The Effect of Information System Precision on Honesty in Managerial Reporting: An Experimental Examination Incorporating Operating Uncertainty

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ABSTRACT: We apply insights from a model of social norm activation to an agency model of capital budgeting to develop a positive behavioral relation between information system precision and honesty in managerial reporting. This relation is based on the ability of a precise information system to reduce information asymmetry between the owner and the manager and thereby promote the activation of an honesty norm. Next, we use this behavioral theory to predict that operating uncertainty in the information system moderates this positive relation by allowing the manager to hide behind the uncertainty and thereby evade the honesty norm. Using an experimental agency setting in the literature, we find evidence consistent with our behavioral theory. Information system precision increases managerial honesty under low but not under high operating uncertainty and managerial honesty is the highest under a precise information system with low operating uncertainty. An analysis of exit questionnaire responses confirms our underlying behavioral theory based on social norm activation.

Keywords: *participative budgeting; honesty norm; information system precision; operating uncertainty*

Data Availability: *Experiment data are available from the authors upon request.*

I. INTRODUCTION

Participative budgeting is a common method by which decentralized firms elicit private information from lower level managers for planning and control purposes (Shields and Shields 1998; Libby and Lindsay 2007). To the extent that such managers truthfully communicate their private information in the budget, participative budgeting yields useful information for production, marketing, and capital budgeting decisions (Evans, Hannan, Krishnan, and Moser 2001). Some researchers have used agency theory to argue that participative budgeting is of little value to the firm because of the incentive to lie when submitting budgets (Jensen 2001; Hope and Fraser 2003). In contrast to this pessimistic view, experimental studies in accounting have found that agents report much more honestly than agency theory predicts and that reducing information asymmetry between the principal and the agent increases such honesty (Young 1985; Stevens 2002; Brown, Evans, and Moser 2009). This evidence suggests that accounting information systems may increase the effectiveness of participative budgeting by reducing information asymmetry and encouraging honesty in managerial reporting. To date, however, there is little theory and empirical evidence to support this role of information systems in participative budgeting. This study contributes to this line of research by examining the effect of information system precision on honesty in managerial reporting and the moderating effect of operating uncertainty.

We use an experimental setting based on the agency model of capital budgeting in Antle and Eppen (1985) and Antle and Fellingham (1995). In the model, the owner of a firm hires a manager whose presence is required to implement production. The owner provides the resources required for production based upon a cost report submitted by the manager, and the manager has an informational advantage regarding production cost. Because the manager consumes all resources provided above actual production cost, he or she is motivated to overstate the cost of production in the cost report.

Thus, the manager's private information regarding production cost represents a moral hazard to the owner. Antle and Fellingham introduce an information system that provides an independent signal of production cost before the manager submits the cost report to the owner and examine a contractual solution that uses the signal of production to induce truthful reporting from the manager.[1] However, it is not always feasible or cost-effective for the owner to commit to incorporate information derived from an information system in the employment contract (Williamson 1975; Arya, Glover, and Sivaramakrishnan 1997). Thus, it is important to examine non-contractual effects of information systems (Hannan, Rankin, and Towry 2006).

We assume that the cost signal from the information system is not used for contracting purposes and examine the behavioral effect of information system precision on honesty in managerial reporting. As such, this study builds directly on Hannan et al.'s (2006) experimental study examining the behavioral impact of an information system. Hannan et al. find that the presence of an information system increases honesty in managerial reporting, but managerial honesty is lower under a precise information system than under a coarse information system. To explain their result that managerial honesty decreases with information system precision, they propose a trade-off model of managerial reporting in which managers trade-off the benefits of appearing honest against the benefit of misrepresentation. According to this trade-off model, information system precision negatively affects managerial honesty by increasing the marginal cost of appearing honest. The implication of their finding is that an owner who does not contract on the information system's signal will prefer to implement a less precise information system than a more precise information system, even if the more precise information system is costless (Salterio and Webb 2006).

[1] We discuss the agency model in Antle and Fellingham (1995) in more detail in the theoretical development section below.

We assert that the relation between information system precision and managerial honesty warrants further examination on both theoretical and empirical grounds. First, Hannan et al.'s trade-off model does not consider the potential for a precise information system to increase the manager's preference for honesty in the budget. Recent theory in social norm activation, however, suggests that information system precision may increase honesty preferences by increasing expectations for an honesty norm (Bicchieri 2006). Second, Hannan et al. hold the operating uncertainty of the information system constant at a relatively high level where the information system reports the true range of the actual cost with only 70 percent accuracy. Experimental tests of game theory (Castillo and Leo 2010, Ockenfels and Werner 2012) and social norm theory (Bicchieri and Chavez 2010) suggest that high uncertainty allows agents to "hide behind probabilities" and thereby evade social norms. Thus, the relatively high level of operating uncertainty in Hannan et al.'s experiment may have masked the true relation between information system precision and honesty in managerial reporting. Given the prevalence of operating uncertainty in accounting information systems (Haka, Luft and Ballou 2000; Luft and Shields 2003; Brüggen and Luft 2011), the moderating effect of operating uncertainty is an important consideration when investigating the effect of information system precision on managerial honesty.

To provide a baseline prediction based on *ceteris paribus* conditions, we review the agency model in Antle and Fellingham (1995) and incorporate insights from the model of social norm activation in Bicchieri (2006). We find that *both* models provide an unambiguous positive relation between information system precision and managerial honesty in the cost report. Antle and Fellingham's positive relation is based on the contractual use of the information signal whereby the owner uses a hurdle contract within the reported cost range to induce honest reporting from the manager. In contrast, Bicchieri's positive relation is based on the ability of the signal to reduce

information asymmetry and thereby increase expectations for an honesty norm. Therefore, we predict that honesty in managerial reporting will increase with the precision of the information system's signal of actual production cost, ceteris paribus. Next, we use Bicchieri's model to predict that high operating uncertainty in the information system moderates this effect by allowing managers to hide behind the uncertainty and thereby evade the honesty norm. Thus, we predict an ordinal interaction effect where high operating uncertainty moderates the positive effect of information system precision on managerial honesty.

To provide experimental evidence for our behavioral theory, we utilize a computerized version of Hannan et al.'s manual experiment and manipulate information system precision and operating uncertainty using a 2×2 factorial design. We vary information system precision at two levels from coarse to precise as in Hannan et al., and we vary operating uncertainty at two levels from low to high (90% accurate to 70% accurate). Consistent with our ordinal interaction prediction, we find that information system precision increases managerial honesty under low but not under high operating uncertainty and managerial honesty is the highest under a precise information system with low operating uncertainty. In support of our behavioral theory, an examination of exit questionnaire responses suggests that high operating uncertainty allowed managers in the precise information system condition to hide behind the uncertainty and thereby evade the honesty norm.

This study contributes new insights that may be useful to accounting theory and practice. First, our study provides theoretical support for a positive effect of information system precision on managerial honesty based on insights from both agency theory (Antle and Fellingham 1995) and a model of social norm activation (Bicchieri 2006). Similar to us, Salterio and Webb (2006) provide theoretical support for a positive effect of information system precision on managerial honesty based on research in organizational behavior. Many of their theoretical arguments, however, are based on

criticisms of the underlying assumptions of agency theory and the presence of organizational forces that are absent in both Antle and Fellingham's (1995) agency model and experimental settings such as Hannan et al. (2006). In contrast, our theoretical development begins with the set of assumptions present in agency theory and incorporates new insights from social norm activation theory that apply to experimental settings in the literature as well as organizational settings in practice. We demonstrate the usefulness of our behavioral theory by showing that it predicts a moderating effect for operating uncertainty and then finding support for that moderating effect in our experimental study. Thus, our experimental study contains the characteristics that Brown et al. (2009) argue maximize its potential to contribute to agency theory.

Second, our study provides a theoretical and empirical explanation for Hannan et al.'s experimental result that information system precision is negatively related to honesty in managerial reporting. In their discussion of Hannan et al.'s study, Salterio and Webb (2006, 929) conclude that "further research is needed to assess the generalizability of their result." To our knowledge, however, no follow-up study has been conducted. In addition, no study has considered the moderating role of operating uncertainty as a common feature of accounting information systems. Our behavioral theory and experimental results suggest that the true behavioral relation between information system precision and managerial honesty is unambiguously positive due to the potential activation of an honesty norm, but that high operating uncertainty moderates this positive relation by allowing managers to hide behind the uncertainty and thereby evade the honesty norm. This suggests that the high operating uncertainty present in Hannan et al.'s experiment may have masked the true relation between information system precision and managerial honesty.

Finally, our theory and experimental results have practical implications for the practice of participative budgeting. Hannan et al.'s trade-off theory and experimental evidence suggest that

investing in a more precise information system decreases honesty in managerial reporting. This contradicts common intuition regarding the perceived benefit of investing in more precise information systems to increase the efficiency of participative budgeting systems (Salterio and Webb 2006). In contrast, this study provides theory and experimental evidence that supports common intuition regarding the perceived benefit of investing in more precise information systems in practice. While some researchers have used agency theory to argue that participative budgeting is of little value to the firm because of the incentive to lie when submitting budgets (Jensen 2001; Hope and Fraser 2003), surveys suggest that participative budgeting continues to play an important role in the control of the multi-divisional organization (Libby and Lindsay 2007; 2010). Our theoretical intuition and experimental results confirm that information system precision can increase the effectiveness of participative budgeting by promoting managerial honesty. Thus, our study helps explain the continued use of participative budgeting for planning and control purposes.

The remainder of this paper is organized as follows: In Section II, we present our theory and develop the hypotheses we test. In Section III, we describe the experimental methodology. In Section IV, we report the experimental results. In Section V, we conclude by discussing the implications of our study.

II. THEORY AND HYPOTHESIS DEVELOPMENT

Agency Theory (Contractual) Prediction

Our experimental setting is based on the agency model of capital budgeting in Antle and Eppen (1985) and Antle and Fellingham (1995).[2] In the model, the owner of a firm hires a manager whose presence is required to implement production. Production requires cash from the owner in addition to the presence of the manager. By virtue of being closer to the production process, the

[2] For a review of agency models of capital investments with private information, see Antle and Fellingham (1997).

manager is assumed to have private information regarding the actual cost of production. In the model, therefore, the manager learns what the actual production cost will be prior to the investment decision of the owner. In contrast, the owner only knows the distribution of possible production costs prior to making the investment decision. As Antle and Fellingham (1995, 43) point out, it can be shown that a participative budgeting scheme is the optimal form of contracting in this setting. Thus, the contract includes a cost report submitted by the manager prior to the investment decision. Because the manager consumes any cash not put into production, however, the owner assumes that the manager will overstate the cost of production in the cost report. As reflected at the inception of the participative budgeting literature (Schiff and Lewin 1970), therefore, the key problem for the owner in this capital budgeting setting is the incentive for the manager to build budgetary slack into the budget.

Antle and Fellingham's model extends the agency theory literature in capital budgeting by introducing a public information system that generates a signal of production cost and thereby reduces the manager's information advantage over the owner. As with other agency models of capital budgeting with private information, Antle and Fellingham rely on intuition and results from the informational economics literature. A major result from this literature is the Revelation Principle, which states that a communication process that induces the manager to report the true cost of production is at least as good as any other communication process (Antle and Fellingham 1997, 893). This principle greatly reduces the number of alternative reporting strategies the researcher must consider as possible equilibria in the model. In particular, the Revelation Principle implies that theorists can confine their attention to equilibrium solutions that motivate truthful reporting from the manager (Lambert 2001, 51). It also implies that, holding all else constant, any increase in truthful reporting on the part of the manager benefits the firm. In summary, agency models of capital

investments with private information confirm that participative budgeting is the optimal contract solution and that honesty in managerial reporting contributes to the efficiency of this solution.

Antle and Fellingham's model relies on key results from Antle and Eppen's (1985) agency model of capital budgeting. Antle and Eppen demonstrate that to induce honest reporting from the manager, the optimal contract is a "hurdle contract" that funds all projects with costs below a threshold but pays the manager for the threshold level of production. Thus, the owner pre-commits to allow the agent to keep the slack associated with projects below the threshold cost and does not renegotiate the contract after the manager submits his cost report. This pre-commitment gives the agent the incentive to reveal his private information truthfully in the budget. However, the threshold is at a middle level of production in the possible range, so the optimal solution requires the owner to turn down some projects that otherwise would be profitable to the firm. Thus, the cost of inducing truthful reporting from the manager is budgetary slack and capital rationing.

Antle and Fellingham's model suggests that the ability of the information system to reduce budgetary slack is increasing in its precision. In the model, the information system provides a subpartition of the initial set of possible costs, and beliefs over the costs in each subpartition are derived by Bayes' rule. Thus, the owner determines an optimal hurdle strategy in each observed subpartition or cost range, and the manager captures all the profits from actual costs lower than the hurdle cost within the subpartition. The precision of the information system is increased by increasing the number of possible subpartitions, which decreases the cost range in each subpartition and reduces the expected budgetary slack. All else held constant, therefore, the owner prefers a more precise information system to reduce expected budgetary slack and increase returns due to production. This result is intuitive and follows common reasoning found in practice that a more precise information system provides less opportunity to create slack (Antle and Fellingham 1995, 49, footnote 15).

In summary, the agency model in Antle and Fellingham (1995) suggests that a more precise information system increases managerial honesty by giving the owner an opportunity to induce more honest reporting from the manager in the contract. This positive relation between information system precision and managerial honesty, however, relies on the assumption of full contracting on the information system signal. In contrast, we examine the non-contractual effect of an information system that provides a public signal that only acts to reduce the degree of information asymmetry between the manager and the owner regarding actual production cost. While this setting provides a weak test of the effect of information system precision on managerial honesty, it is important to examine non-contractual effects because ex-ante contracting on information system estimates may be prohibitively costly or even infeasible (Williamson 1975; Arya et al. 1997). Further, Antle and Fellingham (1995) show that there are conditions where it is optimal for the owner to commit to ignore the public signal from the information system for contracting purposes.[3]

Behavioral (Non-Contractual) Prediction

Researchers in accounting have begun to apply Bicchieri's (2006) model of social norm activation to test behavioral (non-contractual) effects of accounting-related information (Douthit, Kearney, and Stevens 2012; Davidson and Stevens 2013; Maas and Rinsum 2013; Douthit and Stevens 2015). The model defines a social norm as a conditional preference that arises due to clues and information signals present in a given social setting. These contextual clues affect behavior by affecting expectations and beliefs. Bicchieri's model is particularly useful to experimental research based on agency theory. First, her rational reconstruction of what constitutes a social norm substitutes a precise concept for an imprecise one, and specifies in what sense one may say that compliance with

[3] Antle and Fellingham (1995) examine a special case where the owner is able to commit to a contract that depends on the realized partition, thus allowing for the provision of incentives for information-influencing activities. Antle and Fellingham find that it may be optimal for the owner to commit to ignore information for contracting purposes if it is not produced by a desired partition.

a norm is rational. Second, her rational reconstruction allows meaningful predictions to be made regarding the effect of information on behavior. Third, her model is based on experimental tests of economic theory, including systematic tests of game theory. Nevertheless, Bicchieri's model is also based on insights from the behavioral literature in social norms, including the insight that social norms may be activated through an heuristic, automatic route as well as the deliberational route implied by her model.

Bicchieri (2006) identifies four necessary and sufficient conditions for a social norm to be activated and affect behavior in a given social setting: contingency, empirical expectations, normative expectations, and conditional preferences.[4] The *contingency* condition says that actors are aware that a behavioral rule exists and applies to the social setting. The *empirical expectations* condition says that actors expect a sufficiently large proportion of a given population to follow the rule in the social setting because they have previously observed such behavior in similar social settings. The *normative expectations* condition says that actors believe that this subpopulation (or referent group) expects conformance with the rule and may be willing to sanction behavior inconsistent with the rule.[5] The *conditional preferences* condition says that actors will prefer to conform to the rule (i.e., derive positive utility from conformance) if the previous three conditions are met. In addition, Bicchieri (2006, 128-129) incorporates the possibility that information asymmetry allows for *norm evasion*. In particular, Bicchieri's model suggests that non-conformance with an activated norm is likely to occur when one can violate normative expectations without being observed (Bicchieri and Chavez 2010). Bicchieri's model can be used to explain how cues and information signals in an economic setting

[4] Bicchieri's (2006) formal model is presented in its entirety in Davidson and Stevens (2013).
[5] While empirical expectations aid in the activation of a social norm, it is possible that a social norm can be activated by normative expectations alone, provided that an individual recognizes this expectation for compliance as legitimate in and of itself (Bicchieri 2008).

activate social norms such as honesty, fairness, reciprocity, and promise-keeping, and how information asymmetry might allow individuals to evade such norms.

Honesty is considered one of the most prominent social norms found in society (Murphy 1993). Further, the act of presenting a cost report is a strong cue that honesty is a behavioral rule that would apply in a given participative budgeting setting. Thus, we expect the contingency condition from Bicchieri's model to be met in experimental budgeting studies.[6] Because a more precise information system reduces the ability of the manager to create budgetary slack within the signal's range, a more precise information system also promotes higher empirical and normative expectations of honesty. Finally, because it reduces information asymmetry between the owner and the manager regarding production cost, we expect honesty norm evasion to be lower under a precise information system than a coarse information system. Thus, Bicchieri's model suggests that increasing the precision of the information system increases the likelihood that an honesty norm will be activated and reduces the likelihood of honesty norm evasion. In particular, the relative presence of the four conditions necessary for an honesty norm to be activated and followed (contingency, empirical expectations, normative expectations, and conditional preferences) will be greater with a precise information system than a coarse information system. Thus, Bicchieri's behavioral theory implies an unambiguously positive relation between information system precision and managerial honesty. This leads to our baseline prediction based on ceteris paribus conditions (all else held constant):

Baseline Prediction: Ceteris paribus, honesty in budget reporting will increase with the precision of the information system's signal of actual production cost.

[6] Interestingly, Salterio and Webb (2006) point out that experimental studies in the literature are typically void of important cues that generate expectations for honest reporting in organizational settings in practice. In particular, these experimental studies minimize expectations for honest reporting by financially rewarding dishonest reporting, by providing assurances that no negative consequences exist to dishonest reporting, and by limiting interpersonal interaction between the manager and the owner. Because we utilize similar experimental methods, our experimental setting is biased against generating expectations for honest reporting. Because of this bias, our experimental study provides a strong test of the effect of information system precision on managerial honesty in reporting.

The Moderating Role of Operating Uncertainty

Antle and Fellingham's (1995) model does not incorporate the effect of operating uncertainty in their agency model, as the cost range provided by the information system always contains actual production cost. Given the prevalence of uncertainty in accounting information systems (Haka, Luft and Ballou 2000; Luft and Shields 2003; Brüggen and Luft 2011), however, the behavioral effect of operating uncertainty is an important consideration when investigating the effect of the precision of an information system. Bicchieri's (2006) model of social norm activation predicts that behavior inconsistent with a given norm may occur because normative expectations are absent in the decision setting or they are present but one can violate them without being observed (Bicchieri and Chavez 2010). We argue that an information system with a high level of operating uncertainty allows the manager to evade an honesty norm even when such a norm is present.[7]

Consistent with Bicchieri's theoretical possibility of *norm evasion*, experimental tests of dictator games have found that dictators tend to act more opportunistically when the dictator's choice of relative pay can be randomly determined with some level of probability (Ockenfels and Werner 2012).[8] Similar behavior has been found in experimental tests of investment games where a first mover decides how much of an endowment to send to a second mover and the second mover decides how much to return to first mover after the amount sent has been increased. For example, Castillo and Leo (2010) find that restricting the return amount of the second mover to zero with 20 percent probability and making the outcome of the probability known only to the second mover allows the

[7] Some behavioral researchers propose a similar argument. They state that individuals value honesty as part of their internal reward system and want to maintain this aspect of their self-view (Campbell 1964, Henrich et al. 2001, Mazar et al. 2008). However, individuals may act dishonestly if they can successfully avoid negatively updating their self-view as honest individuals by categorizing their actions into more compatible terms or finding rationalizations for their actions (Bandura 1999, Mazar et al. 2008). Information asymmetry, therefore, impedes honest behavior by allowing individuals to avoid negatively updating their self-view as honest.

[8] This phenomenon is established in the experimental economics studies as "hiding behind probabilities" or "hiding behind a small cake" (Castillo and Leo 2010, Ockenfels and Werner 2012). Cox and Li (2012) demonstrate a similar effect for incorporating uncertainties in trust games, and call the observed effect "hiding behind a coin flip".

second mover to hide selfish acts and thereby increase opportunistic behavior. In a similar setting, Vranceanu et al. (2012) find that second movers in the investment game act more opportunistically if they can "hide behind probabilities" by claiming "bad luck" when they have actually implemented their selfish strategy. Similarly, we expect that high operating uncertainty in the information system provides the manager with an opportunity to hide behind the uncertainty and thereby evade the honesty norm.

Given the ability of managers to evade an honesty norm under high operating uncertainty, we predict an ordinal interaction between the precision of the information system and operating uncertainty inherent in that information system. Given theory and related experimental evidence that uncertainty allows for norm evasion, we expect to find our theoretical positive relation between information system precision and honesty in managerial reporting only under low operating uncertainty. Under high operating uncertainty, in contrast, we expect this positive relation to be moderated due to the ability for managers to hide behind the uncertainty and evade the honesty norm. In particular, we do not expect to find our theoretical positive relation between information system precision and honesty in managerial reporting when there is high operating uncertainty. Thus, we use two hypotheses to test our ordinal interaction prediction.

H1: When the operating uncertainty of the information system is low, honesty in budget reporting will increase with the precision of the information system's signal of actual production cost.

H2: When the operating uncertainty of the information system is high, honesty in budget reporting will not increase with the precision of the information system's signal of actual production cost.

Figure 1 presents our theoretical predictions of an ordinal interaction in graph form.

[Insert Figure 1 about here]

III. Experimental Methodology

Experimental Setting

To test our hypotheses, we utilize a computerized version of Hannan et al.'s (2006) manual experiment and manipulate the precision and the operating uncertainty of the information system using a 2×2 factorial design. The firm produces 1,000 units each period, which are sold for 6.50 lira, an experimental currency. Production costs fall within the range of 4.00 lira to 6.00 lira per unit with a uniform distribution of (4.00, 4.05, 4.10, ... , 6.00). This distribution is common knowledge to both the manager and the owner.[9] However, the actual cost of production is revealed to the manager prior to the cost report and becomes private information known only by him. Furthermore, production is always fully funded and the manager receives whatever is in his cost report. This simplification allows us to abstract from strategic rejection effects and focus on the hypothesized effects of the two characteristics of an information system. The manager receives a salary of 1,000 lira each period and keeps for himself any difference between the reported cost (*i.e.*, resources received) and actual cost. Thus, the manager's payoff function each period is

$$\gamma = [(\text{reported unit cost} - \text{actual unit cost}) \times 1{,}000] + 1{,}000 \quad (1).$$

The owner receives an initial endowment of 550 lira each period. The cost of the information system reduces the owner's endowment by 50 lira, making the owner's net endowment 500 lira. While the manager knows that the information system reduces the owner's initial endowment by 50 lira, only the owner knows his endowment. This design choice obscures relative pay and thereby

[9] Consistent with earlier experimental studies, the labels "corporate headquarters manager" and "division manager" are used in the instructions to refer to the roles of the owner and the manager.

diminishes the salience of distributional fairness concerns (Douthit and Stevens 2015).[10] Beside the endowment, the owner keeps the net profits after the cost of production and the manager's salary. Thus, the owner's payoff function per period is

$$\Pi = 500 + [(6.50 - \text{reported unit cost}) \times 1{,}000] - 1{,}000 \quad (2).$$

Participants

We recruited 158 participants (79 owners and 79 managers) from students at a large southeastern university. Most of the manager participants were recruited from the business school and most of the owner participants were recruited from the experimental economics laboratory database.[11] The majority of manager participants were majors in accounting or finance (95 percent) and were primarily undergraduates (28 percent at the junior level and 64 percent at the senior level), although a minority (4 percent) were graduate students enrolled in undergraduate courses. Eighty-seven percent of manager participants had at least one year of full-time work experience with a mean of 3.7 years. Fifty-one percent of manager participants were males.[12]

Experimental Manipulations

Our experiment utilizes a 2×2 factorial design where the precision of the information system is manipulated at two levels (Coarse vs. Precise) and the operating uncertainty of the information system is manipulated at two levels (Low vs. High). Our manipulation of information system

[10] As we discuss below, the diminished salience of distributional fairness concerns is another feature of our experiment that differs from Hannan et al. (2006). They do not incorporate a cost of the information system that reduces the endowment of the owner and they fully disclose the initial endowment of 500 lira to managers.

[11] Through arrangements with some accounting faculty, students recruited from the business school were given extra class credit for their participation in addition to their experimental earnings. We used students recruited from the experimental economics laboratory database to play the role of owners except in three instances where we used a student from the database to play the role of a manager when a business school student failed to show up for the experiment. All of the experimental sessions reported in this paper were conducted within a four week period.

[12] Presented demographics are for all manager participants excluding one who didn't provide his/her demographics.

precision follows that of Hannan et al. (2006).[13] In particular, the information system provided a cost range that contained the actual cost with a specific uncertainty level, as we discuss below. Under the coarse treatment the information system provided a relatively wide cost range: 4.00-4.50 lira, 4.55-5.00 lira, 5.05-5.50 lira, or 5.55-6.00 lira. Under the precise treatment the information system provided a relatively narrow cost range: 4.00-4.25 lira, 4.30-4.50 lira, ... , 5.80-6.00 lira.

To examine the effect of operating uncertainty on managerial honesty, we also manipulate the operating uncertainty of the information system at two levels. Under the Low Uncertainty treatment, the information system cost estimate was accurate with 90 percent probability and inaccurate estimates of 10 percent were evenly distributed across the other ranges. Under the High Uncertainty treatment, the information system cost estimate was accurate with 70 percent probability and inaccurate estimates of 30 percent were evenly distributed across the other ranges. Both the manager and the owner knew the underlying probability distribution of the information system estimates. Before the manager submitted his cost report to the owner, both parties received the public signal of production cost from the information system. Therefore, before deciding which cost to report, the manager knew both the actual production cost and the information system signal that the owner received regarding that cost. The timeline of our experiment is presented in Figure 2.

[Insert Figure 2 about here]

Our choice of 90 percent versus 70 percent certainty of accuracy of the information system signal represents low versus high operating uncertainty as supported by prior findings in experimental economics. As noted above, evidence from experimental tests of game theory suggests that defying norm compliance by "hiding behind uncertainty" is expected in a setting with an uncertainty level as low as 20 percent (Castillo and Leo 2010). Thus, we consider Hannan et al.'s (2006) experimental

[13] We contacted the Hannan et al. (2006) authors and requested their original set of instructions. Their gracious willingness to provide us their instructions allowed us to closely follow their information system manipulation to be consistent with prior research.

setting where there is a 30 percent probability that the cost range is inaccurate as representing relatively high operating uncertainty. On the other hand, we consider a setting with a 10 percent probability of inaccuracy as representing relatively low operating uncertainty. We note, however, that this difference in operating uncertainty is small in magnitude and works against us finding results.

Our decision not to disclose the initial endowment of the owner to managers was intended to obscure relative pay information. This design choice was incorporated into the experiment to increase the internal and external validity of our experimental tests. Experimental research in economics (Carpenter 2002, Dana, Weber, and Kuang 2007) and accounting (Kachelmeier and Towry 2002, Davidson and Stevens 2013, Douthit and Stevens 2015) suggests that keeping relative pay information hidden from the managers reduces the salience of distributional fairness concerns. This is an important consideration because experimental findings in Douthit and Stevens (2015) suggest that the presence of distributional concerns can dominate honesty norms. Further, Salterio and Webb's (2006) discussion of Hannan et al.'s (2006) experimental design suggests that distributional fairness concerns could be a potential alternative explanation for their results. Our decision to obscure relative pay information rules out this concern. Further, accounting researchers have argued that relative pay information is rarely available to subordinate's in participative budgeting settings in practice (Douthit and Stevens 2015). We note, however, that this design choice makes our experimental setting less comparable to Hannan et al.'s experiment setting.[14]

[14] In a pilot test, we included two experimental conditions where the relative pay between the owner and the manager was transparent under the two high operating uncertainty conditions as in Hannan et al. We found that making the relative pay less transparent successfully reduced distributional fairness concerns as reflected in a manipulation check in the exit questionnaire. Inconsistent with Salterio and Webb's (2006) conjuncture, however, this manipulation did not have an effect on the honesty of managerial reporting. Thus, we focus on the experimental results from our experimental conditions where the relative pay between the owner and the manager was opaque.

Experimental Procedures

Two experimental sessions were administered for each of the four experimental conditions (*Coarse/Low Uncertainty Information System, Precise/Low Uncertainty Information System*, *Coarse/High Uncertainty Information System, and Precise/High Uncertainty Information System*). Upon arriving at the laboratory, each participant was randomly seated at a computer terminal to decrease the potential for participants to sit next to someone they knew. Managers sat in two rows at the front of the room and owners sat in two rows immediately behind them, all facing in the same direction. Although participants sat next to each other during the experiment, it was impossible to view each other's computer screen due to divider walls and flaps covering computer screens.[15] Privacy was further assured by not allowing participants to communicate to each other during the experiment.

At the beginning of each experimental session, one of the experimenters read the instructions aloud and answered participants' questions. To assure that they understood the experimental instructions, managers were required to answer a short quiz. After the experimenter reviewed managers' answers and resolved all their misunderstandings, she proceeded with reading aloud the rest of the instructions. Then, participants started the experiment on their computer terminals. The rest of the experiment was implemented over the computer network using z-Tree software (Fischbacher 2007).

Each decision period proceeded as follows. At the beginning of each period, owners and managers were randomly re-matched with each other to avoid the effects of reputation on managerial

[15] We started by randomly seating students who were getting extra class credit in their accounting courses, and then students who were recruited through the experimental economics laboratory database. In this way, we increased the likelihood that participants assigned the role of manager were from the business school as in prior research (Hannan et al. 2006).

reporting.[16] First, each manager received his or her actual cost. Next, each of the owners and the managers were directed to a 10-seconds waiting screen informing them that the information system was generating an estimated range of actual production cost. In the waiting screen the possible ranges of the information system were stated and the probability of an accurate range ("90% (70%)") was emphasized in bold and large text.[17] In the next screen, all participants received the public signal of production cost estimated range from the information system. Then, managers were directed to their private cost report form which included a table showing the manager's personal earnings and his/her contribution to the firm's profits for each possible cost the manager could report.[18] Each manager then reported his cost to the owner by completing a paper-based budget form and handing it directly to the owner. The budget form was the only means of communication permitted during the experiment between the manager and owner. After owners reviewed the submitted budgets, the experimenter collected the forms from them before proceeding to the next period.[19]

Participants interacted with each other for ten periods. To facilitate comparisons across conditions, each participant received the same actual cost for each of the decision periods for all experimental conditions.[20] In the 90% Certainty Level treatment, the information system provided an inaccurate cost range that did not contain the actual cost in only one out of the ten periods (the ninth period), compared to three out of ten periods in the 70% Certainty Level treatment (the first, third and ninth periods). When the system's signal was inaccurate it estimated a higher cost range than the range that contained the actual cost.

[16] In one out of the eight experimental sessions, only 18 students participated. In this session, owners received a budget report from a manager they had interacted with previously only in the last period.
[17] The waiting screen included a flashing text in red at the bottom that says "It will take a few seconds!"
[18] For example, if the owner pay for a certain budgeted cost equaled 1250 Lira, the cost form received by the manager indicated that the owner will get (an endowment+750 Lira).
[19] To facilitate the face-to-face interaction, each computer terminal had a big visible card that indicated the identity of the owner or the manager. Besides, each manager was provided with a tag to wear which indicates his or her identity.
[20] For the first eight periods, we used the same cost signals and information system signals that were randomly generated and used in Hannan et al.'s (2006) eight-period experiment (after fixing for the operating uncertainty manipulation), and we randomly generated the cost signals for the last two periods.

After the ten periods were conducted, participants received an exit questionnaire containing demographic and process-related questions. Payments were based on one period selected randomly by the computer. Participants were paid in cash by converting the lira they earned during that period to dollars at the rate of 75 lira = $1.00. Anonymity of participants was assured by placing the cash in an envelope that was labeled by a unique identification (ID) number that was issued to them at the beginning of the experimental session. A second experimenter placed participants' earnings into envelops by ID number and participants privately picked up the envelope that corresponded to their ID number after they completed their exit questionnaire. Each experimental session lasted approximately two hours and the average earnings per participant was $19.50.

[Insert Figure 2 about here]

The main dependent variable of interest in our study is the average percentage of honesty by the manager. As in prior research, average percentage of honesty = 1 – slack claimed/slack available, where the ''slack claimed'' is the amount of sack the subject earns based on the subject's actual report, and the ''slack available'' is the amount that a subject could earn by reporting the highest possible cost (Evans et. al 2001). Since the realized cost is the same in each decision period across treatments, the total slack available over the course of the experiment is the same in each treatment. Therefore, the average percentage of honesty by manager can be compared between treatments and over time. We also use items in the exit questionnaire to test our behavioral theory.

IV. RESULTS

Before testing our hypotheses, we first test the baseline assumption that the budgeting setting we examine successfully satisfies Bicchieri's required conditions for a social norm to be activated (*i.e.,* contingency condition and empirical and normative expectations). We test this assumption by examining the response to two items on the exit questionnaire: "It would be unethical for a division

manager to take a large portion of the profit by significantly over-reporting the actual cost of the project in the budget report," and "Corporate headquarters managers were expecting to receive honest budget reports from the division managers each period." All responses were on a 7-point Likert scale with 1 labeled "Strongly Disagree", 7 labeled "Strongly Agree", and 4 labeled "Neutral". The baseline assumption of the contingency condition and honesty norm expectations would be supported if the participants' responses are significantly higher than the neutral response of 4. Untabulated results provide evidence that participants' responses for both items are significantly higher than the neutral response of 4 ($t = 12.99$, $p < .01$, and $t = 7.11$, $p < .01$, two-tailed, respectively). Further, participants' responses for both items are significantly higher than the neutral response of 4 across all four experimental conditions.[21] This evidence suggests that the budgeting setting we examine contained the conditions that Bicchieri's model suggests are capable of activating a social norm for honesty.

Additional items in the exit questionnaire were included to provide manipulation checks. Managers' responses in the *Precise Information System* treatment to the item "If the corporate headquarters' cost system had generated an estimate of the actual cost within a wider range, (bigger than 0.20 Lira intervals), I would have felt more flexibility to increase my earnings by reporting a higher cost" were significantly higher than the neutral response of 4 ($t = 7.56$, $p < .01$, two-tailed). Similarly, managers' responses in the *Coarse Information System* treatment to the item "If the corporate headquarters' cost system had generated an estimate of the actual cost within a narrower range, (smaller than 0.50 Lira intervals), I would have felt less flexibility to increase my earnings by reporting a higher cost" were significantly higher than the neutral response of 4 ($t = 3.19$, $p < .01$,

[21] For each of the four conditions (*Coarse/90%, Precise/90%, Coarse/70%, Precise/70%)*, mean responses for the first exit questionnaire item (6.30, 5.95, 6.26, and 6.15, respectively) are all significantly different from 4 (p's < .01). Mean responses to the second item (5.25, 5.60, 5.74, and 4.7, respectively) are all significantly different from 4 (p's < .01) except for Precise/70% condition, which is only marginally different from 4 ($t = 1.76$, $p = .095$, two-tailed).

two-tailed). We also measured the effectiveness of the operating uncertainty manipulation using two items: "If the cost system estimated the range with 100% accuracy rather than 90% (70%) accuracy, I would have reported costs within the estimated range more often," and "Since the corporate headquarters manager was uncertain about whether the cost system estimated range was accurate or not (accurate 90% (70%) of the time), this uncertainty gave me the flexibility of reporting a cost higher than the system estimated range." If our manipulation was successful, we should observe lower mean responses to the two items in the 90% Certainty Level treatment than the 70% Certainty Level treatment. In untabulated results, we find that the average responses to the first item are significantly lower in the 90% Certainty Level treatment ($t = -1.77$, $p = .04$, one-tailed), and the average responses to the second item are marginally lower in the 90% Certainty Level treatment ($t = -1.33$, $p = .09$, one-tailed). Collectively, this evidence suggests that our attempts to manipulate the precision and operating uncertainty of the information system were successful.

The descriptive statistics for our experiment are presented in Table 1. These statistics reflect a pattern of reporting behavior that is consistent with our predictions. The average percent honesty across the two Precise Information System conditions (73 percent) is higher than the two Coarse Information System conditions (58 percent). This suggests that information system precision had a positive effect on honesty in managerial reporting. Similarly, average percentage honesty across the two Low Operating Uncertainty conditions (70 percent) is higher than average percentage honesty across the two High Operating Uncertainty conditions (61 percent), which suggests that operating uncertainty had a negative effect on honesty in managerial reporting. Finally, the average percent honesty in the Precise/Low Operating Uncertainty Information System condition is higher than the other three experimental conditions at 80 percent. The graph of average percent honesty across experimental conditions in Figure 3 reflects the ordinal interaction pattern we predict.

[Insert Table 1 and Figure 3 about here]

We also consider the pattern of reporting behavior by condition over all 10 decision periods to gain additional insight. Table 2 reports descriptive data by period. This data shows that in the Precise/Low Operating Uncertainty Information System condition cost reports were more honest than the three other conditions for all the 10 periods, and the frequency with which the managers reported within/below the information system's signal range (*i.e.,* used the information system estimate as a focal point) is higher in this condition than the three other conditions. In addition, data shows that increasing operating uncertainty deteriorated managers' honesty in reporting for all the 10 periods under the Precise Information System treatment. In contrast, increasing operating uncertainty deteriorated managers' honesty in reporting for seven out of ten periods in the Coarse Information System treatment. Similarly, increasing operating uncertainty had a noticeable negative effect on the percentage frequency that the managers report within/below the signal's range in the Precise Information System treatment compared to the Coarse Information System treatment (from 73% to 52% compared to from 61% to 65%, averaged for the 10 periods, respectively). In addition, increasing operating uncertainty slightly increased the average percentage wealth maximization behavior of the manager in both the Precise Information System and Coarse Information System treatments.

Table 3 reports period-by-period comparisons of actual profit earned by the owners in each experimental condition. Given the actual costs in the 10 periods, owners earned mean (median) total profit of 9,260 lira (10,425 lira) in the Precise/Low Operating Uncertainty Information System condition compared to 7,162.5 lira (7,150 lira) in the Coarse/Low Operating Uncertainty Information System condition, which is significantly different ($t = 1.95$, $p = .03$, one-tailed). In contrast, owners earned mean (median) total profit of 7,718 lira (8,100 lira) in the Precise/High Operating Uncertainty

Information System, and 6,371 lira (7,300 lira) in the Coarse/High Operating Uncertainty condition, which is not significantly different (t = 1.24, p = 0.22, two-tailed). Overall, the above descriptive data suggest that managerial honesty is the highest under an information system characterized by high precision and low operating uncertainty, and that increasing operating uncertainty moderated the predicted positive effect of information system precision on honesty in reporting, consistent with our predictions.

[Insert Table 2 and Table 3 about here]

Table 4 Panel A reports an estimated ANOVA on the effect of Information System Precision, Operating Uncertainty, and the interaction of these two dummy variables on average percent honesty. In the full model, we document a strong main effect on Information System Precision (F = 5.31, p = .01, one-tailed). In addition, we document a marginal main effect on Operating Uncertainty (F=1.92, p = 0.09, one-tailed).[22] These results provide preliminary evidence that information system precision had a strong positive effect on honesty in managerial reporting, consistent with expectations. The marginally significant result for operating uncertainty provides some evidence that this factor also affected managerial honesty, as expected. However, the interaction term in ANOVA provides a very weak test of an ordinal interaction (Buckless and Ravenscroft 1990). Thus, the insignificance of the interaction term is not surprising. To directly test of our predicted ordinal interaction, we rely on simple-main effect tests and contrast coding.

Hypothesis 1 predicts that when operating uncertainty is low, honesty in budget reporting will increase with the precision of the information system's signal of actual production cost, and Hypothesis 2 predicts that when operating uncertainty is high, honesty in budget reporting will not increase with the precision of the information system's signal. To formally test Hypotheses 1 and 2,

[22] An estimation of a multivariate analysis of variance (MANOVA), in which the *cost reports* from all ten periods are the multiple dependent variables, provides a significant effect in Operating Uncertainty in the Full model (F = 1.91, p = .03, one-tailed).

we analyze the simple-main effect of Information System Precision within both Low Operating Uncertainty and High Operating Uncertainty treatments. The results of these simple-main effect tests are presented in Panel B of Table 4. We document that Information System Precision is significant within the Low Operating Uncertainty treatment ($F = 4.18$, $p = .02$, one-tailed). In contrast, Information System Precision is not significant within the High Operating Uncertainty treatment ($F = 1.48$, $p = .24$, two-tailed). This provides strong support for Hypotheses 1 and 2.

We present the results of our contrast coding test in Table 4, Panel C. This test provides a direct test of our ordinal interaction. The contrast coefficients we use to test this ordinal interaction are +3 for the Precise/Low Operating Uncertainty condition, and −1 for each of the other three conditions. The planned contrast interaction is highly significant, providing support for our underlying behavioral predictions ($F = 6.81$, $p < 0.01$, one-tailed). In untabulated results, the F-statistic of the residual variance in the contrast model is not significant, which suggests that the contrast is a good fit. Also, untabulated analysis of the simple-main effect of Operating Uncertainty treatment show that Operating Uncertainty has a marginally significant main effect in the Precise Information System ($F = 1.93$, $p = .08$, one-tailed) compared to a non-significant effect in the Coarse Information System ($F = .32$, $p = .28$, one-tailed). Thus, our predicted ordinal interaction is fully supported in the data.

[Insert Table 4 about here]

Table 4 Panel D provides further evidence for our behavioral theory regarding the moderating effect of operating uncertainty. Our behavioral theory suggests that high operating uncertainty reduces the positive effect of a precise information system on managerial honesty by allowing managers to evade the honesty norm. We use the exit questionnaire item "Corporate headquarters managers were able to guess the actual cost from the estimates they received from the costing

system" as a proxy measure for manager's perceived ability to hide behind operating uncertainty. We find that increasing operating uncertainty significantly increased the perceived ability of managers to hide behind probabilities and evade the honesty norm under the precise information system ($t = 2.06$, $p = .05$, two-tailed).[23] This result provides strong evidence for our underlying behavioral theory that operating uncertainty allows managers to evade the honesty norm by hiding behind the uncertainty.

To provide additional insights regarding the moderating role of operating uncertainty, we consider the possibility that high operating uncertainty also reduced normative expectations and conditional preferences for honesty.[24] We measured normative expectations for honesty using the questionnaire item "Corporate headquarters managers were expecting to receive honest budget reports from the division managers each period." We find that increasing operating uncertainty marginally decreased normative expectations of honesty within the precise information system condition ($t = 1.78$, $p = .08$, two-tailed). We measured conditional preferences for honesty using two questionnaire items: "The budget cost I reported each period was based on a desire to be honest," and "The budget cost I reported each period was based on a desire to have the corporate headquarters manager think I'm honest." We find some evidence that increasing operating uncertainty also decreased conditional preferences for honesty within the precise information system ($t = 1.72$, $p = .09$ and $t = 2.02$, $p = .05$, two-tailed, for the two items respectively). These exit questionnaire results suggest that high operating uncertainty also moderated the positive effect of information precision on managerial honesty by reducing normative expectations and conditional preferences for honesty.

[23] For each of the four conditions (*Coarse/90%*, *Precise/90%*, *Coarse/70%*, *Precise/70%)*, mean responses for this exit questionnaire item are 5.00, 4.30, 4.37, and 3.20, respectively.

[24] Our behavioral theory does not predict that Operating Uncertainty will alter the contingency condition for an honesty norm. Using the exit questionnaire item "It would be unethical for a division manager to take a large portion of the profit by significantly over-reporting the actual cost of the project in the budget report" as a proxy measure for the presence of the contingency condition, we do not find a difference in this condition across all four experimental conditions.

V. CONCLUSION

This study examines the relation between information system precision and honesty in managerial reporting and the moderating effect of operating uncertainty on that relation. Hannan et al. (2006) argue that the theoretical relation between information system precision and managerial honesty in a cost report is ambiguous because of a trade-off between the benefits of appearing honest and the benefits of misrepresentation. By applying insights from Bicchieri's (2006) model of social norm activation to Antle and Fellingham's (1995) agency model of capital budgeting, we develop an unambiguously positive theoretical relation between information system precision and managerial honesty. This positive relation is based on the ability of a precise information system to reduce information asymmetry between the owner and the manager regarding production cost and thereby activate an honesty norm by promoting expectations for honesty. We also predict, however, that operating uncertainty moderates this effect by allowing the manager to evade the honesty norm by "hiding behind the uncertainty." Thus, our behavioral theory predicts an ordinal interaction between the precision of an information system and its operating uncertainty.

We find strong evidence for our ordinal interaction prediction and underlying behavioral theory using a computerized version of Hannan et al.'s manual experiment. We vary information system precision at two levels from coarse to precise as in Hannan et al., and we vary operating uncertainty at two levels from low to high (90% accurate to 70% accurate). Consistent with our ordinal interaction prediction, we find that information system precision increases managerial honesty under low but not under high operating uncertainty and managerial honesty is the highest under a precise information system with low operating uncertainty. In support of our behavioral theory, an examination of exit questionnaire responses suggests that high operating uncertainty allowed

managers in the precise information system condition to hide behind the uncertainty and thereby evade the honesty norm when setting their budget.

We encourage caution when comparing our experimental results directly to Hannan et al. (2006). While we attempted to closely approximate their experimental setting by using their underlying experimental manipulations and instructions, we incorporated many important innovations and controls that have the potential to contribute new insights. First, our experiment was conducted on a computer network whereas theirs was conducted manually. This allowed us to more fully control social interactions between participants. Second, we incorporated a cost of the information system and carefully controlled relative pay information. This allowed us to control for distributional fairness concerns that have been found to affect honesty norms (Douthit and Stevens 2015). Finally, we made the moderating effect of the operating uncertainty of the information system a major focus of our study. Future research could manipulate some of these differences to examine more fully why our results differ from theirs under high operating uncertainty. Future research could also provide a more powerful test of our two behavioral theories. Interestingly, we find the highest level of managerial honesty in the lowest information asymmetry condition where the information system provides a precise signal of actual production cost and operating uncertainty is low. This is the condition where Hannan et al.'s trade-off theory would predict the lowest level of managerial honesty, as the marginal cost of appearing honest is the highest for managers in this condition. Our behavioral theory and experimental results are also more consistent with experimental evidence in Evans et al. (2001) that managerial honesty does not decrease when the marginal cost of honesty (payoff to lying) increases.

This study contributes valuable insights that are useful to accounting researchers and practitioners. First, our study provides theoretical and empirical support for a positive effect of information system precision on managerial honesty based on insights from both agency theory

(Antle and Fellingham 1995) and a model of social norm activation (Bicchieri 2006). Thus, our experimental study contains the characteristics that Brown et al. (2009) argue maximize its potential to contribute to agency theory. Second, our study contributes to the literature by providing a theoretical and empirical explanation for Hannan et al.'s experimental result that information system precision is negatively related to honesty in managerial reporting. As discussed above, however, the ability to directly relate our experimental results to theirs is necessarily limited by important differences in our experimental design. Finally, this study provides important theoretical intuition and experimental evidence for the utilization of budgeting systems in practice. In particular, our theoretical intuition and experimental results confirm that information system precision can increase the effectiveness of participative budgeting by promoting managerial honesty. Thus, firms should factor in this potential benefit when determining whether or not to invest in a more precise information system. As with all experimental studies, however, the generalization of our results is limited by the stark simplicity of our experimental setting.

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FIGURE 1
Theoretical Predictions

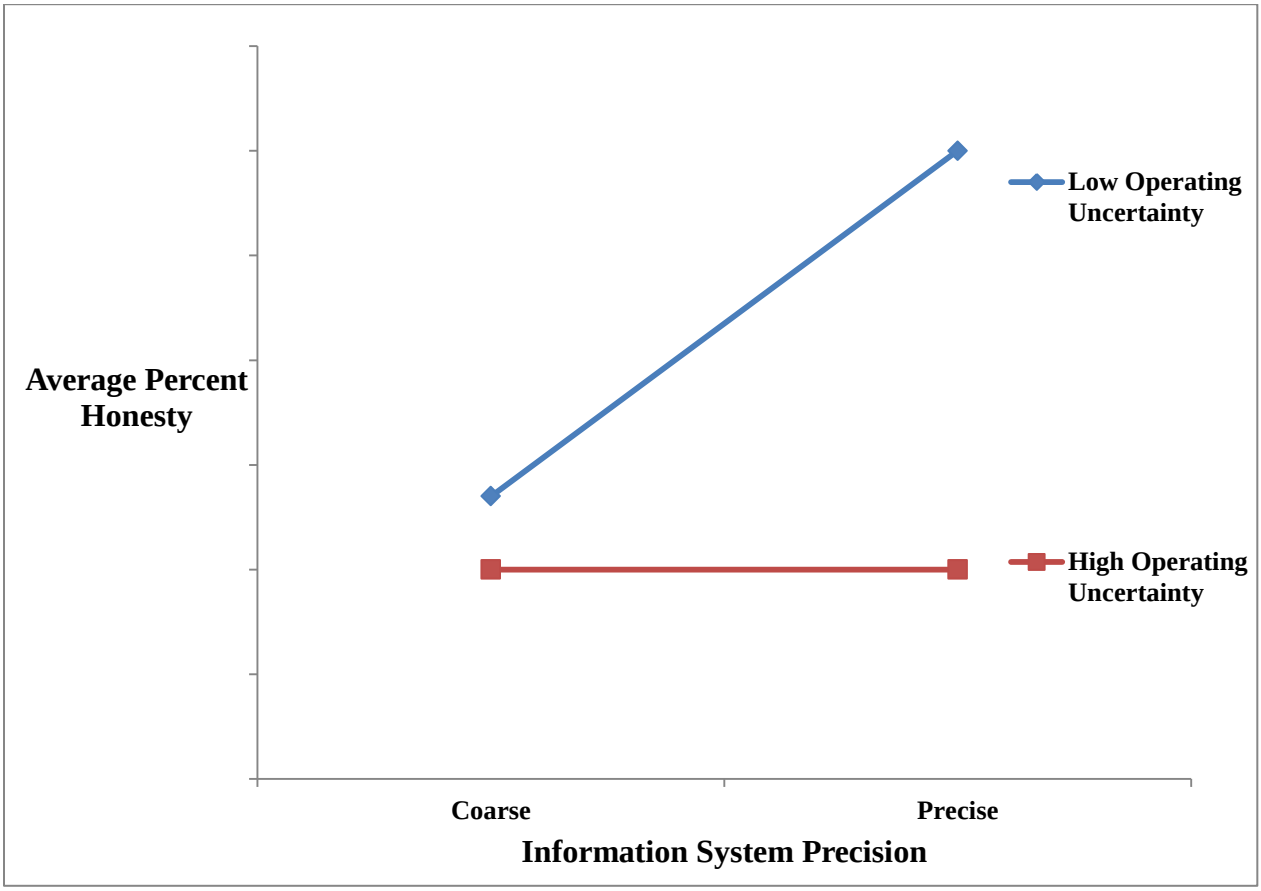
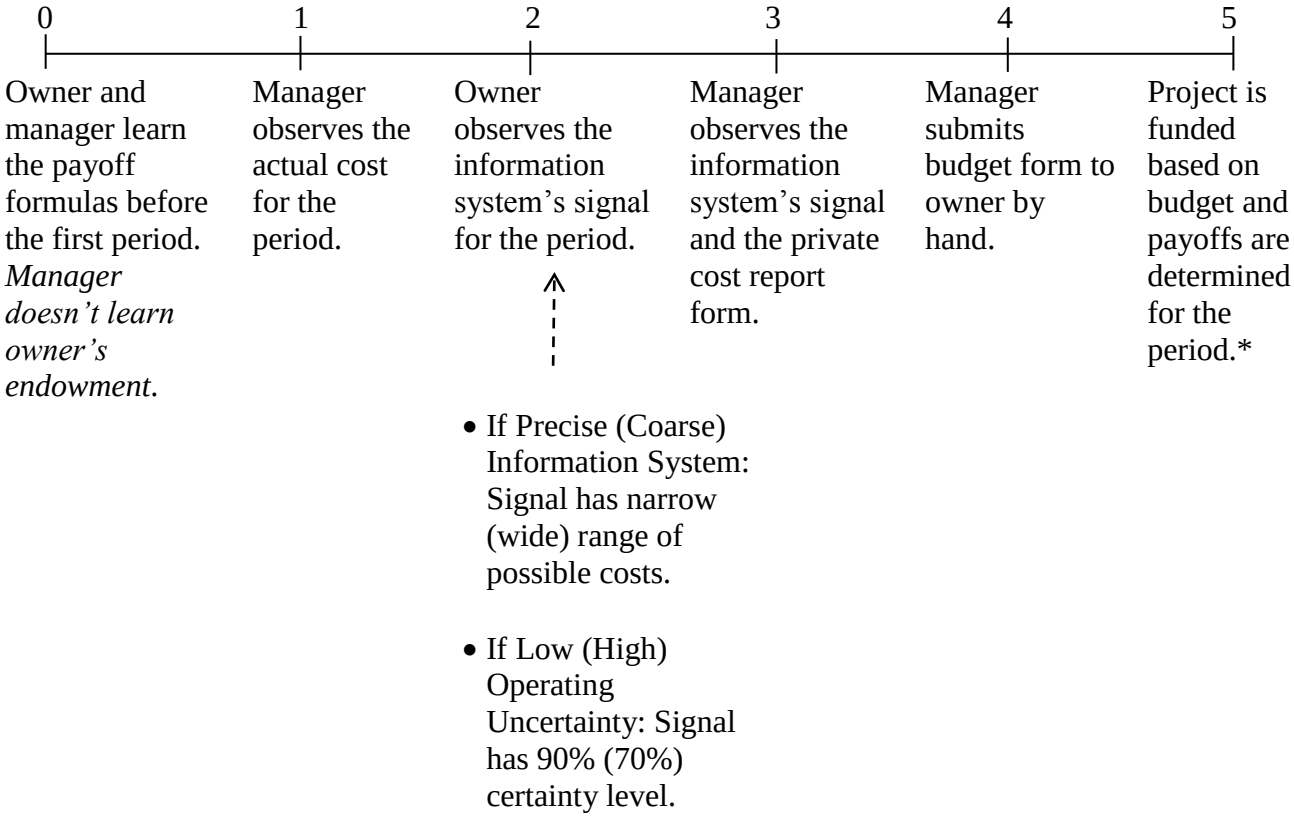


FIGURE 2
Timeline for the Experiment



***** We assume a single-period world at the theoretical level, following Antle and Fellingham's (1995) agency model. At the operational level, we use multiple independent periods with re-matching. That is, each manager is assigned to one owner, to whom he or she reports his or her cost for the period, and participants are re-matched after each period.

FIGURE 3
Average Percent Honesty across Experimental Conditions

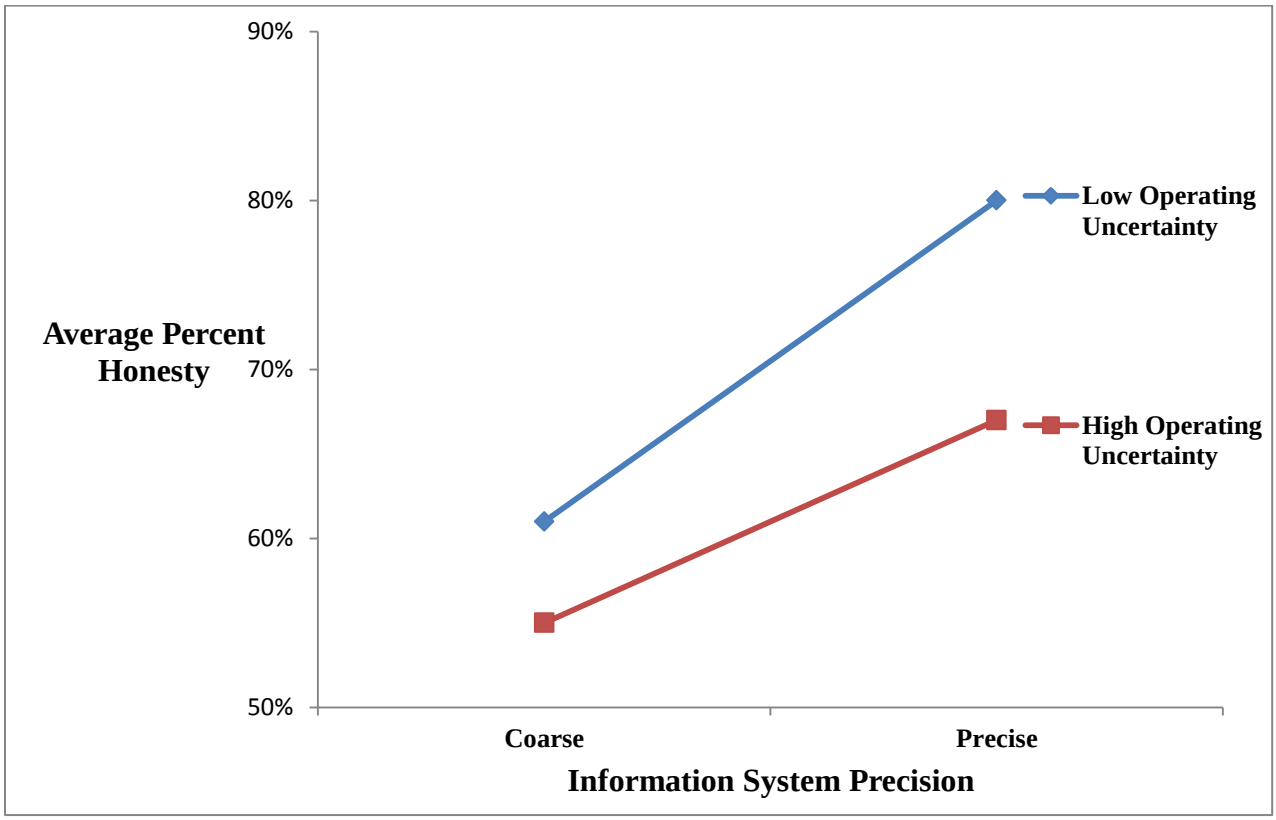


TABLE 1
Descriptive Statistics

Average Percent Honesty for the Ten Periods
Mean, median, and (s.d.)

	Low Uncertainty (90% certainty level)		**High Uncertainty** (70% certainty level)		
Coarse Information System Signal	**(C90)** [a]		**(C70)** [a]		**Total Coarse Sys.**
	n	20	*n*	19	*n* 39
	mean	.61	mean	.55	mean .58
	median	.60	median	.62	median .60
	(s.d.)	(.29)	*(s.d.)*	(.30)	*(s.d.)* (.29)
Precise Information System Signal	**(P90)** [a]		**(P70)** [a]		**Total Precise Sys.**
	n	20	*n*	20	*n* 20
	mean	.80	mean	.67	mean .73
	medain	.90	median	.71	median .88
	(s.d.)	(.30)	*(s.d.)*	(.30)	*(s.d.)* (.30)
	Total Low Uncertainty		**Total High Uncertainty**		
	n	40	*n*	39	
	mean	.70	mean	.61	
	median	.69	median	.64	
	(s.d.)	(.17)	*(s.d.)*	(.29)	

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a. We use the abbreviations to refer to the experimental conditions as presented in this figure, as follows: (The same abbreviations are used in Table 2)

C90: A coarse information system with 90% certainty level.

P90: A precise information system with 90% certainty level.

C70: A coarse information system with 70% certainty level.

P70: A precise information system with 70% certainty level.

TABLE 2
Descriptive Statistics
Cost Reports; Percent Reports ≥ 5.95; Percent Reports In/Below the Signal Range (by Period and Sum of Periods)

P/ ∑P	Actual Cost	Info System signal		**Cost reports:** Mean, median, (s.d.)				**Percent reports in or below signal's range**				**Percent reports ≥ 5.95**			
		Coarse	Precise	**C90** ***n*=20**	**P90** ***n*=20**	**C70** ***n*=19**	**P70** ***n*=20**	**C90** ***n*=20**	**P90** ***n*=20**	**C70** ***n*=19**	**P70** ***n*=20**	**C90** ***n*=20**	**P90** ***n*=20**	**C70** ***n*=19**	**P70** ***n*=20**
P 1	4.25	4.00-4.50	4.00-4.25	4.67 4.50 (0.58)	4.45 4.25 (0.51)	4.89 4.75 (0.55)	4.85 4.63 (0.62)	80%	60%	84%	45%	15%	5%	16%	10%
		4.55-5.00 [a]	4.30-4.50 [a]												
P 2	5.15	5.05-5.50	5.05-5.25	5.48 5.45 (0.26)	5.29 5.25 (0.27)	5.48 5.40 (0.27)	5.40 5.25 (0.30)	75%	80%	74%	55%	15%	10%	16%	10%
P 3	4.95	4.55-5.00	4.80-5.00	5.25 5.08 (0.34)	5.13 5.00 (0.36)	5.45 5.40 (0.37)	5.28 5.25 (0.44)	50%	70%	74%	60%	10%	10%	21%	15%
		5.05-5.50 [a]	5.05-5.25 [a]												
P 4	5.05	5.05-5.50	5.05-5.25	5.49 5.50 (0.30)	5.27 5.20 (0.28)	5.57 5.50 (0.32)	5.43 5.35 (0.35)	70%	80%	58%	45%	15%	10%	26%	10%
P 5	4.75	4.55-5.00	4.55-4.75	5.24 5.00 (0.49)	4.95 4.75 (0.40)	5.39 5.45 (0.48)	5.11 4.95 (0.44)	55%	65%	47%	45%	20%	10%	26%	10%
P 6	5.20	5.05-5.50	5.05-5.25	5.55 5.50 (0.29)	5.37 5.25 (0.29)	5.56 5.45 (0.29)	5.51 5.33 (0.33)	55%	65%	68%	45%	20%	15%	26%	20%
P 7	5.35	5.05-5.50	5.30-5.50	5.68 5.58 (0.28)	5.52 5.45 (0.23)	5.59 5.50 (0.26)	5.54 5.48 (0.20)	50%	80%	63%	60%	35%	10%	16%	5%
P 8	4.30	4.00-4.50	4.30-4.50	4.84 4.50 (0.64)	4.66 4.48 (0.54)	5.02 4.75 (0.68)	4.76 4.50 (0.53)	55%	75%	47%	60%	20%	5%	21%	5%
P 9	4.90	5.05-5.50 [b]	5.05-5.25 [b]	5.42 5.43 (0.40)	5.19 5.18 (0.31)	5.46 5.45 (0.30)	5.37 5.35 (0.35)	70%	85%	79%	50%	20%	5%	16%	10%
P 10	4.6	4.55-5.00	4.55-4.75	5.24 5.05 (0.56)	4.93 4.73 (0.47)	5.23 5.00 (0.49)	5.05 4.75 (0.51)	50%	65%	53%	55%	30%	10%	21%	10%
∑P	-	-	-	52.84 52.85 (3.39)	50.74 49.58 (3.41)	53.63 52.70 (3.43)	52.28 51.90 (3.36)	61%	73%	65%	52%	20%	9%	21%	10%

a. Information system signals in periods 1 and 3 were inaccurate only under the two high operating uncertainty conditions (*i.e.*, at 70% certainty level).
b. Information system signal in period 9 was inaccurate under both low and high operating uncertainty conditions.

TABLE 3
Actual Experimental Profit by Period and Experimental Condition

Periods	Actual mean (median) Profit			
	C90	**P90**	**C70**	**P70**
P 1	1,330 (1,500)	1,552.5 (1,750)	1,107.9 (1,250)	1,155 (1,375)
P 2	525 (550)	707.5 (750)	518.42 (600)	605 (750)
P 3	750 (925)	867.5 (1,000)	550 (600)	717.5 (750)
P 4	510 (500)	735 (800)	434.2 (500)	575 (650)
P 5	765 (1,000)	1055 (1,250)	610.5 (550)	895 (1,050)
P 6	455 (500)	623.5 (750)	444.7 (550)	490 (675)
P 7	322.5 (425)	482.5 (550)	413.15 (500)	460 (525)
P 8	1,162.5 (1,500)	1,340 (1,525)	984.2 (1,250)	1,240 (1,500)
P 9	577.5 (575)	812.5 (825)	536.8 (550)	627.5 (650)
P 10	765 (950)	1,075 (1,275)	771.1 (1000)	952.5 (1,250)
Total	7,162.5 (7,150)	9,260 (10,425)	6,371.05 (7,300)	7,717.5 (8,100)

TABLE 4

Panel A: Two-way ANOVA – Average % Honesty *

Source	df	MS	F-stat	p-value
Intercept	1	9.33	105.40	<0.01
Precision	1	0.47	5.307	**0.01**
Operating Uncertainty	1	0.17	1.92	**0.09**
Precision × Operating Uncertainty	1	0.03	0.33	**0.28**
Error	75			

Panel B: Simple main effects tests – Average % Honesty

Source	df	MS	F-stat	p-value
Precision within 90% Certainty **(Test of H1)**	1	0.37	4.18	**0.02**
Precision within 70% Certainty **(Test of H2)**	1	0.13	1.48	0.24

Panel C: Contrast test of an ordinal interaction effect – Average % Honesty

Test of Ordinal Interaction: + 3 × Precise/Low Uncertainty -1 × Coarse/Low Uncertainty -1 × Precise /High Uncertainty -1 × Coarse/High Uncertainty = 0

Source	df	MS	F-stat	p-value
Contrast (+3, -1, -1, -1)	3	0.04	6.12	< **0.01**
Error	75			

Panel D: Supplemental Analysis of the Moderating Effect of Operating Uncertainty

	C90 vs. C70		P90 vs. P70		90% vs. 70%	
Exit Questionnaire Item	**t-stat**	**p-value**	**t-stat**	**p-value**	**t-stat**	**p-value**
Owners were able to guess the actual cost	1.01	0.32	2.07	0.05	2.12	0.04
Owners were expecting honest reports	-0.92	0.37	1.78	0.08	0.59	0.56
Report was based on a desire to be honest	1.54	0.13	1.72	0.09	2.32	0.02
Report was based on a desire to appear honest	0.12	0.91	2.02	0.05	1.35	0.18

* *Average % Honesty* is calculated as the % of honesty averaged for the ten periods (one observation per manager). *p-values* in bold are one-tailed.