leading indicator. Therefore, we made sure that investing in the project always cost the subject much more in current reward, due to the profit decrease, than the gain in reward based on the increased non-financial performance. The expected value of the total reward, as well as of the rewards based on profit and non-financial performance, was identical across conditions[iii]. Conditions were labeled according to Table 7. Observations were equally distributed across experimental conditions, with 47 observations per cell.

---Table 7 about here---

The experiment was structured as follows. At the start of the experiment, subjects had to answer a series of basic, task related, questions correctly in order to proceed. In case of a false answer, subjects were taken back to the appropriate section of the instructions before they were give the opportunity to answer the question again – thus ensuring comprehension of the task to the greatest extent possible. These questions included the manipulation checks and asked about the duration of the task, the financial and non-financial performance measures used for the reward, the risk percentage involved, and the length of profit evaluation period.

Subsequently, the actual task followed consisting of 16 rounds in which subjects were asked how much they wanted to invest in the project. After a decision was made in each round, a bonus report followed based on the results so far. This report always showed non-financial performance, and dependent on the condition, financial performance either every period or every 8th period. Appendix B contains example screen shots from periods within each treatment condition.

The final part of the experiment was a questionnaire which first posed debriefing questions related to the task in random order, then measured several covariates (both the order of the constructs and the items were randomized), and finally required information on general characteristics of the subject (age, sex)[iv].

Experimental results

We measured subjects' MTO by a summation of the invested amounts in the long-term project in all periods. This DV satisfies the ANOVA assumptions of data normality, homogeneity of variance and observation independence[v]. Table 8 shows descriptive statistics per condition. An ANOVA-analysis of the DV yields the results displayed in Table 9. The low p-value (<0.001) for evaluation period in Table 9 indicates a significant main effect of evaluation period length, clearly supporting hypothesis 2. No main effect of lead-time and interaction effect appear present in the data, as indicated by the high p-values for these variables. No support is therefore provided for hypothesis 1 and hypothesis 3.

---Tables 8 & 9 about here---

Full-factorial ANOVA analyses on the invested amounts per period reveal a significant main effect of evaluation period in periods 2, 7, 10, 11, 12, 13, 14, 15 and 16. The effect of evaluation period thus seems to be concentrated in (though not limited to) the later periods of the experiment[vi]. These are the periods in which an investment in the long-term project is no longer in the subject's best interest, because the profit increase falls (partly) outside of the duration of the experiment. The data thus support the conclusion that a longer evaluation period lengthens MTO, especially in case of a horizon problem.

Additional analyses were performed to provide more insights into the processes that underlie the effects of the two independent variables on MTO. We included several debriefing questions in the experiment to enable this. Regarding evaluation period, subjects in conditions with a long evaluation period (II and IV) scored significantly lower on the item that read: "The total duration of the task (16 periods) was an important factor in determining the amounts I invested". These subjects also scored significantly higher on the item that read "I took the future consequences of my investment decisions for the company *after* the task was over into consideration". This implies that a longer evaluation period indeed assisted or induced subjects to look beyond the duration of the task. These two items, that show a significant main effect for evaluation period in full-factorial

ANOVAs, thus provide corroborating evidence suggesting that a longer evaluation period lengthens MTO, and particularly in case of ending employment contracts.

Regarding lead-time, the experimental design allowed for measurement of its effects by registering the number of times instruction page 3 was consulted during the task. This page contained the table containing the causal linkages between performance measures. In particular, conform the reasoning behind hypothesis 1, we expected that subjects in the long lead-time condition would pay more attention to lagged causal effects, leading to an increased use of the instruction screen. Results from an ANOVA analysis are displayed in Table 10.

---Table 10 about here---

Given the significant p-values (<0.05) for both variables, these results suggest both a main effect of evaluation period length and of lead-time. Additional analysis, a condition comparison of means (see Table 11), reveals that in condition IV, the number of times the table with the causal linkages was studied during the task was significantly higher than in the other three conditions.

---Table 11 about here---

Although subjects in the *long* lead-time conditions were expected to exhibit increased attention to lagged effects, the evidence indicates that a *short* lead-time (combined with a long evaluation period) lead to a more intensive use of information on causal relationships. This suggests that when the effect of investment decisions is not immediately apparent in performance measures, subjects display a need for more information on these effects. This initiates a search for causal linkages, at least in a (necessarily) relatively simple experimental setting.

V. CONCLUSIONS AND IMPLICATIONS

In this study we investigated the main and interactive effects of lead-time and evaluation period length on MTO. As regards the survey study, our results fully support our predictions. We find that lead-time and evaluation period both have a main effect on MTO, and furthermore that these two variables interact such that the effect of lead-time on MTO is more positive for longer evaluation periods. The main finding of the experiment is that a longer evaluation period for accounting performance measures positively affects MTO. A longer evaluation period led subjects to invest higher amounts throughout the duration of the project. In the later rounds of the experiment, when investing was no longer in subjects' interest, the amount of investing was significantly higher in the longer evaluation period condition. The lower evaluation frequency motivated subjects to look further into the future and, apparently, even beyond the duration of the task proper. This finding is in line with the theory that formed the basis for hypothesis 2, which predicted a positive effect of evaluation period length on MTO. Evidence from the debriefing questionnaire provides strong support for this conclusion[vii]. We also established that lead-time affected subjects' search efforts for lagged casual effects, although this did not affect their investment behavior. Longer lead-time is likely to make causal effects more easily apparent, which limits the necessity for elaborate searches as conducted in the short lead-time conditions.

In sum, overall, the evidence from the two empirical studies provides support for our hypotheses. The main effect of evaluation period is fully supported by both studies. The differences in findings with respect to lead-time are most likely reconciled due to different sources for the effect on MTO. Both studies show that lead-time affects attention to long-term or lagged casual effects. The experiment plays a significant role in teasing out the effect of managerial rewards being sensitive to the leading indicators. In practice, represented by the survey data, managers can experience the cognitive effect of lead-time, but they are also likely to maximize leading indicator performance to increase their bonuses. The experiment studies the cognitive effects of lead-time in isolation, by showing that when bonuses are not materially affected, lead-time affects subjects' attention to lagged causal effects (but not their investment decisions).

This study has implications for both theory and practice. We have shown that two performance measurement system properties are of paramount importance when designing a balanced scorecard: lead-time and accounting evaluation period. The results also show that it is essential to consider *how* to use leading indicators. That is, both the selection of the appropriate measure (based on lead-time) and the way the indicator is used for incentive purposes influences MTO. We have shown that it is useful to distinguish cognitive from incentive effects of leading indicators. Lead-time affects managers cognitive horizons, while bonuses based on leading indicators can affect investments based on self-interested reasons. One practical implication is that companies should carefully consider what weight to place on a leading indicator in a balanced scorecard for incentive purposes.

We acknowledge several specific limitations of our empirical results. In the survey study, the effects of lead-time and evaluation period are likely correlated with type of industry. Although these effects were controlled for in the regression analysis, the proxies for industry may not have been entirely adequate for this purpose. Second, the survey data does not enable strong conclusions about the *reason* for the effect of lead-time on MTO. In the survey data, the cognitive effects of lead-time are confounded by incentive effects, because managers' bonuses depend on their performance. Furthermore, the experiment involved student subjects, which may limit generalizibility of the results.

We also acknowledge the general limitations that apply to survey and experimental research. The survey provides cross-sectional correlational evidence and cannot establish causality. The experiment involves a stylized abstract setting, which may lack external validity. In particular, the design (necessarily) compresses time and simplifies relationships.

In spite of the limitations, we believe that this study has several noteworthy strengths. The multi-methods approach enhances reliability (McGrath et al. 1982; Birnberg et al. 1990), as it allows triangulating and optimizing external and internal validity (cf. McGrath et al. 1982). The survey study provides an initial cross-sectional test of the hypotheses, to establish patterns of potential causation. The added value of the experiment lies in isolating the effects of separate properties of the PMS on managerial time orientation, which may be confounded with other variables in the cross-sectional survey study, and by demonstrating causality (Shadish et al. 2002). The combination of the two methods enabled us to demonstrate the effects of the two variables in practice, while at the same time teasing out the cognitive effects of lead-time.

Many possible avenues for future research present themselves – we mention a few in particular. Empirical evidence, especially experimental, on dependent variables other than performance is generally limited (Sprinkle 2003). The effects of PMS properties on DVs other than MTO that can also affect investment behavior, such as risk taking, are worth studying. Second, in this study we did not focus on the effects of different types of incentives attached to the PMS on MTO. Therefore, the effects of stock-based incentives (e.g., Lewellen et al. 1987), bonus banking (e.g., National Academy of Engineering 1992) and career concerns (e.g., Coates et al. 1995) were not analyzed. Nevertheless, this would appear a potentially very fruitful area for future research.

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Figures

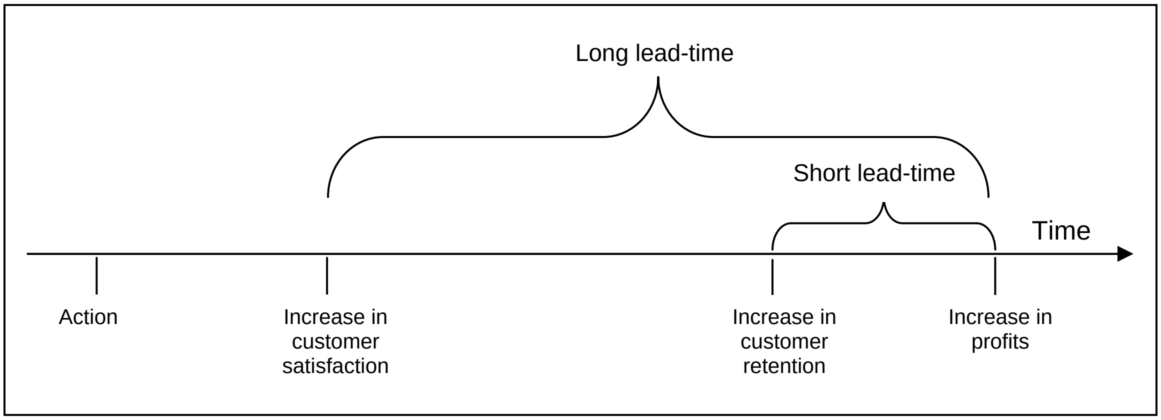


Figure 1: Business process causal chain, with performance measures that exhibit different lead-times.

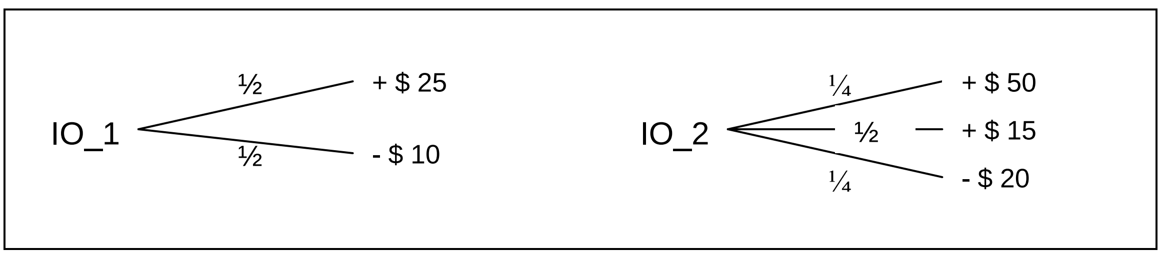


Figure 2: Myopic loss aversion. If losses loom three times larger than gains, accepting IO_1 looks unattractive (0.5 * 25 – 0.5 * - 10 * 3 = - 2.5) while an aggregation of two times IO_1 (see IO_2) is acceptable (0.25 * 50 + 0.5 * 15 - 0.25 * 20 * 3 = + 5) (based on Langer and Weber 2005).

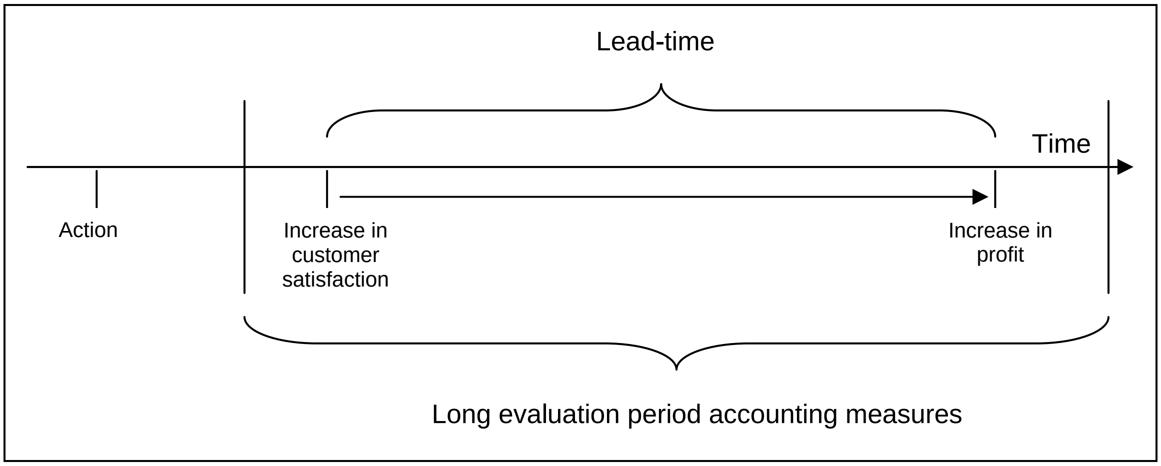


Figure 3, panel A: Combined effects of lead-time and a long evaluation period. The expected managerial horizon is indicated by the arrow below the time-line.

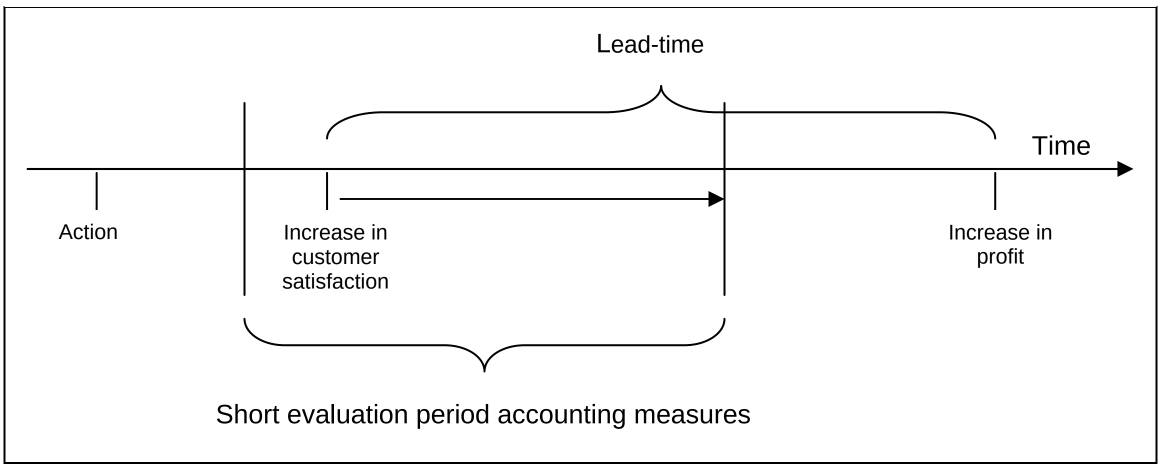


Figure 3, panel B: Combined effects of lead-time and a short evaluation period. The expected managerial horizon is indicated by the arrow below the time-line.

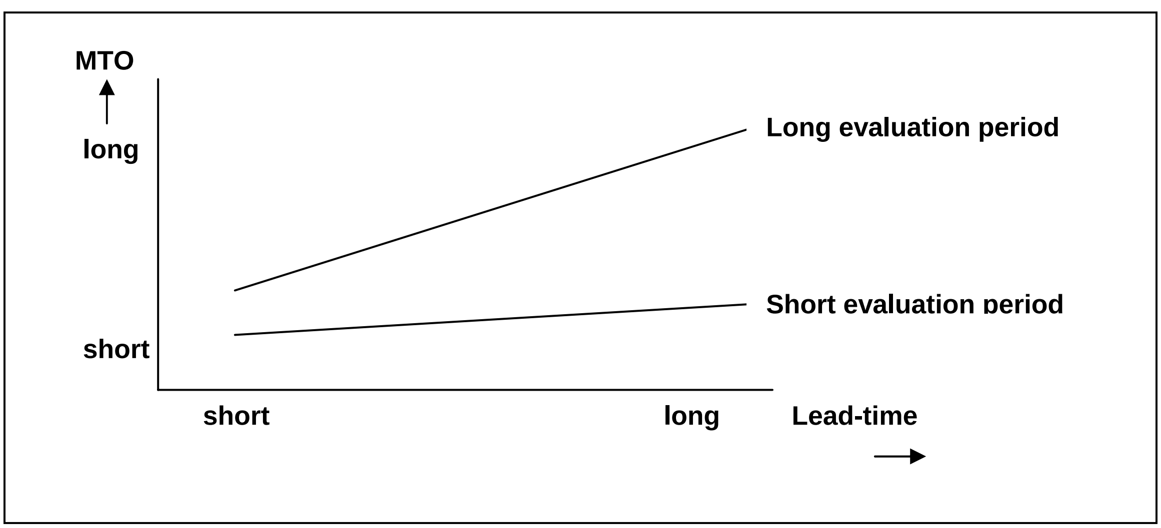


Figure 4: Interactive effect on MTO of lead-time and evaluation period length.

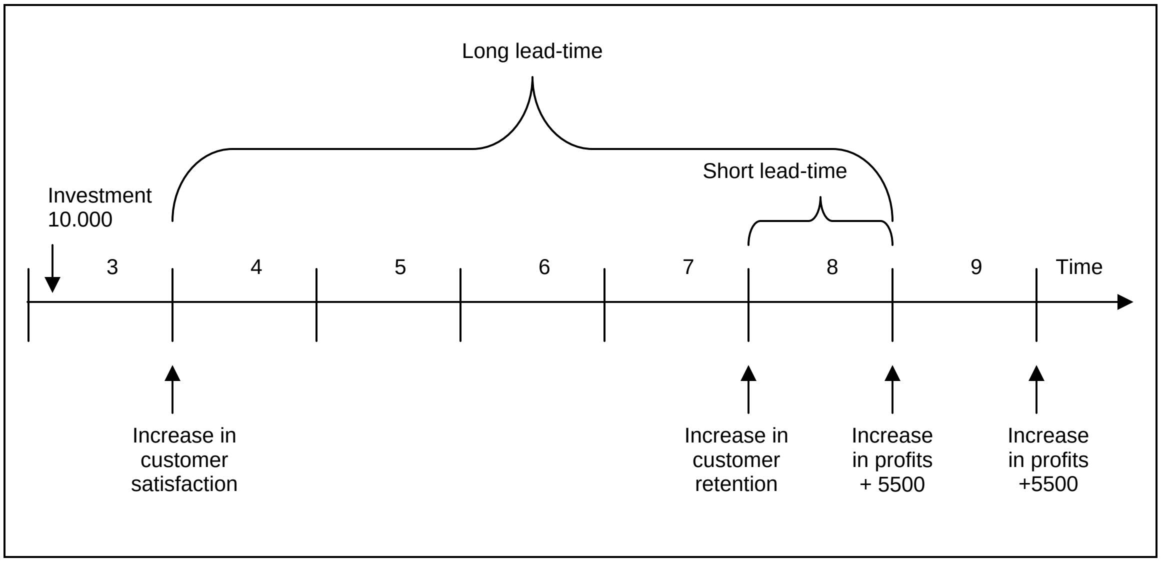


Figure 5: Partial time-line for the experiment, showing the effect of a 10.000 investment at the beginning of period 3. Profit increases occur 6 and 7 periods after the investment, at the end of periods 8 and 9. Increases in leading indicators occur after 1 period and after 5 periods.

Tables

Table 1: Descriptive statistics for survey measurement instruments

Variable	*Unit of measurement*	*Theoretical range*	*Actual range*	*Mean*	*Median*	*Standard deviation*
MTO	%	0-100	0-100	28.24	25.00	22.03
Lead-time	months	>0	1-36	7.88	6.00	6.61
Evaluation period	days	≥1	30-365	76.63	30.42	115.15

n=52.

Table 2: Regression analysis; dependent variable = MTO

Variable	*Expected sign*	*Standardized β-coefficient*	*p-value*
Constant			0.556
Lead-time (L)	+	+0.285	**0.031**
Evaluation period (P)	+	+0.324	**0.015**

n = 52. F-value = 7.092 (p=0.002). Adjusted R^2 = 0.193.

Table 3: Regression analysis; dependent variable = MTO.

Variable	*Expected sign*	*Standardized β-coefficient*	*p-value*
Constant			0.813
Lead-time (L)	+	+0.039	0.823
Evaluation period (P)	+	+0.045	0.805
Interaction (L x P)	+	+0.480	**0.044**

n = 52. F-value = 6.473 (p=0.001). Adjusted R^2 = 0.24.

Table 4: Regression analysis; dependent variable = MTO

Variable	*Expected sign*	*Standardized β-coefficient*	*p-value*
Constant	n.a.		0.295
Lead-time (L)	+	+0.010	0.992
Evaluation period (P)	+	-0.027	0.894
Interaction (L x P)	+	+0.558	**0.037**
Industry[1]	n.a.	+0.249	0.086
Strategy[2]	n.a.	+0.039	0.779
Organizational size[3]	n.a.	-0.239	0.088
Propensity to leave[4]	-	-0.090	0.498

F-value = 3.985 (p=0.003). Adjusted R^2 = 0.29. n = 45.

[1] Industry was measured by a dummy (1 if production, 0 otherwise). Including other dummies also (for trade and financial services) does not materially affect results, with the interaction term still having a significant p-value.

[2] Strategy was measured with the instrument developed by Govindarajan and Gupta (1985); higher values for strategy correspond to a more build oriented, and presumably longer term strategy.

[3] Organizational size was measured by the natural logarithm of the number of employees.

[4] Propensity to leave was measured on a four item five-point Likert scale. Sample item: “If circumstances permitted, I would jump at a chance to accept another job in another organization”. Two items taken from previous studies (Martin and Hunt 1980, Rahim and Afza 1993). Cronbach α = 0.71. Factor analysis using Varimax rotation reveals a one-factor structure, factor loadings of 0.4 and higher.

Table 5: Correlations between lead-time and MTO

		Correlation between Lead-time and MTO	
		Pearson	Spearman
Evaluation period	SHORT	0.080 p = 0.601 n = 45	0.115 p = 0.454 n = 45
	LONG	0.753 p = 0.051 n = 7	0.734 p = 0.060 n = 7

Table 6: Mean analysis. Dependent variable = MTO

		Lead-time	
		LONG	SHORT
Evaluation period	SHORT	Mean: 27.98 n = 23	Mean: 22.05 n = 22
	LONG	Mean: 63.00 n = 5	Mean: 12.50 n = 2

Table 7: Experimental conditions

		Lead-time	
		LONG	SHORT
Evaluation period	SHORT	I	III
	LONG	II	IV

Table 8: Descriptives per experimental condition for MTO

		Lead-time	
		LONG	SHORT
Evaluation period	SHORT	Condition I N = 47 Mean: 77972 S.D.: 26775	Condition III N = 47 Mean: 83991 S.D.: 21090
	LONG	Condition II N = 47 Mean: 96762 S.D.: 27770	Condition IV N = 47 Mean: 92236 S.D.: 31146

Table 9: ANOVA-analysis of MTO

Source	*Type III Sum of Squares*	*d.f.*	*Mean square*	*F*	*p-value*
Corrected model	9921178907[1]	3	3307059636	4.557	0.004
Intercept	1.447E+12	1	1.447E+12	1994.240	0.000
Lead-time (L)	26182369	1	26182369	0.036	0.850
Evaluation period (P)	8588431495	1	8588431495	11.834	**0.001**
Interaction (L x P)	1306565044	1	1306565044	1.800	0.181
Error	1.335E+11	184	725733777		
Total	1.591E+12	188			
Corrected total	1.435E+11	187			

[1]R^2=0.069, Adj. R^2=0.054.

Table 10: ANOVA-analysis; DV = #times instruction page 3 consulted during task

Source	*Type III Sum of Squares*	*d.f.*	*Mean square*	*F*	*p-value*
Corrected model	93.761[1]	3	31.254	4.671	0.004
Intercept	1190.048	1	1190.048	177.851	0.000
Lead-time (L)	29.920	1	29.920	4.472	**0.036**
Evaluation period (P)	44.048	1	44.048	6.583	**0.011**
Interaction (L x P)	19.793	1	19.793	2.958	0.087
Error	1231.191	184	6.691		
Total	2515.000	188			
Corrected total	1324.952	187			

[1]R^2=0.071, Adj. R^2=0.056

Table 11: Condition comparison of means for the use of instruction page 3 (table with lagged effects)

condition	*minus condition*	*mean difference*	*p-value*
I	II	-0.32	0.551
	III	-0.15	0.780
	IV	-1.77	**0.001**
II	III	0.17	0.750
	IV	-1.45	**0.007**
III	IV	-1.62	**0.003**

Post-hoc (LSD) analysis. Results are also significant ($p<0.05$) with the more conservative Bonferroni-test.

APPENDIX A

Experimental materials: instruction screens
Reproduced and translated (original screens in Dutch)

Instruction: general information (page 1/5)

General information
This study investigates investment decisions.
The study consists of a task in which you are asked how much you would like to invest in a specific project.

Introduction of the task
Assume you are working as a manager in a large company. Your job as a manager is to take decisions that are in the interest of the company. The company you work for is a for-profit organization with the objective to maximize long term value. The company has enough cash to repay all its debts.

As a manager, you are in charge of a business unit which produces 16 products, each in a separate plant. The plants are essentially identical en produce similar products, but for different target markets.

At this time, you have the possibility to invest in 1 of the plants. This investment will increase customer satisfaction and customer retention of the customers of this plant and it will also increase the profit of the plant. This investment opportunity will also apply to the other plants in later periods. However, you can only invest in one plant at a time, to a maximum amount of 10.000 per period.

In total you will be working for 16 periods as a manager for this company. At the start of each of these periods, you can invest any amount in the range of 0-10.000 in 1 of the plants in your business unit.

The next instruction page describes how your reward is determined.

Instruction: your reward scheme (page 2/5)

Your reward is based on a financial and a non-financial indicator.

Every period, you will be rewarded based on the profit of your business unit that period. Your reward based on profit, for all plants together, will be determined at the end of each period[1].

For every 1.000 profit, you will receive a reward of 0,06 euro.

Your current profit level is 10.000 per period – this amount of profit stems from current activities and will remain unchanged in the absence of any further action (such as investments).

To determine your reward, the amount invested that period will be subtracted from your profit level, while any returns from investment in previous periods will be added to the profit level.

Every period, you will also be rewarded based on the score for customer satisfaction for the products of all plants in your business unit together. Every period you score 1 point for the determination of your reward for every 1% customer satisfaction. The 16 products of your business unit now all have 80% customer satisfaction each – therefore, you score 16 x 80 = 1280 points for customer satisfaction for the determination of your reward. Customer satisfaction will also remain unchanged in the absence of any further action (such as investments).

Per 100 points of customer satisfaction, you will receive a reward of 0,02 euro.

Payment:
The reward you earn during the task will be periodically reported to you during the task, and will actually be paid to you at the end of the study!!!

The next instruction page provides an overview of investment projects similar to the one you can invest in, that have been carried out in similar plants by managers in different business units.

[1] Condition specific: in conditions with a long evaluation period, this paragraph read as follows: *You will be rewarded based on the profit level of your business unit at the end of periods 8 and 16. Your reward will be based on the cumulative profits from the previous eight periods, for all plants in your business unit together.*
[2] Condition specific: in conditions with a *short lead-time* the performance indicator was *customer retention* instead of customer satisfaction.

Instruction: investment table (page 3/5)
The table below provides an overview of previous experiences with similar projects in 4 other business units in the company. The table shows the effects of four separate projects. The left column indicates the amount the manager in charge decided to invest. The other columns show the effects of the amount invested on customer satisfaction (percentage of customers that indicates they are satisfied), customer retention (percentage of customers that repeatedly purchase), and profit of 1 plant. In order to enable a comparison, all investments were brought to the same moment in time (t=0). The 10.000 profit from t=0 onwards is an amount that is equal in each period which stems from other current activities.

Investment	**Customer satisfaction (%)**						**Customer retention (%)**						**Profits** (the invested amounts at t=0 have not been deducted)							
start t=0	start t=0	end of per 1	end of per 2	end of per 3	end of per 4	end of per **5 and later**	start t=0	end of per 1	end of per 2	end of per 3	end of per 4	end of per **5 and later**	start t=0	end of period 1	end of period 2	end of period 3	end of period 4	end of period **5**	end of periods **6 & 7**	end of period **8 and later**
10.000	80	90	90	90	90	90	80	80	80	80	80%	98,25	10000	10000	10000	10000	10000	10000	15500	10000
7.500	80	87,5	87,5	87,5	87,5	87,5	80	80	80	80	80%	93,96	10000	10000	10000	10000	10000	10000	14125	10000
2.000	80	82	82	82	82	82	80	80	80	80	80%	83,65	10000	10000	10000	10000	10000	10000	11100	10000
9.000	80	89	89	89	89	89	80	80	80	80	80%	96,43	10000	10000	10000	10000	10000	10000	14950	10000

The reported figures have been rounded, but have been measured reliably and objectively without error. Experience has shown that the effects on customer satisfaction and customer retention always occur after an investment and that these effects last in every future period. Profits, however, are only affected in two future periods. After that, profits return to the original level, in other words the level that the profit figure would have had in the absence of that investment, because competitors have followed your investment decision in the mean time. See the table.

After each investment there is a 5% probability that competitors will follow your decision immediately. In that case, profits do not increase in any period due to this investment (the other measures are affected). Therefore, there is a 95% probability there will be an effect on profit in two future periods. In the case of the investments listed in the table, competitors did not follow immediately and profits have been affected.

Based on the results the company has concluded that an investment in this type of project can yield a return of 10% of the invested amount in terms of profit. This return is made divided over two periods, which are timed 6 and 7 periods after the investment. This return will occur with a probability of 95%, while there is also a 5% probability that profits will not increase at all.

Instruction: summary (page 4/5)

* Your task is to take an investment decision.

* Investing has an effect on customer satisfaction, customer retention, and (possibly) profit – see table

* At the start of each of the 16 periods you will be asked to make an investment decision

* Each period you can invest in another plant; the decisions are therefore independent

* You may invest any amount in the range 0-10000 in each period

* Your reward will be based on both profit and customer satisfaction[2], based on the figures for your whole business unit (all plants/product together)

* Your reward based on profit and your reward based on customer satisfaction[2] will be determined at the end of each period[1]

* At the start of each period, your profit is 10000 (from other current activities; this will change only when you decide to invest (>0))

* To determine your reward, the invested amount is subtracted from your profit level and returns from investments in previous periods are added to your profit level

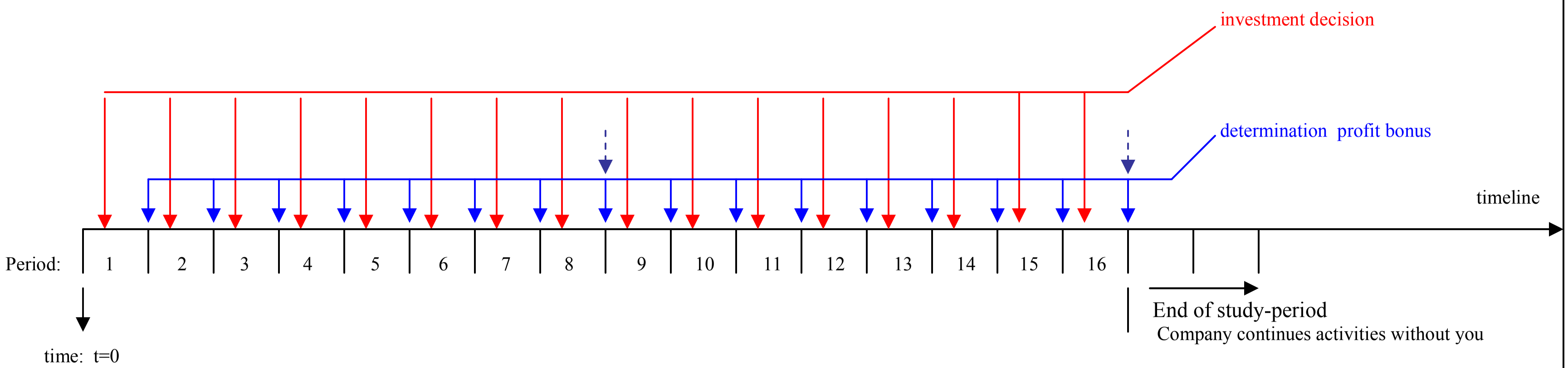
* There is a 5% probability that your competitors will follow your decision immediately and that an investment (>0) does not lead to higher profit levels in future periods and will generate no financial returns at all. The non-financial indicators are always affected if you invest (>0).

Assume there are no interest- and tax considerations, in other words that both the tax rate and the interest percentage are 0%.

The next and final instruction page provides a summarizing timeline for this study.

[1] Condition specific: in conditions with a long evaluation period, this paragraph read as follows: *Your reward based on profit will be determined after every eight periods over cumulative profits; your reward based on customer satisfaction[2] will be determined at the end of each period.*
[2] Condition specific: in conditions with a *short lead-time* the performance indicator was *customer retention* instead of customer satisfaction.

Instruction: Timeline (page 5/5)



Additionally, your reward based on the non-financial indicator will be determined at the end of each[1] period.

Before your reward based on profits is calculated, it will first be determined whether or not your competitors have followed your investment decision (probability=5%).

Explanation: the figure depends on the condition. The dashed arrows at the end of periods 8 and 16 indicate the only arrows included of the line indicating the determination of the profit bonus in the long evaluation period condition.

[1] "each" was underlined in long evaluation period conditions, to emphasize the difference with the profit evaluation interval

APPENDIX B

Screenshots of performance reports from first eight periods

Invested amounts in example: 5000, 7500, 9000, 10000, 2500, 6000, 1000, 500.

Screenshot condition I, period 1

Period 1 – Bonus determination at end of period

Profit this period (fixed base amount):	10.000	
Invested this period:	5.000	-
Profit this period:	5.000	
Profit from investments in earlier periods:	0	+
Total profit	5.000	

Your reward this period based on profit: 5.000 x E 0.06 per 1000 = E ,3

Customer satisfaction this period:

15 factories, 80% each → points:	1.200	
Invested in factory 1 this period: 5.000. Customer satisfaction: 85% → points:	85	+
Customer satisfaction total this period:	1.285	

Your reward this period based on customer satisfaction: 1.285 x E 0,02 per 100 = E ,26

Your total reward this period: E ,3 + E ,26 = E ,56

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 2 (of 16)**

Screenshot condition I, period 8

Period 8 – Bonus determination at end of period

Profit this period (fixed base amount):	10.000	
Invested this period:	500	-
Profit this period:	9.500	
Profit from investment of 7.500 in period 2:	4.125	+
Profit from investment of 9.000 in period 3:	4.950	+
Total profit	18.575	

Your reward this period based on profit: 18.575 x E 0.06 per 1000 = E 1,11

Customer satisfaction this period:

8 factories, 80% each → points:	640	
Invested in 1 of the factories this period: 500. Customer satisfaction: 80,5% → points:	80,5	+
From investments in earlier periods (earliest first): 85;87,5; 89; 90; 82,5; 86; 81 →	600	+
Customer satisfaction total this period:	1.321,5	

Your reward this period based on customer satisfaction: 1.285 x E 0,02 per 100 = E ,26

Your total reward this period: E 1,11 + E ,26 = E 1,38

Total reward including all previous periods:
Based on profits: ,3 + ,15 + ,06 + 0 + ,45 + ,41 + ,95 + 1,11 = 3,43;
Based on customer satisfaction: ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,26 = 2,09;
Total: 3,43 + 2,09 = 5,53

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 9 (of 16)**

Screenshot condition II, period 1

Period 1 – Bonus determination at end of period

Your reward based on profits is not determined this period.

At the end of periods 8 and 16, your reward based on profits will be determined on the basis of the cumulative profits from the preceding eight periods. The cumulative profits will be determined by subtracting the invested amounts from the periodic fixed amounts of profits and adding returns from previous investments to the periodic fixed amounts of profits.

Customer satisfaction this period:

15 factories, 80% each → points:	1.200	
Invested in factory 1 this period: 5.000. Customer satisfaction: 85% → points:	85	+
Customer satisfaction total this period:	1.285	

Your reward this period based on customer satisfaction: 1.285 x E 0,02 per 100 = E ,26

Your total reward this period: E ,26

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 2 (of 16)**

Screenshot condition II, period 8

Period 8 – Bonus determination at end of period

Profit each period (fixed base amount): 10.000 x 8 periods:	80.000	
Invested in periods 1-8 (earliest first): 5.000+7.500+9.000+10.000+2.500+6.000+1.000+500=	41500 -	
Profit this rewardperiod:	38.500	
Profit from investments, booked in period 6:	2.750 +	(2.750 from inv. in period 1)
Profit from investments, booked in period 7:	6.875 +	(2.750 from inv. in period 1 and 4.125 from period 2)
Profit from investments, booked in period 8:	9.075 +	(2.750 from inv. in period 2 and 4.950 from period 3)
Total profit	57.200	

Your reward this period based on profit: 57.200 x E 0.06 per 1000 = E 3,43

Customer satisfaction this period:

8 factories, 80% each → points:	640	
Invested in 1 of the factories this period: 500. Customer satisfaction: 80,5% → points:	80,5	+
From investments in earlier periods (earliest first): 85;87,5; 89; 90; 82,5; 86; 81 →	600	+
Customer satisfaction total this period:	1.321,5	

Your reward this period based on customer satisfaction: 1.285 x E 0,02 per 100 = E ,26

Your total reward this period: E 3,43 + E ,26 = E 1,38

Total reward including all previous periods:
Based on profits: 3,43
Based on customer satisfaction: ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,26 = 2,09;
Total: 3,43 + 2,09 = 5,53

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

[Introduction] [Reward scheme] [Investment table] [Summary] [Timeline] [**To period 9 (of 16)**]

Screenshot condition III, period 1

Period 1 – Bonus determination at end of period

Profit this period (fixed base amount):	10.000	
Invested this period:	5.000	-
Profit this period:	5.000	
Profit from investments in earlier periods:	0	+
Total profit	5.000	

Your reward this period based on profit: 5.000 x E 0.06 per 1000 = E ,3

Customer retention this period:	
16 factories, 80% each (unchanged) → points:	1.280
Customer retention total this period:	1.280

Your reward this period based on customer retention: 1.280 x E 0,02 per 100 = E ,26

Your total reward this period: E ,3 + E ,26 = E ,56

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 2 (of 16)**

Screenshot condition III, period 5

This is the first period showing an effect on the customer retention measure

Period 5 – Bonus determination at end of period

Profit this period (fixed base amount):	10.000	
Invested this period:	2.500	-
Profit this period:	2.500	
Profit from investments in earlier periods:	0	+
Total profit	7.500	

Your reward this period based on profit: 7.500 x E 0.06 per 1000 = E ,45

Customer retention this period:

15 factories, 80% each → points	1.200	
Invested in a factory in period 1: 5.000. Customer retention this period: 89,13% → points:	89,13	+
Customer retention total this period:	1.289,13	

Your reward this period based on customer retention: 1.289,13 x E 0,02 per 100 = E ,26

Your total reward this period: E ,45 + E ,26 = E ,71

Total reward including all previous periods:
Based on profits: ,3 + ,15 + ,06 + 0 + ,45 = ,96;
Based on customer retention: ,26 + ,26 + ,26 + ,26 + ,26 = 1,28;
Total: ,96 + 1,28 = 2,24

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 6 (of 16)**

Screenshot condition III, period 8

Period 8 – Bonus determination at end of period

Profit this period (fixed base amount):	10.000	
Invested this period:	500	-
Profit this period:	9.500	
Profit from investment of 7.500 in period 2:	4.125	+
Profit from investment of 9.000 in period 3:	4.950	+
Total profit	18.575	

Your reward this period based on profit: 18.575 x E 0.06 per 1000 = E 1,11

Customer retention this period:

12 factories, 80% each → points:	960	
Invested in a factory in period 4: 10.000. Customer retention this period: 98,25% → points: 98,25	+	
From investments in earlier periods (earliest first): 89,13; 93,96; 96,42 →	279,24	+
Customer retention total this period:	1.337,49	

Your reward this period based on customer retention: 1.337,49 x E 0,02 per 100 = E ,27

Your total reward this period: E 1,11 + E ,27 = E 1,38

Total reward including all previous periods:
Based on profits: ,3 + ,15 + ,06 + 0 + ,45 + ,41 + ,95 + 1,11 = 3,43;
Based on customer retention: ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,27 = 2,07;
Total: 3,43 + 2,07 = 5,51

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

[Introduction] [Reward scheme] [Investment table] [Summary] [Timeline] [**To period 9 (of 16)**]

Screenshot condition IV, period 1

<u>Period 1 – Bonus determination at end of period</u>

Your reward based on profits is not determined this period.

At the end of periods 8 and 16, your reward based on profits will be determined on the basis of the cumulative profits from the preceding eight periods. The cumulative profits will be determined by subtracting the invested amounts from the periodic fixed amounts of profits and adding returns from previous investments to the periodic fixed amounts of profits.

Customer retention this period:

16 factories, 80% each (unchanged) → points: 1.280

Customer retention total this period: 1.280

Your reward this period based on customer retention: 1.280 x E 0,02 per 100 = <u>E ,26</u>

<u>Your total reward this period: E ,26</u>

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

[Introduction] [Reward scheme] [Investment table] [Summary] [Timeline] [**To period 2 (of 16)**]

Screenshot condition IV, period 5

This is the first period showing an effect on the customer retention measure

Period 5 – Bonus determination at end of period

Your reward based on profits are not determined this period.

At the end of periods 8 and 16, your reward based on profits will be determined on the basis of the cumulative profits from the preceding eight periods. The cumulative profits will be determined by subtracting the invested amounts from the periodic fixed amounts of profits and adding returns from previous investments to the periodic fixed amounts of profits.

Customer retention this period:

15 factories, 80% each → points:	1.200	
Invested in a factory in period 1: 5.000. Customer retention this period: 89,13% → points:	89,13	+
Customer retention total this period:	1.289,13	

Your reward this period based on customer retention: 1.289,13 x E 0,02 per 100 = E ,26

Your total reward this period: E ,26

Total reward including all previous periods:
Based on profits: 0;
Based on customer retention: ,26 + ,26 + ,26 + ,26 + ,26 = 1,28;
Total: 0 + 1,28 = 1,28

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 2 (of 16)**

Screenshot condition IV, period 8

Period 8 – Bonus determination at end of period

Profit each period (fixed base amount): 10.000 x 8 periods:	80.000	
Invested in periods 1-8 (earliest first): 5.000+7.500+9.000+10.000+2.500+6.000+1.000+500=	41500 -	
Profit this rewardperiod:	38.500	
Profit from investments, booked in period 6:	2.750 +	(2.750 from inv. in period 1)
Profit from investments, booked in period 7:	6.875 +	(2.750 from inv. in period 1 and 4.125 from period 2)
Profit from investments, booked in period 8:	9.075 +	(2.750 from inv. in period 2 and 4.950 from period 3)
Total profit	57.200	

Your reward this period based on profit: 57.200 x E 0.06 per 1000 = E 3,43

Customer retention this period:

12 factories, 80% each → points:	960	
Invested in a factory in period 4: 10.000. Customer retention this period: 98,25% → points:	98,25	+
From investments in earlier periods (earliest first): 89,13; 93,96; 96,42 →	279,24	+
Customer retention total this period:	1.337,49	

Your reward this period based on customer retention: 1.337,49 x E 0,02 per 100 = E ,27

Your total reward this period: E 3,43 + E ,27 = E 3,7

Total reward including all previous periods:
Based on profits: 3,43
Based on customer retention: ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,26 + ,27 = 2,07;
Total: 3,43 + 2,07 = 5,51

While studying these results you may return to the instructions, and afterwards you can continue to the next period:

Introduction | Reward scheme | Investment table | Summary | Timeline | **To period 9 (of 16)**

[i] There should be no material difference in the sacrifice made for future returns between subjects in the long versus the short lead-time conditions. If subjects in the long lead-time condition had received a considerable bonus based on increased non-financial performance early on, they would have received a higher bonus than subjects in the short lead-time conditions. This would render these conditions less comparable with respect to the DV, and hinder the detection of cognitive effects of lead-time. Sensitivity of the bonus based on the leading indicator was therefore set at a (very) low level. This was achieved by rewarding the subjects based on the cumulative score on their leading indicators for the 16 plants they were responsible for (see experimental materials and screen examples in appendices A and B). Actual rewards based on non-financial performance paid to subjects varied from $ 5.30 to $ 5.61 (theoretical range: $ 5.25 - $ 5.61), with a mean of $ 5.48.

[ii] To ensure that subjects in every condition faced the same project, we presented the same table with lagged causal effects regarding the investment project - see instruction page 3 of the experimental materials (appendix A). Furthermore, we selected different leading performance measures. The leading measure for the long lead-time conditions was customer satisfaction, while for the short lead-time conditions it was customer retention. Rewarding subjects based on the same measure (for instance, customer satisfaction) with a different lead-time would vary the nature of the project. Differences in invested amounts could then be attributed to preferences for different types of projects. To be more precise, an earlier increase in customer satisfaction could be argued to be generally preferable over a later increase. It was thus deemed necessary to hold the lead-time of specific measures constant and use two different measures. Nevertheless, both measures that were used were related to the same (customer) perspective from the Balanced Scorecard, preventing any obvious bias.

[iii] Total reward (rewards based on profit and non-financial performance) varied between $14.13 and $18.65 (theoretical range: $12.97 - $18.65), with a mean of $16.98. Rounding and timing differences led to negligible differences in pay between the short and long lead-time conditions (max. approximately 3 cent or 0.2% of the mean total reward).

[iv] Sample demographics were as follows. The participants varied between 20 and 35 years of age (mean = 22.39, s.d. = 2.09). Female participants represented 27% of the sample. Most participants (174 or 93%) had no working experience in the area of accounting & finance. All demographic variables were investigated for differences among treatment conditions. Neither ANOVA nor Pearson Chi-square tests (for the demographic variables measured on a nominal scale) revealed significant differences between treatment conditions (at the 0.05 confidence level).

[v] Kolmogorov-Smirnov test for normality value = 0.979, p=0.294; Levene's test for homogeneity of varaince F-value = 2.521, p=0.059; independence of observations was ensured through randomized between-subjects design and preventing interaction during experimental sessions – in addition, with observations in temporal order, DW-statistic = 2.166.

[vi] It could be argued that a summation of the invested amounts in the second half of the experiment is the best way to construct the DV. The reason is that only after period 8 have all subjects, including those in the long evaluation period conditions, seen a profit bonus report based at least once. Using a summation of the invested amounts in periods 9-16 or in periods 11-16 yields inferentially identical results.

[vii] The experiment was carefully designed to exclude the possibility that subjects were unaware of the end of the task. The comprehension check at the start of the experiment involved a question asking subjects for the duration of the experiment. Furthermore, at the end of every period subjects proceeded to the next by pressing a button labeled "go to period # (of 16)" – see appendix B. Finally, statistical analysis of the investment patterns between subsequent rounds revealed identical patterns across conditions. These patterns clearly showed a decrease in invested

amounts between rounds 10 and 11, the point at which the horizon problem becomes relevant. This provides evidence that subjects in every condition were aware of end-game effects on their reward.