Abstract

We model the repair of damaged corporate reputations through organizational structure reform. In a rational-choice framework our model explains the effects of the emergence and growth of the professional reputation-crisis management industry. The model produces two key conclusions: (a) Although, ex post, reputation repair can increase firm value, ex ante, the option to repair reputation dilutes the incentive to maintain reputation. (b) Separating ownership and control by delegating management to professionals can ameliorate this dilution. An experimental implementation of the model supports these conclusions and shows that they are robust to behavioral deviations from rational-choice behavior.

JEL Classification Codes: C7, C9, D82, G31, G32, L15
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1 Introduction

Kobe Steel without input from regulators or other outside parties, concluded that the company had erred by elevating the pursuit of short-term profit over the maintenance of scrupulous quality standards. That failing, it said, was exacerbated by lax oversight by senior executives and an “insular” corporate culture that discouraged employees from questioning improper but long-established practices . . . The report published on Friday outlined several changes the company plans to make to prevent cheating, including automating record keeping for product tests and requiring multiple employees to verify that test results are accurate.


Reputation accounts for a significant fraction of firm value, especially for large consumer-facing corporations. However, reputations are inherently risky. This risk is arguably more difficult to manage than other types of risk firms face (Economist Intelligence Unit, 2005b), and the consequences of a damaged reputation can be substantial (Economist, 2018). Thus, reputation risk management is a central component of corporate governance in large modern corporations (Economist Intelligence Unit, 2005a).

As an integral part of risk management systems, firms have developed elaborate protocols to contain crises resulting from reputation damage. An increasingly sophisticated multi-billion dollar industry of reputation-management consultants has also emerged to help firms navigate reputation crises. With the help of these consultants, crisis-hit firms often launch “corporate reform” efforts, which practitioners and management researchers view as crucial for surviving and mitigating the costs of reputation crises (Gaines-Ross, 2008; Economist, 2018). As we document in Table B.1 in Appendix B using just a few of many examples, efforts at corporate reform frequently center on substantially changing firms’ internal organizational structures, and target systems for controlling insider opportunism and fraud.

In this paper, we examine how the availability of the option of corporate reform to overcome reputation crises affects firms’ ex ante incentives to maintain reputations. We also examine how these incentive effects change with governance structures. We advance two simple hypotheses: (a) the option of corporate reform makes it more difficult for firms to commit to reputable behavior; (b) a governance structure typical of modern corporations that relies on professional-management is better adapted to limiting this undesirable ex ante effect of the option of corporate reform than a governance system in which managers also own their firms. We verify these hypotheses in a rational-choice model, and test them by performing a laboratory experiment. Both our model and experimental evidence indicate that, when corporate reform is

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1 In a survey, eighty percent of firms with revenues in excess of $10 Billion reported that they have reputation crisis management systems (Economist Intelligence Unit, 2005b).

2 In a UK survey of public relations consultancies, 78% offered crisis-management consulting services to cope with reputation damage (Bennett and Kottasz, 2000).
a viable option, professional management can lead to superior reputation maintenance, higher product quality, and greater social welfare.

Our model is close to the classic finite-horizon incomplete information setting developed by Kreps and Wilson (1982) and Milgrom and Roberts (1982) (hereafter, KWMR). Firm reputation is synonymous with the expected quality of its products. Product quality is controlled by a manager whose opportunism—diverting firm resources intended for investment in quality assurance to personal consumption—can lower quality. The firm has a type that is known by the manager but not by outsiders. The type determines whether the manager can act opportunistically. Outsiders form beliefs about the firm’s type based on observed product quality using Bayes’ rule. Quality lapses reveal that the firm is the “bad type,” which makes future production unprofitable.

We make three notable changes to the KWMR setting. First, to examine the role of governance structures, we compare outcomes when the owner is also the manager with outcomes when the owner and manager are distinct agents. The owner sets compensation and employment policies for the professional manager. Second, to accommodate the widely held view that firm reputation is distinct from the reputation of firm managers, in our model the firm’s type is not determined by the manager’s (or owner’s) characteristics. Instead, it is based on the effectiveness of the firm’s “oversight system” that polices the manager. Finally, to capture real world corporate reform efforts in a stylized manner, following a quality lapse which reveals that the firm is the bad type (with an ineffective oversight system), the firm’s owner may have the option to reform and repair the oversight system, which resets outsiders’ beliefs about its efficacy.

As many reputation models demonstrate, risk is inherent in firm reputation: Firms have to commit ex ante to follow policies that will protect their valuable reputations. However, commitment is problematic because there is a tension between the ex ante benefit of commitment and the ex post temptation for firm insiders to opportunistically exploit firm outsiders. When the firm is owner managed, the owner manager has “skin in the game” and internalizes the entire effect of reputation crises through their effects on the value of her ownership stake. Despite the owner’s natural stake in the firm’s reputation, the ex post incentive conflict with firm outsiders gives rise to a real risk of reputation crises, mirroring KWMR’s results. Separating the owner and manager complicates the commitment problem by introducing an owner-manager conflict to the insider-outsider conflict: The professional manager has no natural stake in the firm’s repu-

3Management scholars argue that, like brand value with customers, firm reputation is an intangible asset that adheres to the firm itself (e.g., Burke, 2011; Davies, 2011; Barnett and Pollock, 2012). Moreover, this “organizational reputation” is distinct from “managerial reputation,” which depends on characteristics of firm employees rather than the firm itself (e.g., Hodges, 2011; Macey, 2013)

4An oversight system can be a combination of the following organizational features that are intended to restrict managerial opportunism: governance systems (e.g., McMillan, 2011); accounting, reporting and other management control systems (e.g., Chenhall, 2003), risk management systems (e.g., Protiviti Consulting, 2016), human resources systems (e.g., Martin et al., 2011), organizational initiatives to foster “corporate culture” that induces “pro-social” preferences in employees (Bénabou and Tirole, 2006) and discouraging opportunism (e.g., Toyota’s program to instill the “Toyota Way” culture (Liker, 2004)).

5See Bar-Isaac and Tadelis (2008) for an extensive survey of reputation models.
tation since the reputation is independent of the manager’s personal reputation, and the manager is not endowed with an ownership claim on firm cash flows. Not surprisingly, the firm continues to face a real risk of reputation crises.

Corporate reform, after a reputation crisis, increases firm value. However, by lowering the anticipated cost of the crisis, reform reduces the owner’s ex ante incentive to ensure that ex post opportunism does not occur. Hence, reform adversely impacts the firm’s commitment problem both when the owner manages the firm and when she delegates to a professional. There is, however, a wedge between the adverse incentive effects of reform under the two governance structures. Under owner management, while the owner internalizes the cost of reputation crises, she also internalizes the benefits of corporate reform, which lowers the cost of crises. The professional manager, if offered a compensation contract tied to reputation maintenance, will internalize the cost of a crisis. Under the endogenously determined optimal firm hiring/retention policy, the manager will be terminated when a crisis occurs. Thus, the manager does not internalize the gains from reform. Consequently, separating ownership and management separates the agents whose actions affect reputation (management) from the benefits of corporate reform; benefits which reduce the cost of opportunism. Therefore, separating ownership from management weakens the pernicious ex ante effects of corporate reform on the incentive to commit to policies that protect valuable reputations.

Testing these predictions of our model on field data is a daunting task because of endogeneity. Ownership structure is not randomly assigned to firms. Firms self-select ownership structure and this selection may depend on reputational effects of alternative structures, as well as many other unobservable factors, e.g., the managerial human capital of owners. In the context of ownership structure, standard econometric fixes for endogeneity have been shown to be problematic (Coles et al., 2012). Lacking a natural experiment that tests our predictions, we perform a laboratory experiment. The laboratory setting also provides a challenging test for the plausibility of our theoretical conclusions since prior laboratory experiments on reputation formation have shown that the expectations of uninformed agents tend to be adaptive rather than the forward-looking rational expectations of the model (e.g., Brandts and Figueras, 2003; Noe et al., 2012). Adaptive expectations lower the gains from reputation formation and thus the incentive to commit to policies that protect reputation.

However, as our experimental results show, the logic behind our model’s predictions is robust to deviations from the rational choice setting in which they were developed. In the experiment, the option to reform increases ex ante opportunism, particularly for owner-managed firms. Moreover, when the theoretical analysis predicts that, under owner management, the incentives produced by the option to reform make reputation-assuring policies unsustainable, owner management results in significantly more opportunism than professional management. When the

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6 Such adaptive learning is commonly observed in experimental settings (Part 4.3 Plott, 1982). In fact, experience weighted attraction models similar to Erev and Roth (1998) and Camerer et al. (2002) explain nicely the subject behavior we observe.
theoretical analysis predicts that the gains from reform are insufficient to vitiate reputation-formation incentives, the difference in the incidence of opportunism under owner and professional management is insignificant. The option to reform significantly reduces the steady-state rate of reputable behavior under owner management but not under professional management.

Most of the deviations between experimental behavior and model predictions result from uninformed agents using adaptive strategies rather than anticipating behavior based on rational expectations. Prices follow reputable firm behavior rather than anticipating reputable behavior. This adaptive response reduces the gains from eschewing opportunism and thus weakens the incentive to form reputations. Hence, under both professional and owner management, opportunism is more frequent than predicted by the model and the gains from reputable behavior are smaller. However, the greater propensity for opportunism under owner management with the option to reform still translates into significantly lower product prices. These results have the following significant implications:

a. Reform has a dark side. When reputation is attached to an anonymous entity rather than an agent, the possibility of re-engineering the entity makes commitment to reputation-assuring policies more difficult. Thus, as the technology of corporate reform improves, corporate reputations may become more unstable.

b. In the shadow of reform, separating ownership and management can provide a competitive advantage in reputation maintenance. Thus, the option to reform should increase the degree of association between firm reputation and professionalized management.

c. Because product market pricing deviates from rational expectations, in practice, efficient reputation management is likely to involve considerable investment in coordinating consumer expectations, e.g., public relations and advertising. Such investments are complements, not substitutes, for effective oversight and managerial incentive programs.

Our analysis, though built upon the large body of experimental and theoretical research on reputation, has novel characteristics. These characteristics, which are the result of our departures from the KWMR setting, are motivated by our aim to build a rational action, rational expectations model that explains the incentive effects of the sort of reputation-reform interventions observed in practice. We highlight effects of conflicts within firms that arise because anonymous professional managers are unable to capitalize the reputation value of their firms. This conflict is entirely missing in most reputation models, since they focus on the owner-manager governance structure.7

There is a literature on organizational reputation that recognizes within firm conflicts. However, this literature focuses on conflicts between partners who, as a team of owner-managers, claim all the firm’s reputation rents (e.g., Cremer, 1986; Tirole, 1996; Levin and Tadelis, 2005; Morrison and Wilhelm, 2004). It views firms as means of certifying individual partners. Consequently, an organization’s reputation consists of outsiders’ assessments of its ability and honesty when performing certification. In a fashion similar to brand certification, firms earn reputation

7See Bar-Isaac and Tadelis (2008) for an extensive survey of paradigms for modeling reputation.
rents from providing certification in Choi (1998).

We focus on organizational reputations as opposed to the reputation of firm insiders. Hence, reputation crises must be overcome by organizational reform, which typically involves substantial changes in internal organization structure. In contrast, much existing analysis of organizational reputation is based on the idea that a firm is a “name” that is founded on the characteristics of its owner. Customers believe that a “good” name will produce quality output but their assessment can be changed by the actions of the name’s current owners. Owners can separate themselves from their names by selling the names (Tadelis, 1999). Such sales, by allowing owners to capitalize reputation value when they exit, support equilibria in which owners will maintain reputation even if their tenure is short (Kreps, 1996; Mailath and Samuelson, 2001). Since reputation is tied to the owner’s characteristics, a sale is the only antidote to a reputation crisis (e.g., Hakenes and Peitz, 2007). Similarly, in partnership models, to overcome reputation crises, partners must be replaced (e.g., Cremer, 1986; Tirole, 1996).

In our analysis, reform mitigates the reputational effect of past lapses. In limited memory models, the effect of past lapses is also mitigated, albeit through a very different mechanism: Either because agents’ memory capacity is limited or because acquiring information about past behavior is costly, past lapses are eventually forgotten. Forgetfulness permits firms to build reputation multiple times and then “harvest” their reputations through profitable opportunism (Liu, 2011). However, after a lapse, large modern corporations rarely adopt the strategy of waiting for consumers to forget. Thus, for our purposes, this framework is not appropriate.

Our experimental analysis draws on previous experimental research on reputation. Our significant departure from this literature is the introduction of the option to reform. Despite this departure, our experiments verify the same deviations from equilibrium behavior observed in other experiments on reputation and learning (Camerer and Weigelt, 1988; Brandts and Figueras, 2003; Noe et al., 2012): Managers behave less reputably than predicted on average and prices suggest consumers expect even less reputable behavior. Subjects approach the rational-expectations equilibrium over repeated plays of the game but their behavior does not immediately converge to the predicted equilibrium.

More generally, our results conform to the typical pattern of expectation formation in experiments. In our setting, deviations from equilibrium prices are to some extent self-reinforcing. If consumers have sub-equilibrium expectations of quality, they will set sub-equilibrium prices. Hence, firms have less incentive to invest in their reputations and thereby reduce good quality, confirming consumers’ sub-equilibrium expectations. In experimental markets like ours where expectational errors receive positive feedback, convergence to rational expectation prices typically either fails or is very slow (Wagener, 2014). Despite this obvious behavioral impediment to reputation formation, our experimental results, like our formal rational-expectations analysis, verify our hypotheses regarding the effect of professionalization on firm reputation.

8Plott (Part 4.3 1982) discusses learning in experimental games including in both strategic games (e.g., Camerer et al., 2008) and markets (e.g., Goeree et al., 2002).


2 Model

Consider an economy that operates over three dates, 0, 1 and 2. We refer to the interval of time between dates 0 and 1 (dates 1 and 2) as period 1 (period 2). The risk free rate is zero. The economy has one firm. If the firm operates in a period, it produces one unit of a good, which we refer to as the period \( t \) good. The firm sells each good for the numeraire good, “cash.” There is no storage technology, thus cash and all goods must be consumed immediately.

Agents The agents in the economy are all risk-neutral. They consist of a single owner for the firm, a continuum of identical manager candidates and a continuum of identical consumers. The firm is operated by an operator. The operator is either the owner or one of the manager candidates. The utility or payoff for each agent is given by her expected future cash flows plus the expected value of the goods they purchase. The owner has a sufficient endowment of cash in each period to fund all firm activities.

Products Each good the firm produces may be either high, \( h \), or low, \( l \), quality. All agents observe a good’s quality after it has been consumed. Hence, the period \( t \) good’s quality is common knowledge at the end of period \( t \). A good’s quality is neither verifiable nor contractible.

Product price formation Consumers compete in Bertrand fashion by bidding for each good. The price they set for the period \( t \) good, \( p_t \), represents a bid that will be filled if the good is produced. Prices are verifiable and contractible. Consumers have identical preferences, which are common knowledge: they assign a value of one to a high-quality good and a value of zero to a low-quality good. Consistent with Bertrand competition, we assume that the consumers’ bid price equals their expected valuation of the good.

Production decisions In each period, after observing the price set by consumers, the owner chooses whether or not the firm will operate, i.e., produce a good. To ensure that the firm operates, the owner must supply the firm with capital equal to \( e \). Otherwise, the owner shuts down production for the period, i.e., the owner supplies no capital and the firm does not produce a good in the period. The firm’s operator invests the capital supplied by the owner in the firm’s operations. If the operator invests the entire capital, \( e \), the firm employs the reliable technology. This technology produces a high quality good with probability one. Another production technology is also available to the operator, the vulnerable technology. The vulnerable technology

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9A finite-time setting facilitates a unique equilibrium in models of reputation under incomplete information. Two periods is the simplest to consider reputation reform. We assume a zero discount rate to improve exposition, and would obtain identical results if all agents discount at the same positive rate.

10This timing for consumer bids ensures that in each period there is a price for the good on which contracts can be written. If prices are set after production, in any period in which the firm does not produce, the good would not have a price and a contract based on the period’s price would be ill defined. Alternatively, we could assume price setting after production and extend the definition of “price” to include the “null price” and specify contracts over this extended set. However, this modification of the model would add complexity without producing insight.

11This assumption rules out a “trivial” equilibrium in which consumers believe goods are worthless and bid zero, goods are not produced and, because consumer bids are never filled, Bayes rule cannot be applied to consumer beliefs.
requires an investment in production of $I = e - c < e$, but only produces a high quality good with probability $\delta \in (0, 1)$, and a low quality good otherwise.

**Oversight system and diversion** The firm has an oversight system. The oversight system can be either *secure* or *insecure*. If the oversight system is secure, the operator can only invest in the reliable technology. If the oversight system is insecure, the operator can unobservably choose between the reliable and vulnerable technologies. If the operator chooses the vulnerable technology, the cost savings, $c > 0$, is diverted unobservably from the firm’s account and is consumed by the operator. We call the operator’s choice of the vulnerable technology *diversion*. If, in a given period, the operator follows the strategy of diverting whenever diversion is possible, i.e., choosing the reliable technology if and only if the oversight system is secure, we will say that the operator acts opportunistically during the period. If no period qualification is given, acting opportunistically should be interpreted as acting opportunistically in both periods. In contrast, if, in a given period, the operator follows the strategy of choosing the reliable technology regardless of whether the oversight system is secure or insecure, we will say that the operator acts reputably in that period.

**Information** At date zero, the operator, and only the operator, observes whether the oversight system is secure. The remaining agents (including the owner if the owner is not the operator), whom we collectively refer to as “outsiders,” do not know whether the oversight system is secure. Instead, outsiders have a common prior distribution over the security of the oversight system. At the start of period 1, they believe that the oversight system is secure with probability $\rho_1$. Thus, $\rho_1$ measures outsiders’ assessment of the effectiveness of the oversight system.

**Revelation** A good’s quality can reveal the oversight system’s type to outsiders: A low quality good can only be produced if the operator chooses the vulnerable technology. This is only possible if the oversight system is insecure. Since nothing happens after period 2, this revelation is only meaningful in period 1. We refer to the firm and its oversight system as revealed once consumers learn, from the period 1 good’s quality, that the oversight system is insecure.

**Prices and belief updating** If outsiders’ conjecture the operator will act reputably in period $t$, the period $t$ good’s price, $p_t = 1$. When $p_1 = 1$, outsiders will expect the firm be unrevealed in period 1. If outsiders conjecture the operator will act opportunistically in period 1, the period 1 good’s price will equal its floor price, $F_1$, where

$$F_1 = \rho_1 + (1 - \rho_1) \delta. \quad (1)$$

$F_1$ also represents outsiders’ assessment that the firm will remain unrevealed through period 1. In period 2, if outsiders conjecture that the operator will act opportunistically, the period 2 good’s

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12While attempting to circumvent oversight systems, insiders are likely to learn more about the actual effectiveness of these systems than firm owners. For example, insiders at Volkswagen identified and exploited flaws in its oversight system for a considerable period, and judging by its stock price’s reaction to the emissions cheating revelation, shareholders were surprised to learn that the firm’s oversight systems had been circumvented.
price will vary in accordance with Bayes rule based on what outsiders expected and observed in period 1 as follows: First, if outsiders conjecture that the operator acted reputably in period 1 and the period 1 good was high quality, or if the firm did not operate in period 1, outsiders’ assessments of the oversight system’s effectiveness will not change and the period 2 good’s price will equal $F_1$. Second, if outsiders conjecture that the operator acted opportunistically in period 1 and, nevertheless, the firm produced a high quality good, outsiders will update their assessment of the oversight system’s effectiveness and the period 2 good’s price will equal $F_2$, where

$$F_2 = 1 + \delta - \frac{\delta}{F_1}. \quad (2)$$

Note $F_2 > F_1$. Third, if outsiders observe a low quality good in period 1 and hence the firm is revealed, the period 2 good’s price will equal $\delta$. Because goods’ prices and the probability of revelation do not directly depend on the probability that the oversight system is secure, but rather on the probability that the good is high quality, we use the good-quality assessments we have just described to capture Bayesian updating.

**Reform** If the reform option is available, and the firm’s oversight system is revealed to be insecure in period 1, the owner can reform the oversight system at the start of period 2. Reform succeeds and transforms the oversight system to a secure system with probability $r \in (0, 1)$. Reform fails and the oversight system remains insecure with probability $1 - r$. To reform the oversight system and ensure that the firm operates in period 2, the owner must pay $R$ in period 2 (in addition to the period-two operating cost of $e$). Only the operator observes whether reform succeeds. Following reform, if consumers conjecture that the operator will act opportunistically, the price of the good will equal $F_r = r + (1 - r) \delta$, which we refer to as the reform floor price.

### 2.1 Ownership structures

We examine outcomes under two ownership/control structures: *professional management* and *owner management*. The operator’s identity distinguishes these structures: Under professional management, a professional manager, and not the owner, is the operator; under owner management, the owner is the operator. Thus, the professional management structure is similar to modern companies where owners delegate management, and the owner management structure is similar to sole proprietorships.

#### 2.1.1 Professional management

Under professional management, to start period 1 the owner hires a manager as the operator. The owner can change the manager in period 2. The market for managers is competitive with a continuum of identical candidates whose abilities and preferences are common knowledge. Managers have a per-period reservation wage of zero.

In contrast to standard reputation models, an owner-manager agency conflict arises from the professional manager’s ability to unobservably divert funds intended to ensure quality, lowering
goods’ expected quality and price. This conflict within the firm arises because decisions affecting the firm’s reputation are made by an agent who has no ownership rights over the rents from reputation but who does capture gains from opportunistic diversion.

To mitigate this agency conflict, the owner can contract with a manager when he is hired. Outsiders can observe the contract’s terms. Since the period $t$ good’s price is set before production and technology decisions are known (or, technically, even made), a payment based on the period $t$ good’s price will be insensitive to the manager’s technology choice in period $t$. Thus, a period $t$ incentive payment cannot motivate the manager’s period $t$ technology choice but may affect the manager’s $t-1$ choice. Consequently, an incentive payment in period 1 is wasteful. Thus, without any loss of generality, we only consider contracts with the manager hired in period 1, and contracts that make a payment to him only in period 2. The payment depends solely on the only contractible variables: the periods one and two goods’ prices. We assume that the payment is non-negative.

2.1.2 Owner management

Under owner management, the owner is the operator. Since the owner fully internalizes all the consequences of diversion, there is no role for a compensation contract or employment policy. Under owner-management, our model is close to the classic models of reputation (e.g., Kreps and Wilson, 1982; Milgrom and Roberts, 1982). In this setting, the tension militating in favor of opportunistic diversion is the conflict between the owner’s ex post and ex ante incentives to adopt the reliable technology.

2.2 Parametric assumptions

In order to focus on the subset of the parameter space that yields interesting and insightful results, we impose the following restrictions:

Assumption 1. $I > \delta > 0$.

Assumption 2. $F_1 - e \geq 0$.

Assumption 3. $F_r - e - R > 0$.

Assumption 4. $r \leq \rho_1$.

Assumption 1 ensures that the vulnerable technology produces high-quality goods with positive probability, but that this probability is too low to make known use of the vulnerable technology profitable. Assumption 2 ensures that, even under the most pessimistic consumer conjecture about good quality in period 1, production will be profitable in period 1. Assumption 3 ensures that reform is profitable in expectation. Assumption 4 simply ensures that reform following revelation (i.e. reputation damage) caused by insider opportunism cannot increase consumer assessments of the security of the firm’s oversight system above its pre-revelation level.
2.3 Equilibrium

A Bayesian Nash equilibrium is a set of owner and manager actions, prices for goods, and beliefs in each period such that:

i. Under professional management the owner’s managerial hiring and replacement decisions are incentive compatible.

ii. The owner’s reform and shut down/operate decisions are incentive compatible.

iii. The operator’s divert/not divert decisions are incentive compatible.

iv. Consumers set prices equal to the goods’ expected quality conditioned on the owner’s and operator’s strategies.

v. Belief updating is consistent with Bayes’ rule.

Under owner management, an equilibrium is a Bayesian Nash equilibrium. Under professional management, an equilibrium is a compensation contract and an associated Bayesian Nash equilibrium such that there exists no other contract with an associated Bayesian Nash equilibrium that produces a higher ex ante expected payoff for the owner. We will refer to an equilibrium in which the operator acts reputably in period 1, as a reputation equilibrium.

3 Equilibrium outcomes

We focus on deriving conditions for reputation equilibria with and without the option to reform. We derive equilibrium conditions separately under owner management and professional management. We first characterize common features of equilibria under these two ownership/control structures. Formal proofs appear in Appendix A.

3.1 Common characteristics of equilibrium outcomes

Although the model features many actions, the equilibrium actions in many cases are determined simply by the fact that our model is a finite-date incomplete information game like classic reputation models. Because period 2 is the last period in the model and good quality is not observed until the good is consumed, opportunism in period 2 imposes no costs on the operator but allows him to benefit from the cost reduction, $c$, from adopting the inferior vulnerable technology. Thus, the operator will always act opportunistically in period 2. If the firm is revealed (in period 1), consumers will price the period 2 good’s price $p_2 = \delta$. Consequently, by Assumption 1 period 2 production will not be profitable absent reform. At the same time, Assumption 3 ensures that period 2 production will be profitable if the oversight system is reformed. If the firm is unrevealed, Assumption 2 along with $F_2 > F_1$ ensures that operating the firm is profitable even when consumers conjecture the operator will act opportunistically. The consequences of these observations are summarized in the following lemma.

Lemma 1. Regardless of the firm’s ownership structure,

a. In period 2, if the firm produces, the operator will act opportunistically.
b. If the firm is revealed, absent reform, the consumer’s period 2 bid price for the good will equal $d$ and the firm will not produce in period 2.

c. If the firm is revealed and the reform option is available, the owner will choose reform and the firm will operate in period 2.

d. The firm will operate in period 1 and will operate in period 2 if it is not revealed.

3.2 Professional management

We now identify the optimal replacement policy for managers and characterize their optimal compensation. These results help us derive conditions for reputation equilibria.

3.2.1 Manager replacement policy

Lemma 1.d shows that the firm will operate in period 1 and will operate in period 2 if it is not revealed. Diversion when the control system is insecure is the only action that a professional manager can undertake which reduces firm value. As Lemma 1.a shows, the owner cannot curb the manager’s opportunism in period 2. Thus, for any given expected expenditure on managerial compensation, the owner’s welfare is maximized by selecting compensation contracts and managerial replacement policies that minimize the manager’s gain from opportunistic actions relative to reputable actions in period 1. The replacement policy that maximizes owner welfare is the policy of terminating the manager at the start of period 2 if and only if the firm is revealed. Retaining the manager permits the manager to capture diversion gains in period 2. Terminating the manager if the firm is revealed deprives him of period 2 diversion gains, and thus imposes an opportunity cost on period 1 diversion. This replacement policy is incentive compatible in period 2 since the replacement manager is equally likely to divert in period 2. This observation is summarized by the next Lemma.

**Lemma 2.** The incumbent manager will be retained in period 2 if and only if the firm is unrevealed.

Lemma 2 demonstrates that, once a firm’s reputation is damaged, it is optimal to replace its manager. The factors driving this result differ dramatically from Tirole (1996), who also considers how a firm can overcome reputation damage. In Tirole (1996), the firm is a group of agents who share a reputation and it is optimal to terminate agents whose actions damage the group’s reputation. Termination allows the group to repair its reputation by bringing more reputable agents into the group. In our model, the incumbent and replacement managers are identical in characteristics and incentives. Replacement acts only as a penalty for deviant behavior, which maximizes the manager’s ex ante incentives to act reputedly. This logic resembles the incentive effect of termination in Cremer (1986), who also models the firm as a team of agents. Unlike Tirole (1996) and Cremer (1986), in our setting, the firm fails after revelation because consumers learn about the character of the oversight system. Thus, consistent with the arguments developed in the management literature and the corporate actions documented in Table B.1 in Appendix B,
personnel policies, in and of themselves, cannot restore corporate reputations. Only reforming control systems can. Replacing management is merely coincident with reputation repair, not the means of repair.

3.2.2 Optimal compensation

Determining the optimal incentive contract for the manager is relatively simple. Optimal contracts, for a fixed level of expected compensation payments, minimize the gains from opportunism in period 1. Consequently, an optimal contract always takes the following form: The contract makes no payment to the manager in period 1. In period 2, the contract specifies a payment of \( b \), where \( b \geq 0 \) if \( p_2 \geq F_1 \) and a payment of 0 if \( p_2 < F_1 \). Verifying the optimality of this contract form is straightforward. First note that the period 2 price is greater than or equal to \( F_1 \) if and only if the firm is not revealed. To see this, note that Lemma 1.a implies that the manager will act opportunistically in period 2. Thus, if the firm is revealed and the owner reforms, the period 2 good’s price will equal \( F_r \). By Assumption 4, \( F_r = r + \delta (1 - r) < r_1 + \delta (1 - r_1) = F_1 \). If the owner does not reform, the good price will equal \( \delta < F_1 \). If the firm is unrevealed, regardless of the consumer’s conjecture about managerial behavior the price of the good will at least equal \( F_1 \). Thus, this form of contract in effect specifies (a) a payment in period 2 of \( b \geq 0 \) if the firm is unrevealed, (b) a payment in period 2 of 0 if the firm is revealed, (c) and a payment in period 1 of 0. Because period 1 payments have no incentive effects for reasons discussed in Section 2.1.1, and because, for any fixed \( b \geq 0 \), a payment of 0 when the firm is revealed maximizes the difference between the manager’s payoff from acting reputably and payoff from acting opportunistically, this contract form is optimal.

Next consider the problem of setting the specific contracted payment, \( b \). Compensation only affects managerial behavior when the oversight system is insecure. So consider the problem of a manager who knows the oversight system is insecure. If the firm is unrevealed, the manager will be retained (Lemma 2) and can divert in period 2. In addition, he will receive the contracted bonus \( b \). Thus, his payoff in period 2 will equal \( b + c \). If the firm is revealed, the manager will be terminated, thus cannot divert in period 2, and will not receive the contracted payment \( b \). Therefore, the manager’s period 2 payoff will equal 0. If the manager diverts in period 1, the probability that the firm will be unrevealed at the start of period 2 equals \( \delta \). Hence, not diverting will be a best response for the manager in period 1 if and only if

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\begin{align*}
\text{payoff: divert} & \quad \text{payoff: not divert} \\
\hat{c} + \delta (\hat{b} + c) & \leq \hat{b} + c
\end{align*}
\]

(3)

Solving for the minimum \( b \) that satisfies this inequality yields

\[
b^* = \frac{c \delta}{1 - \delta}.
\]

(4)

Thus, \( b^* \) is the minimum incentive payment that will induce the manager to act reputably in
period 1. If the owner offers any positive compensation payment, i.e., chooses to set $b > 0$, the owner will set $b = b^*$. We call such a compensation scheme reputation-assuring compensation. If the owner does not offer reputation-assuring compensation, then the owner will not offer any compensation to the manager, i.e., the owner will offer the contract that sets $b = 0$. Reputation-assuring compensation increases the manager’s utility above his reservation level and the prospect of losing these rents deters opportunism. Hence, reputation-assuring compensation’s function in our analysis is similar to that of efficiency wages in Klein and Leffler (1981). Our implementation differs from Klein and Leffler because opportunism is not directly observable and can only be estimated via a noisy signal: the good’s price.

3.2.3 Conditions for reputation equilibria

As the earlier analysis demonstrated, reputation equilibria can only be supported if the owner offers reputation-assuring compensation. If the owner offers such compensation, the manager will act reputably in period 1 and the period 1 good’s price, $p_1$, will equal one. In period 2 the manager will act opportunistically as shown by Lemma 1.a. Therefore, the period 2 good’s price will equal $F_1$. Thus, under reputation-assuring compensation, the owner’s expected payoff is:

$$ z_{period 1} \left( 1 - e + F_1 - e - b^* \right). $$

(5)

If instead, the owner does not offer reputation-assuring compensation, the manager will act opportunistically in period 1 implying a period 1 good’s price of $F_1$. With probability, $1 - F_1$ the firm is revealed at the start of period 2. In this case, Lemma 1.c shows the owner will opt for reform, if this option is available. With probability $F_1$ the firm remains unrevealed, and the price of the good at date 2 will be given by $F_2 > F_1$, where $F_2$ is defined by Equation (2). Lemma 1.d ensures that the firm will operate in period 2. Thus, if the option to reform is available, the owner’s payoff from not offering reputation-assuring compensation is given by

$$ z_{period 1} \left( F_1 - e + (1 - F_1)(F_2 - R - e) + F_1 (F_2 - e) \right). $$

(6)

When the reform option is not available, by Lemma 1.b, the firm will shut down in period 2 if and only if the firm is revealed. Consequently, the owner’s payoff from not offering reputation-assuring compensation is given by

$$ z_{period 1} \left( F_1 - e + F_1 (F_2 - e) \right). $$

(7)

A reputation equilibrium will exist whenever the owner’s payoff from offering reputation-assuring compensation at least equals the owner’s payoff from not offering reputation-assuring compensation. These observations, and a bit of algebraic manipulation, yield the following conditions for reputation equilibria under professional management:
Proposition 1. If the option to reform is available, then a reputation equilibrium exists if and only if

\[ F_t \leq 1 - \frac{b^*}{\delta + \pi_t - \pi_r}, \]  

(8)

where \( b^* \) is defined in equation (4), \( \pi_t = 1 - e \) equals the period 1 profit if the goods price is 1, and \( \pi_r = F_t - e - R \) equals the period 2 profit if the firm is reformed. If the option to reform is not available, then a reputation equilibrium exists if and only if

\[ F_t \leq 1 - \frac{b^*}{\delta + \pi_t}. \]  

(9)

This characterization is intuitive. Reputation-assuring compensation yields two benefits. First, it eliminates the possibility of revelation. The owner’s assessment of this probability absent reputation-assuring compensation is \( 1 - F_t \). Thus, the direct gain from reputation-assuring compensation is inversely related to the floor price. This benefit is reflected in the proposition by the range of floor prices that support reputation equilibria being a lower interval. Second, reputation-assuring compensation has an informational effect. When consumers observe such compensation it leads them to set a price of 1 for the period 1 good, and thus permits the owner to capture a profit of \( \pi_t \) in period 1. This effect is reflected through the positive relation between \( \pi_t \) and the length of the interval of period 1 floor prices which support reputation equilibria. The cost of offering reputation-assuring compensation is captured by the required payment to the manager, \( b^* \). This cost is reflected in the proposition by the negative relation between \( b^* \) and the length of the interval supporting reputation equilibria.

Since \( \pi_r > 0 \) by Assumption 3, the following corollary is immediate.

Corollary. Under professional management, the set of parameter values for the model that support reputation equilibria when the option to reform is available is a proper subset of the set of parameter values that support reputation equilibria when the option to reform is absent.

The corollary shows that the option to reform, by generating profit \( \pi_r \) after revelation, lowers the owner’s loss from revelation and thus weakens her incentive to adopt reputation-assuring compensation. Hence, the option to reform shrinks the interval over which reputation equilibria are sustainable, as does higher profitability of reform.

When the equilibrium conditions of Proposition 1 are not satisfied, the owner does not pay reputation-assuring compensation, the owner operates the firm in both periods if it is unrevealed, and the equilibrium price in period \( t \) equals \( F_t \) when the firm is unrevealed. If the firm is revealed, when the option to reform is available, the firm operates and the period 2 equilibrium price equals \( F_t \). If the option to reform is not available, the revealed firm shuts down in period 2.

3.3 Owner management

There are three essential differences between the incentives generated under owner management and professional management. First, the owner-manager, being the operator, is an
informational insider who knows whether the oversight system is secure. Thus, the conditions for a reputation equilibrium depend only on the owner-manager’s payoffs when the oversight system is insecure. Second, when the oversight system is insecure, the owner-manager captures the rents generated by outsider’s mistaken confidence in the security of the oversight system. Third, the owner-manager also captures the rents from diversion after failed reform. To capture the third difference, let \( g = (1 - r) c \), where \( g \) represents expected post-reform gains from diversion. To see this, note that, in period 2, by Lemma 1.a, the owner-manager will always divert when the oversight system is insecure. After reform the probability that the oversight system is insecure equals \( 1 - r \) and the reward for diversion is \( c \).

Now consider the viability of reputation equilibria under owner management. Consider the owner’s diversion decision when the control system is insecure. Lemma 1.d shows it is optimal for the owner to operate the firm in period 1. Regardless of whether the option to reform is available, if the owner-manager chooses the reliable technology in period 1 the period 1 good’s rational expectations equilibrium price is 1. In period 2, by Lemma 1.a, the owner-manager diverts and produces using the vulnerable technology, making a net investment of \( I \). The rational expectations price for the period 2 good is, thus, \( F_1 \). Hence the owner-manager’s payoff in an equilibrium in which the owner-manager does not divert equals

\[
\text{period 1} \quad \text{period 2} \\
1 - e + F_1 - I. \tag{10}
\]

If the owner-manager defects from the equilibrium and diverts in period 1, the firm enters period 2 unrevealed with probability \( \delta \). With probability \( 1 - \delta \) the firm is revealed. If the firm is revealed and the reform option is available, by Lemma 1.c, the owner-manager will reform and the firm will operate in period 2; otherwise, by Lemma 1.b, the firm will shut down. By Lemma 1.a, the owner-manager will divert in period 2 if the firm operates. Thus, the owner-manager’s payoff if she defects from the equilibrium and if the reform option is available equals

\[
1 - I + \delta (F_1 - I) + (1 - \delta) \left( r(F_r - e) + (1 - r)(F_r - I) - R \right), \tag{11}
\]

and, if the option to reform is not available, equals

\[
1 - I + \delta (F_1 - I). \tag{12}
\]

A reputation equilibrium will exist if and only if not diverting in period 1 when the firm is insecure produces at least as great a payoff for the owner-manager as deviating to diversion. These conditions yield the following characterization of reputation equilibria under owner management:

**Proposition 2.** When the firm is controlled by an owner-manager and the option to reform is
available, reputation equilibria exist if and only if

\[ F_1 \geq 1 + b^* - \pi_1 + (\pi_r + g), \]

(13)

where \( b^* \) is defined by equation (4) and \( \pi_1 \) and \( \pi_r \) are defined in Proposition 1. When the firm is controlled by an owner-manager and the option to reform is not available, reputation equilibria exist if and only if

\[ F_1 > 1 + b^* - \pi_1. \]

(14)

The conditions for reputation equilibria for owner management are in some respects quite similar to those for professional management. However, in other respects the conditions are quite different. For both owner and professional management, increasing the profits from reputable behavior, \( \pi_1 \), increases the length of the interval of floor prices over which reputation equilibria can be supported. As is the case with professional management, increasing the gains from opportunism, which are proportional to \( b^* \), reduces the length of the interval over which reputation equilibria can be sustained.

However, there are also two significant differences between the conditions for reputation equilibria under owner as opposed to professional management. First, although the gains from opportunism make sustaining reputation more difficult under both ownership structures, they do so for very different reasons. With professional management, increasing the gains from opportunism increases the reputation-assuring compensation required to induce the manager to forgo opportunism. This cost is traded off against another expected cost: the cost of revelation to the uninformed owner. With owner management, the owner-manager is informed about the oversight system. Because diversion is only possible when the oversight system is insecure, the incentives of the owner when the oversight system is insecure determine the viability of reputation equilibria. When the oversight system is insecure, the owner can gain from diversion. Thus, the gain from opportunism represents a temptation not a cost under owner management.

The primary difference between the reputation conditions for owner and professional management is the role of the floor price \( F_1 \), which reflects outsiders’ prior beliefs about the effectiveness of the control system. The owner-manager’s incentive to eschew diversion in period 1 arises because diversion risks revelation and losing profits in period 2. Period 2 profits depend on the price of the good in period 2, which by Lemma 1.a depends on \( F_1 \). Thus, higher floor prices expand the region of the parameter space over which reputation equilibria can be sustained. The effect of higher floor prices changes under professional management. If \( F_1 \) is higher, failing to provide reputation-assuring compensation is less likely to reveal the firm as insecure. Thus, owners see less value in paying compensation, making it less likely they will pay to sustain a reputation. Hence, under owner management, the interval of floor prices that sustain reputation equilibria is an upper interval and under professional management the interval is a lower interval.

Because \( \pi_r + g > 0 \), the following corollary is immediate.
Corollary. Under owner management, the set of parameter values for the model that support reputation equilibria when the option to reform is available is a proper subset of the set of parameter values that support reputation equilibria when the option to reform is not available.

The effect of reform on the viability of reputation equilibria, like the case of professional management, includes $\pi_r$, the expected firm profit after reform. As in the case of professional management an increase in $\pi_r$ reduces the interval of floor prices over which reputation equilibria are sustainable. However, there is an additional impediment to sustaining reputation equilibria under owner management—the gain from diversion post reform, $g$. Under professional management this gain is not captured by the owner, but rather by a (replacement) manager and thus does not enter into the owner’s decisions. Under owner management this gain is captured by the owner when the oversight system is insecure and increases the owner-manager’s temptation to divert.

When the reputation equilibrium conditions of Proposition 2 are not satisfied, depending on the parameter values, the equilibrium is either a mixed strategy equilibrium in which the owner-manager randomizes between reputable and opportunistic behavior in period 1 or the owner manager always acts opportunistically in period 1. The expressions defining managerial strategies are somewhat complex and not directly relevant to the focus of our analysis. However, they are required for predicting the outcomes of the experiment. Thus, we develop these equilibria in Lemma A-1 in Appendix A.

3.4 Reform and reputation

As Propositions 1 and 2 indicate, the conditions for reputation equilibria under professional and owner management vary considerably, particularly when the option to reform is available. Under both ownership structures, the option to reform makes sustaining reputation equilibria more difficult. However, the effect of reform on the owner’s payoffs is fundamentally different under the two ownership structures. The cost of failed reform is lower for owner-managers. To see this note that under both ownership structures increasing the effectiveness of reform, by increasing $r$, benefits the owner as it increases $F_r$ implying a higher price for the period 2 good. However, increasing $r$ imposes a cost on the owner manager when the control system is insecure, albeit a cost smaller than the benefit: increasing $r$ reduces their expected diversion gains. Thus, the value of reform to the owner-manager is less sensitive to the effectiveness of reform than is the value of reform to the owner when the firm is professionally managed. At the same time, because the owner-manager always has some probability of capturing diversion gains, her expected gain from the reformed firm’s operation, is higher.

Thus the owner manager finds relatively ineffective (low $r$) reform more attractive than non-owner managers. Because reform is never so effective that it completely restores the reputation of the firm’s oversight system to its pre-revelation level (Assumption 4), reform will not be extremely effective unless the consumers initial assessment of the oversight systems effectiveness, and thus $F_1$, is very high. These results imply that, as long as the initial floor price is not too
high, an owner-managed firm is more likely than a professionally managed firm to eschew reputable behavior in period 1 in favor of opportunism in period 1 and risk having to reform in period 2.

**Proposition 3.** When the option to reform is available and

$$F_1 < \frac{1 + \delta + g}{1 + \delta + (\pi_1 - \pi_r)},$$  \hspace{1cm} (15)

then, if a reputation equilibrium exists under owner management, a reputation equilibrium exists under professional management.

### 4 Experiment

Our experiment tests the prediction (Proposition 3) that introducing the option to reform is more likely to lead to opportunistic operator behavior when firms are owner-managed. The experiment employs the two parameterizations of our model presented in Table 1. The only difference between the parameterizations is that Parameter Set II features a higher value of $r_1$, the outsiders’ initial effectiveness rating of the oversight system. To ensure “salience,” i.e., that subjects’ payoffs vary meaningfully with their technology choices (e.g., Plott, 1982), both parameterizations involve two slight departures from the model’s assumptions. First, we set the value of a high quality good at 1,000 instead of 1. This change merely scales up all cash flows by a factor of 1,000. Second, we set the professional manager’s compensation equal to 30 instead of the minimum reputation-assuring compensation of 3.16 characterized by equation (4).  

Neither of these two departures changes equilibrium prices or operator actions described in Section 3. Under Parameter Set II, the model predicts a reputation equilibrium under both owner and professional management, regardless of whether the option to reform is available. Under Parameter Set I, the model predicts a reputation equilibrium under professional management and when the firm is owner managed and the option to reform is not available. When the option to reform is available, the model predicts a mixed strategy equilibrium in which the owner manager sometimes chooses the vulnerable technology in period 1. Table 2 presents the operator’s predicted period 1 equilibrium behavior as well as period 1 and 2 goods’ prices.

| Table 1: Parameters used in the experiment. |
|---|---|---|---|---|---|---|---|---|
| Parameter | $\rho_1$ | $I$ | $c$ | $\delta$ | $R$ | $r$ | Value $l$ | Value $h$ |
| Parameter Set I | 0.125 | 51 | 60 | 0.05 | 10 | 0.1 | 0 | 1000 |
| Parameter Set II | 0.250 | 51 | 60 | 0.05 | 10 | 0.1 | 0 | 1000 |

$^{13}$The bonus of 30 leads to a net expected cost of 25.50 when a professional manager defects from the reputation equilibrium. This is comparable to the 22.24 incentive that an owner manager has to maintain a reputation equilibrium under Parameter Set I.
Table 2: Equilibrium predictions.

<table>
<thead>
<tr>
<th>Parameter Set</th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operator</td>
<td>w/o Reform</td>
<td>w/ Reform</td>
</tr>
<tr>
<td>Owner or Prof.</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Reputation equilibrium</td>
<td>1.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Probability of reputable behavior</td>
<td>1,000</td>
<td>1,000</td>
</tr>
<tr>
<td>Period 1 Price</td>
<td>168.75</td>
<td>168.75</td>
</tr>
<tr>
<td>Period 2 Price</td>
<td>50</td>
<td>145</td>
</tr>
</tbody>
</table>

4.1 Experimental design

While our theoretical analysis is not particularly complex relative to recent models of reputation, it is quite complex relative to the typical game implemented in laboratory settings. Complexity increases subject decision costs and, thus, subject errors (Smith and Walker, 1993). Moreover, implementing the complete theoretical model would (a) make it difficult to diagnose differences between model predictions and experimental behavior (Davis and Holt, 1993), and (b) involve providing a great deal of contextual information which might increase subjects’ likelihood of making decisions based on the contextual information rather than the monetary payoffs from the experiment (Zizzo, 2010). Thus, as we will now describe, we design our experiment to lower complexity.

Our theoretical analysis focuses on the core question raised in this paper—how do ownership structure and corporate reform affect the propensity of firms to form reputations through operating policy? The key operating policy that determines firm reputation is the period 1 technology choice. Therefore, we focus the experiment on testing the following prediction:

**Hypothesis 1.** Under Parameter Set II, the operator’s probability of selecting the vulnerable technology in period 1 is invariant to ownership structure and the option to reform. Under Parameter Set I, if the firm is owner managed, introducing the option to reform will increase the likelihood that the operator will choose the vulnerable technology. If the firm is professionally managed, the introduction of the option to reform will have no effect on the operator’s technology choice.

To increase focus on the period 1 technology choice, we restrict the owner’s operate/shut down decisions to conform with the predicted equilibria as follows: In period 1, the owner always capitalizes the firm. In period 2, the owner capitalizes the firm if it is unrevealed, effectively shuts it down if it is revealed and the reform option is unavailable, and undertakes reform and capitalizes the firm if the reform option is available. Hence, the owner manager under owner management, and the manager under professional management, focus only on making technology choices. Under professional management, the experimenter sets employment policy to conform with the predicted equilibrium by retaining the manager in period 2 if the firm is
unrevealed and effectively terminating the manager if it is revealed. Thus, under both owner and professional management, subjects only play the role of consumers and operators.

In period 2, the opportunistic policy of choosing the vulnerable technology is strictly dominant. Hence, in order to increase the number of rounds implementable in each experimental session and reduce strategic uncertainty arising from noise created by subject conjectures about the rationality of other subjects’ period 2 choices, we restrict subjects’ period 2 actions to conform with our model’s predictions. Specifically, in accordance with Lemma 1.a, each operator is restricted to using the vulnerable (reliable) technology in period 2 if the oversight system is insecure (secure). Period 2 operator payoffs are based on the owner’s optimal operate/shut down decision and the period 2 good’s equilibrium price conditional on the publicly available information about the firm’s type. These payoffs are detailed in Table C.2 in Appendix C.

Thus, in the experiment, the operator effectively acts only in period 1: When the control structure is insecure, the operator chooses either the reliable or vulnerable technology. When the control structure is secure, the operator is constrained to choosing the reliable technology. Given equilibrium owner actions, both the reform and no-reform scenarios produce the same payoffs to the operator when the firm is professionally managed. In both scenarios, the operator is employed in period 1, and the operator remains employed in period 2 (and receives the same bonus compensation) if and only if the firm is unrevealed. Consequently, the professional management/reform treatment is equivalent to a professional management/no reform treatment. Therefore, for each parameter set in Table 1, we run the following three treatments, each consisting of two sessions: (1) owner management without the opportunity to reform, (2) owner management with the opportunity to reform and (3) professional management with the opportunity to reform. Because of the equivalence between a professional management/reform treatment and a professional management/no reform treatment, our design effectively becomes a 2 (parameter set) × 2 (ownership structure) × 2 (reform opportunity) design relative to operator choices and first-period prices. Table 3 summarizes our design. We will use the labels in the table to identify the experiments, dropping the parameter set suffix when the discussion applies to both parameter sets.

4.1.1 Subjects, instructions, and payments

Subjects were drawn from a volunteer pool of undergraduate business and MBA students at University of Iowa. Sessions lasted for at most two hours and subjects were paid a $5 show-up fee. The experimental currency was “francs,” which were converted to dollars at known exchange rates (depending on the treatment and subject’s role). Subject payments (including the $5 show-up fee) ranged between $10.31 and $32.00. They averaged $21.45 with a standard deviation of $4.37. Expected profits across roles were equalized by allowing consumers to

14Lucas (1986) argues that players follow adaptive strategies and higher levels of strategic uncertainty slow convergence. Van Huyck et al. (1990) show how strategic uncertainty affects convergence to equilibria in repeated games, leading to coordination failures, for example. Because our focus is on operator choices, we eliminate strategic uncertainty as much as possible along other dimensions.
Table 3: Experimental design.

<table>
<thead>
<tr>
<th>Ownership Structure</th>
<th>Parameter Set</th>
<th>I</th>
<th>Label</th>
<th>Obs.</th>
<th>II</th>
<th>Label</th>
<th>Obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner Management</td>
<td></td>
<td></td>
<td>OM-I</td>
<td>264</td>
<td>OM-II</td>
<td>264</td>
<td></td>
</tr>
<tr>
<td>Owner Management w/ Reform</td>
<td></td>
<td></td>
<td>OMR-I</td>
<td>264</td>
<td>OMR-II</td>
<td>264</td>
<td></td>
</tr>
<tr>
<td>Professional Management (w/ or w/o Reform)</td>
<td></td>
<td></td>
<td>PM-I</td>
<td>228</td>
<td>PM-II</td>
<td>264</td>
<td></td>
</tr>
</tbody>
</table>

Keep some of an endowment they received each period and setting different exchange rates for operators across the treatments.

Upon arrival, subjects sat at separate computer terminals and received a set of instructions (provided in Appendix E), forms to record profits by period, and receipts to be filled in during the session. They were randomly assigned to roles (“Green” player (consumer) or “Blue” player (operator)) and remained in their roles throughout the session. The instructions were read aloud and all questions were answered in public before each session. The experiments were programmed in Z-Tree (Fischbacher, 2007).

Each session consisted of a number of “rounds.” Each round implemented one two-period play of the experimental game. To start a round, subjects were randomly assigned to groups consisting of one consumer and one operator. Each operator was assigned available production technologies or “methods.” All operators could produce using a reliable technology (called “Method 1: Sure” in the experiment) that always produced a high quality good (a “round item” in the experiment) worth 1,000 francs to the consumer. A fraction of operators (7/8 or 3/4 depending on the parameter set) could alternatively produce with the vulnerable technology (called “Method 2: Mixed” in the experiment) that cost 60 francs less but produced a high quality good only 5% of the time and a low quality good (a “square” item worth 0 francs to the consumer) 95% of the time. Effectively, the oversight system was insecure (secure) if the operator could (not) use the vulnerable technology. All players knew the production technology assignment rules and fractions of each firm type.

In the first period of each round, the operator chose a production technology and consumers set a price. In the second period, as discussed earlier, operator production choices and consumer prices were fixed based on predicted equilibrium actions and the prices presented in Table C.2 in Appendix C. Because operators effectively only made technology choices in the first period,

---

15 While we will refer to the players as consumers and operators, these terms were not used during the experiment to avoid value-laden connotations.

16 Throughout each session, the technology determination methods were displayed on computer screens at the front and sides of the room. The displays showed (1) the probability the Blue players (operators) had only reliable or both reliable and vulnerable technologies, (2) the probability that each technology produces each item type and (3) the period 2 technology imposed by the experimenter based on period 1 quality and available technologies.
we will refer to operator technology choices in the first period simply as technology choices.

4.1.2 Price setting

We used a modified Becker et al. (1964) procedure (hereafter “BDM procedure”) to set prices. This procedure is designed to elicit the highest price the consumer is willing to pay for the good. First, the consumer specifies the most she is willing to pay. Once this “limit price” is set, the experimenter randomly draws a “discounted price” between 0–1,000 francs from a uniform distribution. The experimenter then buys the good from the firm at the limit price. The experimenter resells the good to the consumer at the discounted price only if the limit price exceeds the discounted price. Otherwise, the experimenter keeps the good. When a consumer purchases the item, she receives a payoff equal to her endowment plus the value of the item minus the discounted price. When the experimenter keeps the good, the consumer receives only her endowment. In either case, she receives an ex post report showing the quality of the item and the discounted price. In the following analysis we report consumer limit prices.

5 Evidence on reform and reputation equilibria

Figure 1 graphs the percentage of times operators of insecure firms use the reliable technology under each treatment. Consistent with prior evidence (e.g., Brandts and Figueras, 2003; Noe et al., 2012), there is a systematic deficiency in reputable behavior across all treatments. When our model predicts mixed equilibria (treatment OMR-I) in which a firm should use the reliable technology about 80% of the time, in our experiment firms use the reliable technology only about 50% of the time. Similarly, while our model predicts a 100% use of the reliable technology in the remaining treatments, we observe it only a maximum of 73% of the time, which occurs in treatment OM-I.

Nevertheless, the relative rates of the reliable technology’s use conform with our model’s predictions. Introducing reform lowers the reliable technology’s usage significantly by owner managed firms under Parameter Set I from 73% to 50%. Under Parameter Set II, the corresponding drop is from 68% to 57%, which is both smaller and statistically insignificant.

To minimize the confounding effects of subject learning, we test for differences in subject behavior in the second half of each session. Table 4 presents the frequency with which insecure firms use the reliable technology during the second half of the experiment. Consistent with Figure 1, there is a systematic deficiency in reputable behavior across all our treatments. However,

17 See the instructions in Appendix E for details. Research shows that, on average, the BDM procedure elicits risk neutral valuations (Berg et al., 2005) which, here, correspond to competitive prices. Through this procedure, we elicited a competitive price from a single subject. Further, it was fast to implement, it avoided complications from auction procedures (e.g., overbidding, as in Kagel and Levin, 1993), and did not require pre-specifying a limited set of allowable prices (e.g., Forsythe et al., 1999).

18 Using the entire data set leaves the results essentially unchanged, but there is some adjustment as subjects learn about the game. As a result, we are more comfortable using statistical tests based on the later periods in the experiment. Later we will provide insights into subject learning.
Figure 1: Frequency of reputable behavior. This figure presents the frequency with which operators of insecure firms choose the reliable production technology.

the variation in reputable behavior across treatments is consistent with model predictions. Under Parameter Set I, in treatment OMR-I, in which the owner can reform after the firm is revealed, we expect the firm to adopt the reliable technology less frequently than in treatments OM-I and PM-I (Hypothesis 1). Consistent, with this prediction, in treatment OMR-I, the firms used the reliable technology only 48.7% of the time. This usage is statistically significantly lower than the usage of the reliable technology in treatment OM-I (t=4.35, p-value=0.00). Under Parameter Set II, we expect the firm to act reputably regardless of its control structure and the availability of the option to reform (Hypothesis 1). Although treatment OMR-II still featured the lowest rate of reputable behavior (58.4%), this rate was not statistically significantly different than the rate in treatments OM-II (68.4%) or PM-II (66.0%). Consistent with our model’s predictions, we find no significant difference between the incidence of reputable behavior between Parameter sets I and II for treatments OM and PM. While, consistent with our expectations, we find more reputable behavior in treatment OMR-II than in OMR-I, the difference is not statistically significant.

5.1 Explaining subject strategies

Like earlier research on reputation in laboratory settings, we find less reputable behavior than in the rational choice equilibrium benchmark. Prior research also documents that, as subjects gain experience, their strategies better approximate equilibrium predictions (e.g., Brandts and Figueras, 2003; Noe et al., 2012). For this reason, we now examine the evolution of subject behavior in our experiment.

5.1.1 Evolution of operator strategies

We initiate our study of strategy evolution by modeling operator choices as a Markov process (cf. Axelrod, 1987; Erev and Roth, 1998). The states for the Markov model are deter-
Table 4: Incidence of reputable behavior. In this table we present the frequency with which insecure firms use the reliable production technology during the second half of each session.

<table>
<thead>
<tr>
<th>Control Structure</th>
<th>Parameter Set Parm. I</th>
<th>Parameter Set Parm. II</th>
<th>Parameter Set I vs II Difference</th>
<th>t-Stat.</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM</td>
<td>75.42%</td>
<td>68.37%</td>
<td>-7.06%</td>
<td>-1.15</td>
<td>0.25</td>
</tr>
<tr>
<td>OMR</td>
<td>48.67%</td>
<td>58.43%</td>
<td>9.75%</td>
<td>1.38</td>
<td>0.17</td>
</tr>
<tr>
<td>PM</td>
<td>71.43%</td>
<td>66.04%</td>
<td>-5.39%</td>
<td>-0.83</td>
<td>0.41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Set Difference</th>
<th>t-Stat.</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM vs OMR</td>
<td>-26.75%***</td>
<td>-9.94%</td>
</tr>
<tr>
<td>t-Stat.</td>
<td>-4.35</td>
<td>-1.41</td>
</tr>
<tr>
<td>OMR p-Value</td>
<td>0.00</td>
<td>0.16</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Set Difference</th>
<th>t-Stat.</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM vs PM</td>
<td>-4.00%</td>
<td>-2.33%</td>
</tr>
<tr>
<td>t-Stat.</td>
<td>-0.66</td>
<td>-0.35</td>
</tr>
<tr>
<td>PM p-Value</td>
<td>0.51</td>
<td>0.73</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Set Difference</th>
<th>t-Stat.</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMR vs PM</td>
<td>22.76%***</td>
<td>7.61%</td>
</tr>
<tr>
<td>t-Stat.</td>
<td>3.43</td>
<td>1.09</td>
</tr>
<tr>
<td>PM p-Value</td>
<td>0.00</td>
<td>0.28</td>
</tr>
</tbody>
</table>

mined as follows: the firm’s control system can be in one of two possible conditions—secure or insecure. When the firm is secure the operator has one feasible choice, the reliable technology, and, when the firm is insecure, the operator has two feasible choices: the reliable and vulnerable technology. Thus, there are three possible choice–condition pairs: (reliable, secure), (reliable, insecure), (vulnerable, insecure). These three pairs are the states of the Markov model. We term the first pair the “secure” state. The second the “reputation” state, and the third, the “opportunistic” state.  

We estimate the transition matrix using the method of moments, and use the estimated transition matrix to compute steady-state probabilities (Norris, 1998). The estimates are presented in Panel A of Table 5. Except perhaps for treatment OMR-I, the estimates suggest an increase in reputable behavior over time. Initial frequencies of adopting the reliable technology, are measurably lower than overall frequencies, which, in turn, are measurably lower than the estimated steady-state probabilities.

Panel B of Table 5 provides suggestive evidence for the drivers of reputation formation. Except for the OMR treatments, operators of insecure firms, whose firms were secure in the previous round, were more likely to select the reliable technology in the current round. Operators of insecure firms who, in the previous round, operated insecure firms and chose the reliable technology, were also more likely to choose the reliable technology in the current round. However, consistent with our earlier observations, the dominance of reliable technology is weaker for the OMR treatments. Except for treatment OMR-I, operators of insecure firms who, in the previous round, operated insecure firms, chose the vulnerable technology and produced a low quality good, were also more likely to choose the reliable technology in the current round. The

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19 Of course, the operator has no control over transitions to the secure strategy. These transitions are controlled entirely by the parameter set and random draws. However, the transitions will figure into the overall stable probabilities and, therefore, must be considered.
only case where the vulnerable technology dominated the reliable technology was when the operator, in the previous round, operated an insecure firm, chose the vulnerable technology and produced a high quality good. However, the probability of a high quality good being produced by the vulnerable technology is low in our experiment, so the effect of this case on the overall evolution of subject actions is small. In general, Table 5 documents a tendency for reputation formation to increase with operator experience.

Table 5: Evolution of reputation formation. Panel A presents the initial frequency, overall frequency, and estimated steady state probability of the reputation state, the state where the firm is insecure yet the reliable technology is adopted by the operator. Panel B presents the frequency of adoption of the reliable technology by operators whose firms are insecure conditioned on the outcome in the previous round. The last column of Panel B shows the $\chi^2$ statistic for independence between the prior strategies and reputable behavior in the next period.

| Panel A: Frequencies and steady state (SS) probabilities of reputation building |
|-----------------------------|------------------|-----------------|------------------|------------------|
| Parameter Set I             | Parameter Set II |
| Treatment                   | Overall          | SS              | Overall          | SS              |
| OM                         | 61.9%            | 72.6%           | 74.0%            | 61.1%           | 68.2%           | 68.7%           |
| OMR                        | 50.0%            | 50.2%           | 50.2%            | 50.0%           | 56.8%           | 57.2%           |
| PM                         | 46.7%            | 69.7%           | 72.8%            | 47.1%           | 59.6%           | 61.3%           |

| Panel B: Frequency of reputation building conditioned on previous round’s outcome |
|---------------------------------------------|------------------|-----------------|------------------|------------------|
| **Outcome in previous round**              | Secure High      | Reputation High | Opportunistic Low | High |
| **State:**                                  |                   |                 |                   |                  |
| **Good’s Quality:**                        |                   |                 |                   |                  |
| Parameter                                  | OM                | 80.0%           | 78.5%            | 61.1%           | 0.0%            | 12.10 (0.007)   |
| Parameter Set I                            | OMR               | 30.8%           | 61.5%            | 46.4%           | 0.0%            | 13.12 (0.004)   |
| Parameter Set II                           | PM                | 59.1%           | 83.9%            | 51.0%           | 33.3%           | 22.38 (0.000)   |
| Parameter                                  | OM                | 58.7%           | 75.3%            | 66.7%           | 0.0%            | 4.70 (0.195)    |
| Parameter Set II                           | OMR               | 48.7%           | 62.2%            | 58.6%           | 0.0%            | 6.36 (0.095)    |
| Parameter                                  | PM                | 52.3%           | 85.2%            | 31.5%           | 20.0%           | 46.31 (0.000)   |

5.1.2 Reasons why operators’ strategies evolve

To examine the forces underlying the evolution of operators’ choices, we estimate logit models of the operators’ choice of the reliable technology. We model their choice as a function of the treatment, subject demographics, and experience. We use dummy variables to represent treatments and parameter set/treatment interactions and gender (which is the only demographic variable that appears significantly correlated with behavior). We account for subject experience using experience weighted attraction (EWA) models along the lines of Erev and Roth (1998) and Camerer et al. (2002), that account for the profitability of past choices. We formally define the experience weighted attraction variables in Appendix D, but, to summarize, each model assumes that the propensity to make a choice (i.e., the choice’s “attraction”) depends on the weighted
average of the prior profitabilities of playing each choice relative to the prior profitabilities of playing other choices. We calculate two sets of attraction measures: In one set, the propensities depend only on the profitabilities of prior choices, referred to as “Gross Profit EWA.” In the second set, the propensities are computed by comparing the outcome of each choice relative to the most profitable feasible alternative choice, defined as “Net Profit EWA.” Our estimates employ robust standard errors clustered by subject to control for repeated observations. Further details about our implementation of EWA models are provided in Appendix D.

We present the estimates in Table 6.

Table 6: Logit regression analysis of reputable behavior by operators of insecure firms. The dependent variable equals 1 if an operator chooses the reliable technology. Gender is a dummy variable equal to 1 if the subject is male. Owner-Mgr., Owner-Mgr. w/ Reform and Professional Mgr. are dummy variables for the control structure treatments. Experience weighted attraction (EWA) regressions include separate propensities to play the reputation strategy in each treatment as defined in equations (D.13) and (D.14) with \( \delta = 0 \) or \( \delta = 1 \). Robust standard errors clustered by subject appear in parentheses below each estimate.

<table>
<thead>
<tr>
<th>Parameter Set</th>
<th>Gross Profit EWA</th>
<th>Net Profit EWA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Parameter Set I</td>
<td>Parameter Set I</td>
</tr>
<tr>
<td>Constant</td>
<td>0.66***</td>
<td>-0.57</td>
</tr>
<tr>
<td></td>
<td>(0.24)</td>
<td>(0.41)</td>
</tr>
<tr>
<td>Gender</td>
<td>0.53*</td>
<td>0.45**</td>
</tr>
<tr>
<td>(1=Male)</td>
<td>(0.28)</td>
<td>(0.20)</td>
</tr>
<tr>
<td>Owner-Mgr. w/ Reform</td>
<td>-0.84***</td>
<td>-0.24</td>
</tr>
<tr>
<td></td>
<td>(0.29)</td>
<td>(0.46)</td>
</tr>
<tr>
<td>Professional Mgr.</td>
<td>-0.15</td>
<td>-0.77</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.70)</td>
</tr>
<tr>
<td>Exp. Wtd. Propensity x Owner-Mgr.</td>
<td>2.09***</td>
<td>1.39***</td>
</tr>
<tr>
<td></td>
<td>(0.66)</td>
<td>(0.54)</td>
</tr>
<tr>
<td>Exp. Wtd. Propensity x Owner-Mgr. w/ Reform</td>
<td>1.52***</td>
<td>1.17***</td>
</tr>
<tr>
<td></td>
<td>(0.51)</td>
<td>(0.54)</td>
</tr>
<tr>
<td>Exp. Wtd. Propensity x Professional Mgr.</td>
<td>2.94***</td>
<td>3.09***</td>
</tr>
<tr>
<td></td>
<td>(0.76)</td>
<td>(0.54)</td>
</tr>
<tr>
<td>Obs.</td>
<td>667</td>
<td>605</td>
</tr>
<tr>
<td>Psuedo R2</td>
<td>4.43%</td>
<td>0.87%</td>
</tr>
</tbody>
</table>

***, ** and * denote significance at the 99%, 95% and 90% levels of confidence, respectively.

The first two columns in Table 6 show estimates of a baseline model under each parameter set. The positive and highly significant intercept indicates significant reputation building behavior in the OM treatments. Consistent with our model’s prediction, adding reform significantly affects the propensities.
reduces reputable behavior under Parameter Set I, as indicated by significant negative coefficients on the dummy variable capturing owner-manager with reform treatments. Surprisingly, the introduction of reform also reduces reputable behavior on Parameter Set II, though the effect is only marginally significant. Also, consistent with our model’s predictions, there is no significant difference between the OM and PM treatments in fostering reputation. Men are somewhat more likely to form reputations under Parameter Set I.\textsuperscript{22}

The estimates using EWA models clearly show that operators are more likely to choose the reliable technology when this choice has led to higher payoffs in previous rounds. The Gross Profit EWA models and the Net Profit EWA models yield qualitatively similar results: Men are more likely to form reputations under Parameter Set I (and overall in unreported aggregate regressions). Under Parameter Set II (and overall), operators are less likely to form reputations in treatment PM-II than in treatment OM-II. However, the dominant factors influencing reputable behavior are payoffs from prior choices. Higher rewards for the reputable choice (the reliable technology) increase the probability of doing so in the future. Under both parameter sets, professional managers are more responsive to past profitability than owner-managers.

5.2 Consumer perceptions of firm reputation

The estimates in Table 6 indicate that operator behavior evolves based on past profitabilities of choices, which depends on goods’ prices. These prices reflect consumers’ choices and capture firms’ reputations with consumers. To provide deeper insights into our experimental outcomes, we examine goods’ prices and consumer choices.

Figure 2 shows both average limit prices set by consumers (bars) under each treatment, and the average actual values of the goods (circles) offered to consumers. Consumers generally under-price goods.\textsuperscript{23} First, compare prices in the experiments to equilibrium prices predicted by our model. In a reputation equilibrium, the period 1 good’s price should equal 1,000 francs. The experimental prices are well below this prediction. The OM treatments produce the highest average prices: 666 francs in OM-I and 661 francs in OM-II. In the mixed equilibrium supported by treatment OMR-I, the period 1 good’s equilibrium price is 835.3 francs. Once again, prices in the experiment are much lower, averaging only 539 francs. The prices consumers offer for goods are even markedly lower than the actual values of the goods on offer. The undervaluation of the good ranges from 154 francs in treatment PM-II to 59 in treatment OMR-I. The effect of this undervaluation of goods on lowering operators’ profits from using the reputation strategy can help explain the systematic deficiency in reputable behavior.

To examine the effect of the firm’s control structure and the option to reform on prices, we compare goods’ prices across treatments in Table 7. To limit confounding effects arising from subject learning which we will examine later, we focus on prices in the second half of.

\textsuperscript{22}In unreported regressions aggregating across treatments, men remain somewhat more likely to form reputation than women. Men (women) account for 50.36% (49.64%) of operator decisions for insecure firms. Interactions of gender, treatment and parameter set show no significant coefficients.

\textsuperscript{23}This accords with prior research in Noe et al. (2012).
the experiments.\textsuperscript{24} As in Figure 2, prices are systematically lower than their equilibrium values across all our treatments. For example, under Parameter Set I, the average price is only 716.7 francs in treatment OM and 666.4 francs in treatment PM compared with our model’s prediction of 1000 francs. Under Parameter Set II, contrary to our model’s predictions, the prices are even lower in the OM and PM treatments, though the drop is statistically significant only in the case of the PM treatment. The prices in treatments OMR-I and OMR-II are not statistically different.

Table 7: \textit{Consumer assessments of firm reputation}. In this table we present prices for goods in the second half of the experiment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Parameter Set I</th>
<th>Parameter Set II</th>
<th>Difference</th>
<th>t-Stat.</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM</td>
<td>716.73</td>
<td>668.27</td>
<td>-48.46</td>
<td>-1.24</td>
<td>0.22</td>
</tr>
<tr>
<td>OMR</td>
<td>554.75</td>
<td>601.66</td>
<td>46.91</td>
<td>1.07</td>
<td>0.29</td>
</tr>
<tr>
<td>PM</td>
<td>666.39</td>
<td>590.47</td>
<td>-75.92</td>
<td>-1.77</td>
<td>0.08</td>
</tr>
</tbody>
</table>

The effect of introducing the option to reform on goods’ prices is consistent with our

\textsuperscript{24}As with our operator analysis, using the entire data set leaves the results essentially unchanged.
model’s predictions. Under Parameter Set I, in treatment OMR-I, in which the owner can reform, we expect prices to be lower than in treatments OM-I and PM-I. Consistent with this prediction, the average price in OMR-I is 554.8 francs, which is statistically significantly lower than the average price of 716.7 francs in OM-I (t=3.87, p-value=0.00) as well as the average price of 666.4 francs in PM-I (t=2.62, p-value=0.01). Under Parameter Set II, we expect the good’s price to be the same regardless of the firm’s control structure and the availability of the option to reform. Consistent with this prediction, we find that goods’ prices in treatment OMR-II (601.7 francs) are not significantly different from prices in OM-II (668.3 francs) or PM-II (590.5 francs). Thus, it appears that consumers recognize the effect of firms’ ownership structures and the availability of the option to reform on the incentives for reputable behavior.

5.2.1 Evolution of Prices

A comparison of goods’ prices in Figure 2 and Table 7 indicates that average prices during the second half of sessions were higher than in the overall experiment. This difference is less marked in the treatments with the option to reform. The increase in prices is consistent with consumers increasingly recognizing the value of firm reputation.

Table 8 presents estimates of the effect of treatments, parameter sets and experience on prices. Once again, we account for experience using experience weighted attraction (EWA) models. We modify the experience models to account for the fact that the consumers’ strategy space is continuous. We define two measures of attraction: (1) average net profits, value less the purchase price paid (“Average Prior Net Profit Attraction”), and (2) the average of good values observed in prior rounds (“Average Prior Value Attraction”). The detailed definitions of these variables are provided by Appendix D.

In the baseline models, presented in the first two columns, we do not control for experience-based attraction. The statistically significant coefficients on the experience variable “Round Number” in these estimates indicate that prices increase between 5 francs to 8 francs with each round. These increases bring prices closer to their equilibrium values. Adding reform to the owner-manager treatment reduces prices under Parameter Set I by an economically meaningful and statistically significant 215.6 francs. Under Parameter Set II, the introduction of reform lowers prices by 98.5 francs but the effect is not statistically significant. Under both sets of parameters, the difference in prices between treatments OM and PM are not statistically significant. These effects of reform and control structure are consistent with our model’s predictions.

The estimates incorporating EWA models uniformly indicate that experience matters. For treatments using Parameter Set I, experience alone significantly raises prices, as shown by the significant positive coefficients on the variable “Round Number.” However, these changes are

25Because, in theory, prices directly convey probabilities of high quality items, we could construct a logistic version of this regression using OLS on the implied logistic variable defined as \( \ln\left(\frac{0/1000}{1000/1000}\right) \). However, if we do this, we lose 36% of the observations because subjects either set prices at 0 or 1000.
Table 8: Censored normal regressions explaining prices. Gender is a dummy variable equal to 1 if the subject is male. Round number is the number of rounds at that point in the experimental session. Owner-Mgr., Owner-Mgr. w/ Reform and Professional Mgr. are dummy variables for the control structure treatments. Attraction regressions include average values and average prior net profits in previous rounds. Robust standard errors clustered by subject appear in parentheses below each estimate.

<table>
<thead>
<tr>
<th>Parameter Set</th>
<th>Average Prior Net Profit Attraction</th>
<th>Average Prior Value Attraction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Constant</td>
<td>704.15***</td>
<td>759.76***</td>
</tr>
<tr>
<td></td>
<td>(112.30)</td>
<td>(100.35)</td>
</tr>
<tr>
<td>Gender (1=Male)</td>
<td>-48.07</td>
<td>-135.84</td>
</tr>
<tr>
<td></td>
<td>(83.45)</td>
<td>(83.84)</td>
</tr>
<tr>
<td>Round Number</td>
<td>8.02**</td>
<td>4.94*</td>
</tr>
<tr>
<td></td>
<td>(3.42)</td>
<td>(2.87)</td>
</tr>
<tr>
<td>Owner-Mgr. w/ Reform</td>
<td>-215.63**</td>
<td>-98.53</td>
</tr>
<tr>
<td></td>
<td>(105.40)</td>
<td>(111.94)</td>
</tr>
<tr>
<td>Professional Mgr.</td>
<td>-104.89</td>
<td>-143.75</td>
</tr>
<tr>
<td></td>
<td>(112.12)</td>
<td>(97.45)</td>
</tr>
<tr>
<td>Attraction x Owner-Mgr.</td>
<td>1.07***</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>(0.36)</td>
<td>(0.23)</td>
</tr>
<tr>
<td>Attraction x Owner-Mgr. w/ Reform</td>
<td>0.44***</td>
<td>0.64*</td>
</tr>
<tr>
<td></td>
<td>(0.14)</td>
<td>(0.37)</td>
</tr>
<tr>
<td>Attraction x Professional Mgr.</td>
<td>0.41*</td>
<td>0.49</td>
</tr>
<tr>
<td></td>
<td>(0.21)</td>
<td>(0.33)</td>
</tr>
<tr>
<td>Obs.</td>
<td>756</td>
<td>792</td>
</tr>
<tr>
<td>Left Censored</td>
<td>76</td>
<td>96</td>
</tr>
<tr>
<td>Right Censored</td>
<td>191</td>
<td>196</td>
</tr>
<tr>
<td>Pseudo R2</td>
<td>0.41%</td>
<td>0.29%</td>
</tr>
</tbody>
</table>

***, ** and * denote significance at the 99%, 95% and 90% levels of confidence, respectively.
dwarfed by the effect of past profits. Average Prior Net Profit has a uniformly large and positive effect on prices in all treatments under Parameter Set I. The effect remains positive but is only weakly significant (at best) in Parameter Set II. In contrast, Average Prior Values always has a large and statistically significant positive effect on prices in both parameter sets. The estimates range from 0.41 francs to 0.80 francs for a one franc increase in the goods’ average prior value under Parameter Set I and from 0.42 francs to 0.88 francs under Parameter Set II. Thus, in general, consumers markedly raised (lowered) their bid prices for goods after observing higher (lower) valued goods in the past. Our earlier evidence indicates that operators’ strategies evolve toward adoption of the reputation strategy, especially after experiencing higher profits. This tendency, when combined with the evolution of consumer strategies toward setting higher good prices suggests that the feedback between consumer and operators’ strategies tends to reduce both the systematic deficiency in reputable behavior as well as the substantial undervaluation of goods observed in the experiment.

6 Discussion

We extend a model of organizational reputation to incorporate two features. The first is an “oversight” system to prevent managerial opportunism. The oversight system allows the firm to form an organizational reputation based on evidence about the system’s effectiveness. This reputation is distinct from those of individuals who own or operate the firm. The second feature is the option to reform the oversight system and, potentially, replace it with a more effective system. This allows firms to repair damaged reputations and continue operating after reputation loss. In this context, we study two standard ownership/control structures: (1) owner operated firms and (2) firms that separate ownership and control. The latter structure is typical of a modern corporation with outside owners and professional management, creating well known agency problems.

We find that the control structure and the opportunity for oversight system reform interact in important ways. The control structure affects both (1) the relative sizes and (2) the costs and benefits of forming and maintaining reputations. Owner-management eliminates the agency conflict between owners and professional managers while allowing the owner to internalize all reputation costs and benefits. While professional management introduces an owner-manager agency conflict, the owner can incentivize the manager to form and maintain a reputation. This can allow professional management to maintain reputations even when owner management cannot.

Under either control structure, the opportunity to restore reputations through reform dilutes incentives to form and maintain reputations. However, the extent of the dilution varies with the control structure. When a firm reforms, owners always benefit because the firm can continue operating after its reputation is damaged. Professional managers do not benefit from reform

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26 Differences across treatments are generally not significant. Thus, we find no evidence that consumer responses to operator actions differ significantly across ownership/control structures and parameter sets.
because they are fired from firms following reputation damage. Thus, professional managers are less inclined to risk a reputation for short run gains than owner-managers. This makes it even more likely that professionally managed firms with outside owners will focus on creating and maintaining reputations.

We design and run an experiment to test these ideas. Similar to prior experiments on reputation, subjects under-invest in reputations. However, the data clearly show incentive effects of control structure and reform on outcomes. We vary both the control structure and reform option with the initial effectiveness of the oversight system. Changing each dimension generally moves the data in the directions predicted by our theory. In one critical treatment we both predict and observe significantly reduced reputation formation, product quality and prices when the option to reform is available.

Because the experimental outcomes do not immediately and exactly conform to theory, we also provide evidence on how reputations are likely to evolve when owner, manager and consumer behaviors differ from theory. We find that all parties learn from past outcomes. This process results in differences in data across treatments that converge toward differences predicted by theory. Thus, we conclude that the effects we predict are likely to predict tendencies in real world data.

References


