Governance, Reputation, Crises and Recovery: An Experiment

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Abstract

We model and experimentally test the relationship between firm governance and reputation. We also consider how corporate reform after reputation damage affects this relationship. Our model shows that conditions for establishing a reputation depend on whether control of firm operations is delegated to professional managers. Moreover, although the option to reform always dilutes firms' incentive to commit to reputable behavior, delegation ameliorates the dilution. We assess the external validity of our model through a laboratory experiment. The results of this experiment are directionally consistent with the model's predictions.

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The incentives of individuals not to milk the firm's reputation has not been clarified; it must be the case that somehow the incentives of the stock-holding layer trickles down through the rest of the hierarchy.

–Holmstrom and Tirole (1989)

1 Introduction

By some estimates, reputation accounts for more than 60% of a firm's value and is its most valuable asset (Gaines-Ross, 2008). Economists have argued that the desire to maintain a (good) reputation underpins a range of firm policies including responses to competitive threats, product quality, dividend payments, and the financing mix (e.g., Kreps and Wilson, 1982a; Milgrom and Roberts, 1982; John and Nachman, 1985; Diamond, 1989; Maksimovic and Titman, 1991; Mailath and Samuelson, 2001; Cripps et al., 2004). The models on which these arguments rest rely on the assumption that firms are "owner managed," i.e., owners control reputation management because they directly set the policies that impact a firm's reputation.[1] This assumption fits firms like Bechtel, Cargill, Comcast, or Tesla that are controlled by hands-on "mavericks," i.e., non-financial or inside blockholders (Amel-Zadeh et al., 2022).

Owner management clearly doesn't fit firms like Boeing, Kobe Steel and Wells Fargo, which have had their reputations damaged by policies set by professional managers. These firms, like the majority of large firms in the U.S. and overseas, have a very different governance structure: They are "professionally managed," i.e., reputation management is the purview of professional managers with small or negligible ownership stakes (McMillan, 2011; Economist Intelligence Unit, 2005). Ownership effectively resides with large institutional investors like BlackRock and Fidelity, referred to as "common" or "universal" owners, that hold substantial stakes in many firms and are not intimately involved in reputation management.

The extensive principal-agent literature suggests that delegating management to professionals can have a profound effect on firm behavior (e.g., Myerson, 1982; Shleifer and Vishny, 1997; Cole and Kocherlakota, 2001). This raises a long-standing question, whose importance is evidenced by the opening quotation: Do standard reputation models, which focus on the reputations of owner-managed firms, accurately describe reputations when its management is delegated to professionals?

In this paper, we provide a partial answer to this question by modeling reputation for professionally managed firms, comparing the results of this exercise with reputation for owner-managed firms, and testing for the robustness of our comparisons with a laboratory experiment. We make the comparison in a "no-reform setting" in which, as in classic reputation models, the revelation of opportunistic behavior permanently impairs future reputation. In our baseline setting firms "reform" to repair reputation damage much like real world firms do, as illustrated by the examples in

[1] More generally, reputation models have been employed to model the actions of economic agents in incomplete information settings by many authors (e.g., Mailath and Samuelson, 2001; Cripps et al., 2004; Liu, 2011; Cremer, 1986; Tirole, 1996; Morrison and Wilhelm, 2004; Levin and Tadelis, 2005). See Bar-Isaac and Tadelis (2008) for a survey of reputation models. The framework has also been deployed to examine the sustainability of pro-social behavior (e.g., Bénabou and Tirole, 2006), which is consistent with a broader definition of quality in our model and experiment.

Table 1 (Farber, 2005; Gaines-Ross, 2008; Chakravarthy et al., 2014; Economist, 2018).[2] Some of the examples are of owner-managed firms (e.g., Thernos and Benetton), and some are of professionally-managed firms with dispersed ownership (e.g., Mattel and Wells-Fargo). While this list is not exhaustive, the descriptions of reform are not complete, and the governance structures of all the firms do not fit our model exactly, the examples underline our motivation for considering a setting with reform.[3]

Our model shows that owners face very different incentives than professional managers when managing reputations. Customers recognize the implications of these incentive differences for the goods firms produce, so the price for a firm's goods depends on its governance structure. Importantly, in our model, professional management creates stronger incentives to support firm reputation in low trust environments, particularly when reform is possible. Thus, in these environments goods from professionally-managed firms command higher prices and these firms are more profitable. Our experiment confirms that (a) delegation to professional managers fundamentally changes the conditions under which firms act reputably and is better able to support firm reputation in low trust environments; (b) good's prices vary with governance structure in the way our model predicts, and (c) the presence of an opportunity to reform dilutes the ex ante incentive to act reputably.

In our model, we adopt the incomplete-information reputation framework developed by Kreps and Wilson (1982a) and Milgrom and Roberts (1982) (henceforth KWMR) and frequently employed in experiments (e.g., Camerer and Weigelt, 1988; Neral and Ochs, 1992; Brandts and Figueras, 2003; Noe et al., 2012). We consider a firm whose value depends on its reputation with customers for producing high quality goods.[4] An operator picks the firm's operating policies. The operator may be a "committed type" who, like the "tough monopolist" type in Kreps and Wilson (1982a) or the "honest firm" type in Maksimovic and Titman (1991), always picks a "reputable" policy that always results in high quality goods.[5] If the operator is not the committed type, instead of always picking the reputable policy,

[2] For example, the New York Times (Nov. 10, 2017) describes Kobe Steel's reform as follows: *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.*

[3] Some firms in the table are neither owner managed nor professionally managed. For example, Kobe, Takata and Toyota are parts of keiretsus. Volkswagen has a particularly complex ownership structure. Effective voting control is owned by Porsche Automobil (in turn, owned entirely by the Porsche and Piech families). The State of Lower Saxony has a significant stake and Volkswagen is partially publicly traded.

[4] The features that determine "quality" depends on the firm's circumstances. For example, if the customers are other firms, the features could be the adherence to these firms' supplier codes of conduct. Alternatively, if the customers are retail consumers, the features might also include sustainable production practices or the goods' carbon footprint.

[5] The "committed type" is a feature of the KWMR framework that delivers analytical convenience and sharp results (Kreps, 1996). It is motivated by the possibility that, as real-world firms often publicly assert, some real-world firms may in fact be committed to only implementing reputable policies. The commitment can stem from operators' intrinsic motivations or social/corporate norms (e.g., Kreps, 1996; Bénabou and Tirole, 2006). Firms often point to some aspect of their culture or internal control systems, the sorts of systems that they overhaul when they reform, to support their assertions that they are committed to acting reputably. For example, Toyota publicized its "Toyota Way" corporate culture to underline its commitment to high quality (Liker, 2004). A lack of commitment to high quality is often revealed by evidence of low quality, and judging by the extensive value losses firms experience in these instances, preserving the perception that there is even a small probability that a firm is committed to reputable

Table 1. *Examples of reform to repair reputation damage.*

Year	Company	Event	Response
2006-2008	Siemens	Corruption	Set up anticorruption task force. Created rules and compliance processes, training programs, disciplinary actions, terminated employees.
2007	Mattel	Lead paint on toys.	Recalled toys. Created new testing procedures. Changed suppliers. Put Mattel personnel in supplier's factories.
2007	RC2	Lead paint on toys.	Recalled toys (initially at owners' shipping expense). Takara Tomy purchased RC2 in April, 2011.
2009-2010	Toyota	Acceleration problems.	Recalled and redesigned systems. Developed the "Toyota Way." Restructured oversight under "Customer First Committee."
2009-2016	Takata Air Bags	Manipulated test data on air-bag inflators.	NHTSA ordered revision of production and quality control procedures. NHTSA fined Takata for inadequate response. Takata filed for bankruptcy on 6/26/17.
2012	JP Morgan	"London Whale."	Overhauled risk metrics. Replaced personnel. Dismantled trading arm that caused the problem.
2012	Barclays	Manipulated LIBOR rates.	Created new "Brand and Reputation Committee." Replaced CEO. Adopted "zero tolerance" policy.
2013	Lululemon	"Too sheer" yoga pants.	Created new factory oversight system and new organizational structure. Replaced CEO.
2015	Volkswagen	Faked emission test results.	Replaced CEO. Suspended some employees. Recalled cars. Refocused on electric and hybrid vehicles. Compensated owners. Regulators signed off on software updates.
2015-2018	Theranos	Falsified medical testing ability.	Theranos denied allegations. Partners stopped using Theranos. SEC charged Thernos with Fraud, removed CEO, and barred her from serving as an officer or director of public companies. Theranos closed 9/5/2018.
2016	Wells Fargo	Fake accounts.	Fined by regulators. Terminated employees, ended sales goals, restructured sales practices, replaced CEO and other management. New CEO resigned in April 2019.
2017	Kobe Steel	Falsified quality data.	Changed quality control processes and reporting procedures. Established an Independent Investigation Committee, a Quality Governance Restructuring Deliberation Committee and a Quality Management Department.
2018	Benetton / Autostrade	Failure to maintain bridge resulting in collapse and killing 43 people.	Italy nationalized some toll road and bridge concessions and restructured others held by Autostrade. CEO of subsidiary later fired.

the operator can opportunistically adopt a cheaper operating policy, that sometimes results in low-quality goods, and internalize the cost savings.

Outsiders, including customers, do not know the operator's type and learn about the operator's commitment by observing the quality of the firm's goods. Outsiders' initial beliefs about the operator's type reflect their "base level of trust" in the firm's commitment to the reputable policy. The production of a low-quality good results in reputation damage, which we refer to as "revelation" because it reveals an absence of commitment to quality. Successful reform completely blocks operator opportunism and ensures high quality goods in the future. While reform can restore some outsider trust in the firm's commitment to the reputable policy, it is costly and its success is uncertain.

Under owner management, as is typical in the KWMR framework, ex ante, the operator is the owner and would like to commit to reputation-ensuring policies. However, the operating policies that affect the firm's reputation are set ex post. When setting these policies, ensuring the reputation is only optimal for an uncommitted operator when the benefits of current opportunism are less than the expected future cost of reduced goods' prices following revelation. Price reductions are larger when the base level of trust is larger. Hence, a high base level of trust encourages the owner operator to eschew opportunism.

Under professional management, the owner faces a very different problem. Like the principal in a typical principal-agent model, the owner, who is an outsider, can only influence operating policies indirectly via the terms of the professional operator's compensation. To maintain the firm's reputation, the owner must bear the cost of incentivizing the operator to eschew opportunism. When the operator is committed, the operator will choose reputation-ensuring safe policies even without costly compensation. Thus, the owner's gain from providing costly incentives is low when the base level of trust is high. Hence, a low base level of trust encourages owners to ensure reputable behavior and protect the firm's reputation through compensation.

Reform decreases the anticipated cost of opportunism under both ownership structures, and weakens the owner's ex ante incentive to prevent/eschew opportunism. However, the ex ante incentive effect varies across the ownership structures. Under owner management, because firm value flows entirely to the owner, the owner internalizes both the cost of revelation and the benefits of reform. Under professional management, the owner ties operator compensation to goods' prices, which reflect goods' quality via rational expectations. Because the professional operator is replaced when prices reveal that customers expect only low-quality goods, the operator manager will not internalize the gains from reform. Consequently, delegating to a professional separates the agent whose actions affect reputation from the benefits of corporate reform. Since these benefits reduce the cost of opportunism, delegation can mitigate the pernicious ex ante effects of corporate reform and promote commitment to reputation assuring policies.

All agents in our model are rational. They clearly distinguish any difference, however subtle, in the incentives for opportunism under the two governance structures. All agents also accurately infer the ex ante incentive effects

policies is valuable (Peltzman, 1981; Jarrell and Peltzman, 1985; Barber and Darrough, 1996; Karpoff and Lott, 1993; Alexander, 1999; Murphy et al., 2009; Karpoff et al., 2008; Karpoff, 2011).

of reform. Moreover, the incentive for the owner to commit the firm to non-opportunistic ex post behavior arises because the firm's actions, including opportunism, induce price responses from customers that are based on their rational assessments of the future quality of goods based on observed outcomes. It is unclear whether this level of rationality describes real-world behavior. In fact, considerable evidence suggests that actual agents frequently forecast future events using behavioral backward-looking adaptive expectations (e.g., Camerer and Weigelt, 1988; Brandts and Figueras, 2003). This evidence raises the question of external validity: does the model capture significant features of firm reputation in the real world?

Answering the external validity question with field data requires measuring firm policies, customer expectations, managerial commitment, and outsider trust, which is difficult, if not impossible, and, in addition, tackling thorny issues related to endogeneity.[6] However, we can accurately make these measurements in a laboratory setting while controlling confounding factors. Further, in the laboratory, we can set governance policy (e.g., managerial contracts) and reform to match our model. Then, we can explore whether operating decisions and customer behavior respond as predicted to ownership structure and reform, and isolate behavioral biases in customer beliefs and manager behavior. Therefore, we conduct a laboratory experiment and test whether (i) ownership structure affects opportunism; (ii) reform weakens the ex ante incentive to prevent opportunism; (iii) customers recognize how ownership structure affects opportunism; and (iv) whether customer responses create incentives for reputable behavior like those in our model.

Like prior reputation experiments using the KWMR framework, we find that subject behavior deviates from rational-expectations predictions. Experience weighted attraction models similar to Erev and Roth (1998) and Camerer et al. (2002) explain how subject behavior evolves with experience.[7] Despite the deviations from predicted behavior, we find that (i) reputable firm actions are commonly observed; (iii) customers anticipate firms actions reasonably well; (iii) customers punish firms when opportunism is revealed; and (iv) reform raises the likelihood that firms will act opportunistically. The important insights of our model survive the behavioral deviations: When the model predicts that the likelihood of reputable actions is lower under owner management, owner management actually does result in significantly more opportunism. Moreover, when the model predicts ownership structure will not affect the level of reputable actions, there are not significant differences between opportunism levels under owner and professional management.

[6] Governance structures vary across firms, industries, and countries, and are not randomly assigned. The structures may be chosen for their reputational effects, but myriad other factors also matter. While some of these factors may be observable, others, such as the managerial human capital of owners, may not. Econometric fixes may not resolve ownership structure endogeneity (Coles et al., 2012).

[7] Such adaptive learning is commonly observed in experimental settings (e.g., Part 4.3 in Plott, 1982).

Related literature

Our model of owner management closely matches the KWMR framework on which much research on reputation is based, including many models linking the quality of goods with firm reputation,[8] and models of the sustainability of pro-social behavior (e.g., Bénabou and Tirole, 2006), which is consistent with our broader definition of quality. Our experimental implementation of owner management also closely matches experiments using the KWMR framework (e.g., Camerer and Weigelt, 1988; Neral and Ochs, 1992; Brandts and Figueras, 2003; Noe et al., 2012).[9]

Our model of professional management represents a fundamental departure. First, the firm's rents from reputation are owned by uninformed outsiders who can only use governance policy to indirectly affect the informed insider's actions, which do directly determine the firm's reputation. Second, the insiders have no personal reputation, no ownership claim to the rents produced by firm reputation, and can be costlessly replaced at any time. These model features reflect principal-agent models in which an uninformed principal (outside owner) sets policies to incentivize an informed agent (professional manager) to maximize the principal's welfare (e.g., Myerson, 1982; Shleifer and Vishny, 1997; Cole and Kocherlakota, 2001). However, in contrast to typical principal-agent models, the effects of the agent's actions are not exogenously specified. Rather, as in typical reputation models, the effects are produced by the behavior of outsiders (customers) who have incomplete information about the firm. Our model and experiment show that incorporating this principal-agent problem into a reputation framework fundamentally changes the calculus of reputation.

2 The model

We model a firm that operates for two periods.[10] Agents are risk-neutral and patient. The firm has an owner and an operator. At the start of each period, the owner supplies capital, denoted by $e > 0$, to an operator who uses the capital to produce a good. The good is sold to customers for the numeraire good, cash. There is no storage technology, thus cash and any good produced in a period must be consumed during the period.

Quality A good's quality, denoted by q_t in period $t = 1,2$, is either high, h, or low, l. All agents observe q_t only at the end of period t. Hence, the quality of a good produced in period t, the period t good, is common knowledge at the end of period t. Quality is neither verifiable nor contractible.

Prices Customers assign value $v_t = 1$ to a quality h good and $v_t = 0$ to a quality l good in period $t = 1,2$. They set the period t good's price, $p_t \in \mathbb{R}_+$, at the beginning of the period. The price equals customers' expectation of the

[8]See, for example, Maksimovic and Titman (1991); Mailath and Samuelson (2001); Cripps et al. (2004); Liu (2011); Cremer (1986); Tirole (1996); Morrison and Wilhelm (2004); Levin and Tadelis (2005).

[9]In these experiments, reputations and trust arise from supposedly "rational" behaviors. This contrasts with experimental "trust games" where behavior is not explained by self-interested rational choice of (e.g., Berg et al., 1995).

[10]As shown by Noe et al. (2024), in settings like the ones we consider, increasing the number of periods, by increasing the potential expected loss from opportunistic behavior, can make it easier to sustain equilibria in which firms produce high-quality goods due to reputational concerns.

good's value. Goods' prices are verifiable and contractible.

Operating policy In period $t = 1,2$, the operator sets an operating policy, o_t. The policy is hidden from all other agents, whom we refer to as "outsiders." There are two possibilities: "safe," denoted by s, and "mixed," denoted by m. Policy s costs e to implement and always produces a high-quality good. Policy m costs $e-c$, where $c \in (0,e)$. If the operator chooses policy m in period t, it triggers a draw by nature from a Bernoulli distribution, $\tilde{n}_t$, that determines the period t good's quality. With probability δ, $\tilde{n}_t = 1$ and $q_t = h$; with probability $1-\delta$, $\tilde{n}_t = 0$ and $q_t = l$. Draws $\tilde{n}_1$ and $\tilde{n}_2$ are independent.

We impose the following restriction on the mixed technology, which ensures that, the firm cannot operate profitably if customers are certain that the operator will set policy m.

Assumption 1 $\delta < e$.

Operator type There are two types of operators: "committed" and "normal." A committed operator is non-strategic and always sets policy s. A normal operator chooses strategically between acting reputably and setting policy s, and acting opportunistically by setting policy m and consuming the cost savings.[11] Operator type is the operator's private information. Outsiders assign prior probability $\rho \in (0,1)$ to the operator being committed. Thus, ρ measures outsiders' base level of trust in the firm's commitment to high quality and policy s.

Revelation Only a normal operator can produce a low quality good, and we will refer to the operator as being "revealed" (to outsiders) if $q_1 = l$. The operator remains "unrevealed" otherwise.

Reform If the operator is revealed, the firm reforms at the start of period 2. Reform imposes a cost on the owner equal to R and is publicly observable. Reform is an attempt to make the operator in period 2 commit to the safe operating policy s. The period 2 operator behaves like a committed type if and only if reform succeeds. Reform succeeds with probability r and fails with probability $1-r$. Only the period 2 operator observes whether reform succeeds.

We impose the following restriction on the effectiveness of reform, which ensures that, after the firm produces low quality goods, reform cannot completely restore customers' trust in the firm's commitment to high quality.

Assumption 2 $0 < r < \rho$.

Payment structure Each period the operator receives a payment, i.e., cash, from the firm that depends on a "payment structure." Under a payment structure, the operator in period 2 receives a period 2 payment, ϕ_2, that depends on the period 2 good's price and whether the operator was revealed, i.e., $\phi_2 : [0,1] \times \{h,l\} \to \mathbb{R}_+$. In period 1, the operator's payment, ϕ_1, depends on the period 1 good's price, i.e., $\phi_1 : [0,1] \to \mathbb{R}_+$. The payment structure ultimately depends on the firm's governance structure in a fashion that we will describe later. At the time that the operator makes operating

[11] We tie the adoption of opportunistic policies to the operator's type to simplify the model. We will obtain identical equilibrium outcomes if we tie the operator's ability to act opportunistically to a firm monitoring system. In fact, a large literature models monitoring systems that increase the costs of opportunism (Johnson et al., 2000; Shleifer and Wolfenzon, 2002)

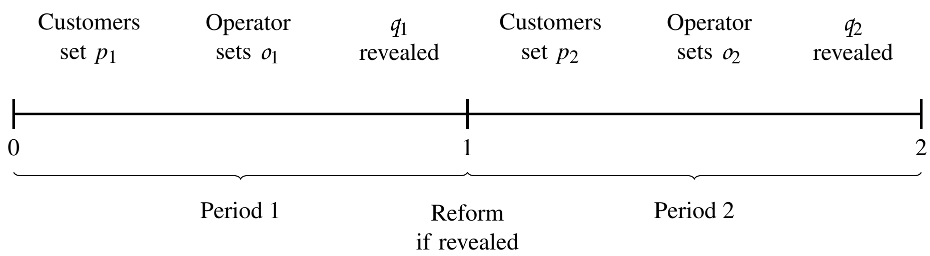


Figure 1. *Timeline.* This figure shows the sequence of events in the game.

decisions, how the payment structure originated has no effect on the operator's welfare and thus on the operator's best replies.

We denote a normal operator's period 2 payoff which, in addition to the payment from the firm, also reflects the period 2 policy choice and any resulting cost savings, by

$$v_2^{\mathrm{o}}(o_2, q_1) = \begin{cases} \phi_2(p_2, q_1) & o_2 = s, \\ \phi_2(p_2, q_1) + c & o_2 = m. \end{cases} \tag{1}$$

We denote the expected payoff to a normal period 1 operator by

$$v_1^{\mathrm{o}}(o_1) = \phi_1(p_1) + \begin{cases} v_2^{\mathrm{o}}(o_2, h) & o_1 = s. \\ c + \delta\, v_2^{\mathrm{o}}(o_2, h) + (1-\delta)\Big(r\, v_2^{\mathrm{o}}(s, l) + (1-r) v_2^{\mathrm{o}}(o_2, l)\Big) & o_1 = m, \end{cases} \tag{2}$$

We denote the operator's payment structure by the pair $\phi \equiv (\phi_1, \phi_2)$, and represent the set of payment structures with Φ.

Operator replacement In one setting we consider the operator from period 1 continues to operate the firm in period 2 whether or not the firm reforms. In this setting, the payment structure is what we have just described. We also consider a setting in which the operator is replaced if and only if the firm reforms, and all agents know this. The following aspects of reform are also common knowledge in this setting: The replacement is a normal type, whose characteristics and preferences are the same as the period 1 normal operator's. The replacement behaves like a committed type if and only if reform succeeds.

In the setting in which the period 1 operator is replaced after reform, the replaced operator receives no payment, i.e., $\phi_2(p_2, l) := 0$, and no longer controls operating policy so the replaced operator's period 2 payoff is zero, i.e., $v_2^{\mathrm{o}}(o_2, l) := 0$ for the replaced operator. As will be apparent later, because the period 2 goods' price depends on operator actions in period 1 but not actions in period 2, the replacement operator receives no payment, i.e., $\phi_2(p_2, q_1) := 0$ for the replacement operator.

Normal operator history and strategy Before setting the operating policy in period 1, the operator observes the payment structure and the period 1 good's price. In period 2, the operator has also observed o_1, q_1, and p_2. Since the policy-realized quality pair (s,l) is impossible when $o_t = s$, we can denote a normal operator's period t history by $h_t^o \in \mathcal{H}_t^o$, $t = 1,2$, where

$$\begin{aligned} \mathcal{H}_1^o &:= \Phi \times \mathbb{R}_+, \\ \mathcal{H}_2^o &:= \mathcal{H}_1^o \times (\{s,m\} \times \{h,l\}) \backslash \{(s,l)\}) \times \mathbb{R}_+. \end{aligned} \tag{3}$$

Each period, the normal operator maximizes the expected payoff under the payment structure. A normal operator's strategy, is an ordered pair $o := (o_1, o_2)$, where $o_t : \mathcal{H}_t^o \to \{s,m\}$, $t = 1,2$.

Customers' history and goods' prices Before the period 1 good's price is set, outsiders observe the payment structure. At the end of period 1 outsiders observe the quality of the period 1 good and whether the firm reforms. Thus, we can represent customers' histories at the start of each period, when they set prices, by $h_t^c \in \mathcal{H}_t^c$, $t = 1,2$, where

$$\begin{aligned} \mathcal{H}_1^c &:= \Phi, \\ \mathcal{H}_2^c &:= \mathcal{H}_1^c \times \{h,l\}. \end{aligned} \tag{4}$$

Let $P = (P_1, P_2)$ represent the vector of pricing functions, where $P_t : \mathcal{H}_2^c \to [0,1]$, $t = 1,2$. Prices also depend on customers' belief about the operator's type and, in period 2, their belief about the success of reform. We denote these beliefs by μ_t, where $\mu_t : \mathcal{H}_t^c \to [0,1]$, $t = 1,2$.

Definition 1 [Equilibrium] Let SE(ϕ) represent the set of sequential equilibria (Kreps and Wilson, 1982b) in the subgame rooted in payment structure ϕ, i.e., the set of ordered triples (P^*, o^*, μ^*) that satisfy, under payment structure ϕ, the following conditions for being a pure-strategy sequential equilibrium:

(a) Pricing condition: $P^*(h_t^c) = \mathbb{E}[\tilde{v}_t | h_t^c]$, for all $h_t^c \in \mathcal{H}_t^c$, $t = 1,2$.

(b) Operator sequential rationality: $o_t^*(h_t^o)$ is a best response for the operator for all $h_t^o \in \mathcal{H}_t^o$, $t = 1,2$.

(c) Belief consistency: Customer beliefs, μ^*, are determined by Bayes rule for all histories reached on the equilibrium path. For histories off the equilibrium path, beliefs must be the limit of some sequence of purely mixed normal operator strategies that reach the history.

As we will soon show, in an equilibrium, only in period 1 will the normal operator choose policy s. We will refer to equilibria in which the operator acts in this way as "reputation equilibria." We will refer to all other equilibria as "no-reputation equilibria."

Definition 2 [Reputation equilibria] For a given payment structure $\phi \in \Phi$, a *reputation equilibrium* is an equilibrium in which $\tilde{q}_1^* = h$ with probability 1; a *no-reputation equilibrium* is an equilibrium in which $\tilde{q}_1^* \neq h$ with positive probability.

3 Preliminary results

We will start with some results that greatly simplify our analysis of governance structures and firm reputation. All derivations not in the body of the paper are provided in Appendix A.

Because a good's price reflects only its expected quality and the operator's actions are unobservable, operating policy in the current period has no effect on the payment received by the operator in the current period. In period 2 there are no future periods, so the only effect of choosing the mixed policy, m, over the safe policy, s, is that the operator captures the cost saving, c. Thus, a normal operator will always act opportunistically in period 2, i.e., choose policy $o_2 = m$.

Lemma 1 *In all equilibria, the normal operator will select policy m in period 2, i.e, in all equilibria, $o_2^*(h_2^o) = m$, for all $h_2^o \in \mathcal{H}_2^o$. In fact, m is the strictly dominant strategy at all period 2 operator histories.*

Lemma 1 implies that the period 2 good's equilibrium price is a "floor" price that reflects the expectation that the normal type operator will act opportunistically. If outsiders learn nothing about the operator's type in period 1, they will continue to believe that the operator is the committed type with probability ρ. We denote the resulting period 2 floor price by F_ρ, where

$$F_\rho := \rho + \delta(1-\rho). \tag{5}$$

If the firm is revealed, outsiders know that the period 1 operator is the normal type and, after reform, they will believe that the operator is the committed type with probability r. We will denote the resulting period 2 floor price by F_r, where

$$F_r := r + \delta(1-r). \tag{6}$$

In a reputation equilibrium outsiders will expect the operator to set the operating policy s in period 1. Thus, if the period 1 good's quality $q_1 = h$ outsiders will not learn anything about the operator's type, and the period 2 good's price will equal F_ρ. If $q_1 = l$, which is off the equilibrium path, the firm will reform and the period 2 good's price will equal F_r. Consequently, when picking operating policy o_1, the operator must trade off the immediate gain from opportunism, c, against the cost of revelation, which will depend on the payments $\phi_2(F_\rho, h)$ and $\phi_2(F_r, l)$. The following result describes conditions under which the operator will set $o_1 = s$ in equilibrium.

Lemma 2 *(a) In a setting in which the operator remains with the firm after reform, a reputation equilibrium exists if and only if*

$$(1-\delta)\big(\phi_2(F_\rho, h) - \phi_2(F_r, l)\big) \geq c\,(1-(1-\delta)r).$$

(b) In a setting in which the operator is replaced after reform, a reputation equilibrium exists if and only if

$$(1-\delta)\phi_2(F_\rho, h) \geq \delta\, c.$$

(c) *Every equilibrium is a reputation equilibrium if the applicable condition* (a) *or* (b) *is satisfied and the inequality is strict or if* ϕ_2 *is a strictly increasing function of the period 2 good's price,* p_2*.*

(d) *In a reputation equilibrium, good's prices are* $P_1^*(h_1^c) = 1$, $P_2^*(h_1^c, h) = F_\rho$, $P_2^*(h_1^c, l) = F_r$ *for all* $h_1^o \in \mathcal{H}_1^o$*, and operator strategies are* $o_1^*(h_1^o) = s$*, for all* $h_1^o \in \mathcal{H}_1^o$*, and* $o_2^*(h_1^o) = m$*, for all* $h_2^o \in \mathcal{H}_2^o$*.*

Lemma 2 shows that reputation equilibria exist when the normal operator expects revelation to trigger a sufficiently large penalty. If the operator expects to remain with the firm after revelation, the penalty is proportional to $\phi_2(F_\rho, h) - \phi_2(F_r, l)$. For reputation equilibria to exist this difference should be large relative to the operator's anticipated gain from opportunistically choosing $o_1 = m$ instead of $o_1 = s$, which equals c in period 1 less $c(1-\delta)r$ in period 2 because successful reform blocks period 2 opportunism. If the operator expects to be replaced following reform, the operator anticipates both a larger penalty from revelation, $\phi_2(F_\rho, h) - 0$, and a smaller gain from opportunistically choosing $o_1 = m$, $c(1-(1-\delta))$. Thus, it is easier to satisfy condition (b) in Lemma 2 than condition (a).

4 Reputation equilibria, governance structures and reform

We want to examine whether a firm's ability to sustain its reputation is different under professional management than it is under owner management, the governance structure typically employed in reputation models. We will start by describing the payment structure and operator replacement under professional management and derive conditions for reputation equilibria under it. Then we will turn to owner management. We will end the section by examining how reform, another unique feature of our model, affects conditions for reputation equilibria under both professional and owner management.

4.1 Reputation equilibria under professional management

Under professional management, the owner and operator are different agents. The payment structure is codified in a compensation contract for the professional operator. The owner, who is an outsider and is entitled to the firm's profits, chooses the compensation contract before the period 1 good's price is set.

The professional operator has no natural claim on the benefit of reform. Lemma 2 shows that it is easier to satisfy the conditions for a reputation equilibrium if the operator is replaced when the firm reforms. It also shows that, if a revealed operator is replaced, only the period 2 payment contingent on the operator remaining unrevealed matters for the period 1 operating policy choice. Thus, to keep the analysis of professional management simple and transparent, we assume that the owner replaces the professional operator if and only if the firm reforms, and the operator receives no payment in period 1, i.e., $\phi_1(p_1) = 0$ for all p_1. Moreover, as we have described previously, the replaced operator's period 2 payment and payoff are both zero, and the replacement operator receives no period 2 payment, i.e., $\phi_2(p_2, l) := 0$ and $v_2^o(o_2, l) := 0$ for the replaced operator, and $\phi_2(p_2, q_1) := 0$ for the replacement.

Only if the (period 1) operator remains unrevealed does the operator receive a payment in period 2. We define this payment as $\phi_2(p_2,h) := g(p_2)$, where $g : [0,1] \to \mathbb{R}_+$. We refer to $g(p_2)$ as the firm's *governance policy*, and this policy can be interpreted as a bonus payment tied to the period 2 good's price that is paid if and only if the operator is unrevealed. Note that the governance policy, g, combined with the payment restrictions following revelation completely describe the payment structure, ϕ, under professional management.

We assume that governance policies, g, are weakly increasing in the period 2 price. Thus, the set of feasible governance policies, denoted by $\mathcal{G}$, is the set of weakly increasing functions mapping the period 2 good's price into the non-negative real numbers. Governance policies must ensure that the professional operator's participation constraint is satisfied. We assume that the reservation payoff for operators is zero. Thus, the binding constraint on the design of governance policy is the operator's incentive constraint.[12]

The firm's owner, in each period, receives the firm's profit net of the operator payment. Thus, at the start of period 1, the owner's expected payoff $v^{\text{PM}}(g,P,o)$ is given by

$$v^{\text{PM}}(g,P,o) = p_1 - e + \begin{cases} p_2 - e - g(p_2) & o_1 = s. \\ (\rho + (1-\rho)\delta)\Big(p_2 - e - g(p_2)\Big) + (1-\rho)(1-\delta)\Big(p_2 - e - R\Big) & o_1 = m, \end{cases} \tag{7}$$

For any payment structure, ϕ, Definition 1 describes the set of sequential equilibria. Thus, we define a *g-subgame equilibrium* as a sequential equilibrium for the payment structure g. Because the owner chooses governance policy to maximize the payoff in expression (7), we define governance optimality as follows:

Definition 3 [Governance optimality] A governance policy g^* is optimal if g^* maximizes the owner welfare over all *g-subgame equilibria* of all feasible governance policies $g \in \mathcal{G}$.

To account for owner control of governance policy we define a *reputation equilibria under professional management* as a reputation equilibrium in which the governance policy is optimal. More formally, a reputation equilibrium under owner management is a 4-tuple (g^*, P^*, o^*, μ^*), where (P^*, o^*, μ^*) satisfies Definitions 1 and 2, and g^* satisfies governance optimality (Definition 3).

The owner's welfare depends both on the operator's actions and the cost of the governance policy, i.e., expected compensation payments to the operator. Thus, across all governance policies that engender the same operator equilibrium behavior, the owner's welfare is maximized by minimizing expected compensation. The cost minimizing governance policy that ensures $o_1 = s$ makes the smallest operator payment that satisfies condition (b) in Lemma 2. If

[12]If an operator's reservation value were positive, the operator's reservation constraint might be the binding constraint and the firm's owner could ensure high-quality output in the first period without conceding rents to the operator. Because conceding rents to the operator is the only thing deterring the owner from offering compensation that will ensure the operator behaves reputably, a positive reservation payoff would never discourage and sometimes encourage the owner to adopt such reputation ensuring compensation. Thus, the zero reservation assumption, militates *against* reputation equilibria under professional management and thus against the superiority of professional management relative to owner management with respect to assuring reputation.

follows immediately from parts (b) and (d) of Lemma 2 that the optimal payment conditioned on the period 2 price $p_2 = F_\rho$ is b^*, where

$$g(F_\rho) = b^* := c\,\frac{\delta}{1-\delta}, \tag{8}$$

Many governance policies can deliver this payment. For example, the equity contract: $g(p_2) := \frac{b^*}{F_\rho}\,p_2$. We will refer to a governance policy that satisfies (8) as a *reputation-assuring governance policy*.

If the owner doesn't choose a policy that satisfies condition (b) in Lemma 2, the operator will pick policy m in period 1. Let g_0, denote the governance policy with $g(p_2) = 0$, for all p_2. The only subgame sequential equilibria following g_0 is the no-reputation equilibrium. Obviously, this governance policy minimizes expected operator compensation. Other governance policies also induce the operator to pick $o_1 = m$ and make no payments to the operator, e.g., $g(p_2) = \max[p_2 - 1, 0]$. We call a governance policy that provides no compensation to the operator along the equilibrium path a *no expected compensation policy*.

All reputation-assuring governance policies are payoff equivalent, i.e., the payoffs to the operator and the owner along the equilibrium path are the same. Let $\pi_1 = 1 - e$ denote the period 1 profit if the good's price is 1. Then, under all reputation-assuring governance policies, the owner's expected payoff is

$$\pi_1 + \left(F_\rho - e - b^*\right). \tag{9}$$

Under a no expected compensation policy, the operator will pick policy m in period 1, so the operator will remain unrevealed with probability δ. In this case, by Bayes rule, the period 2 floor price will equal

$$F_2 := 1 \times \frac{\rho}{\rho + \delta\,(1-\rho)} + \delta \times \left(1 - \frac{\rho}{\rho + \delta\,(1-\rho)}\right). \tag{10}$$

Thus, under all no expected compensation policies, all equilibria are no-reputation equilibria, and the owner's expected payoff is

$$F_\rho - e + \left(1 - F_\rho\right)\,\pi_r + F_\rho\,\left(F_2 - e\right), \tag{11}$$

where $\pi_r = F_r - e - R$ denotes the period 2 profit if the firm is reformed.

In equilibrium the governance policy will maximize the owner's welfare. A comparison of the expected payoffs described in expressions (9) and (11) provides conditions for the existence and uniqueness of reputation equilibria under professional management, which we describe in the following proposition.

Proposition 1 *Under professional management: (a) If*

$$\rho \le 1 - \frac{b^*}{\delta + \pi_1 - \pi_r} \times \frac{1}{1-\delta}, \tag{12}$$

then a reputation equilibrium exists, and (b) if the inequality in condition (12) *is strictly satisfied, (i) All equilibria are reputation equilibria and, (ii) if g^* is also strictly increasing, then all g^*-subgame equilibria of any governance optimal policy are reputation equilibria.*

Part a and b.i show that, under professional management, satisfaction of equation (12) is sufficient to ensure that reputation equilibria exist (part (a)) and its strict satisfaction is sufficient to ensure that all equilibria are reputation equilibria (part b.i). Part b.ii shows that, when the hypothesis of part b.i is satisfied and g^* is any strictly increasing optimal governance policy, all g^*-subgame equilibria are reputation equilibria.[13] Making g^* strictly increasing has no cost to the owner because the only p_2 price on the equilibrium path in a reputation equilibrium is F_ρ, so only the payment to the manager when $p_2 = F_\rho$, i.e., b^*, affects the owner's payoff. However, a strictly increasing governance policy, g^*, does ensure that no-reputation g^*-subgame equilibria do not exist.

Interpreting Proposition 1 is straightforward: reputation-assuring compensation yields two benefits. First, it eliminates the possibility of revelation. This results in a direct gain to the owner that is inversely related to the profit after reform, π_r. Hence, low values of the profit after reform favor reputation equilibria. Second, reputation-assuring compensation has an informational effect: when consumers observe such compensation in period one, consumers rationally infer that the operator will choose policy s and thus the good's period-one price equals one, and the firm's period-one profit equals $\pi_1 := 1 - e$. If the owner opts for a no expected compensation policy, consumers rationally infer that the normal operator will choose policy m and thus the period-one good's price equals F_ρ and period-one profit equals $F_\rho - e$. Thus, the period-one gain from paying reputation assuring compensation is inversely related to F_ρ, and hence inversely proportional to ρ, the base-level of outsider trust. Hence, under professional management, low base levels of outsider trust favor reputation equilibria.

4.2 Owner management and reputation equilibria

As is typical in models of firm reputation, under owner management, each period, the owner-operator's payment equals the firm's profit, i.e., revenue (prices of goods) minus the investment cost, e. The owner-operator also internalizes both the cost of reform, R, and its benefit. To capture the operator's benefit from reform in the simplest possible way, we assume that the owner-operator remains with the firm in period 2 whether or not it reforms.[14]

Thus, under owner management, the operator's period 2 payment is $\phi_2(p_2, h) = p_2 - e$ after $q_1 = h$ and $\phi_2(p_2, q_1 = l) = p_2 - e - R$ after $q_1 = l$. In period 1, the operator's payment is $\phi(p_1) = p_1 - e$. Because the payment structure is

[13] All equilibria being reputation equilibria under professional management means that there exists a governance policy, g^*, such that the owner-preferred equilibrium of the g^*-subgame, is a reputation equilibrium of the subgame and this subgame equilibrium produces a higher payoff than any of the no-reputation equilibria of any other g-subgames. This does not imply that all equilibria of the g^*-subgame are reputation equilibria.

[14] Clearly, putting a professional manager in place as the operator instead of the owner after reform, while depriving the owner-manager of the rents from failed reform, will change the governance structure to professional management. It is possible that the owner could sell the firm to another owner-manager as part of the reform. However, since the replacement owner-manager would anticipate capturing the rents from diversion after failed reform, the sale price would reflect these rents and transfer them to the original owner manager through the sale price. Incorporating the sale option would thus offer little new insight.

fixed exogenously, the governance optimality condition, as defined in Definition 3, is trivially satisfied. So a reputation equilibrium under owner management is simply defined as a reputation equilibrium (Definition 2) for the owner management payment structure detailed above.

The next proposition describes the condition for the existence of a reputation equilibrium under owner management. It also shows that all equilibria are reputation equilibria when this condition is satisfied.

Proposition 2 *Let $\hat{c} = (1-r)\,c$ represent the owner-operator's expected post-reform gain from opportunism. Then, if*

$$\rho \geq 1 - \frac{\pi_1 - b^* - (\pi_r + \hat{c})}{1-\delta}, \tag{13}$$

a unique equilibrium exists and that equilibrium is a reputation equilibrium.

Proposition 2 shows that, as is typical in models of firm reputation, under owner management, reputation equilibria exist when outsiders have a sufficiently high base level of trust in the operator's commitment. The reason is that the owner-operator's penalty for acting opportunistically in period 1 is the cost of revelation which eliminates the owner-operators reputation rents in period two. This cost is increasing in outsiders' base level of trust. Condition (13) shows that, in contrast to professional management, under owner management high base levels of outsider trust, ρ, favor reputation equilibria.

To illustrate the contrasting effects of the base level of outsider trust on the viability of reputation equilibria under professional and owner management, we present an example rooted in our experiment. Consider Table 2. Panel A presents the parameter sets we use in our experiment, and Panel B presents calculated equilibrium operator payoffs for each parameter set. Note that the two parameter sets vary only with respect to the base level of outsider trust, ρ, which is higher in Parameter Set II.

First consider Parameter Set II/ professional management. Under a reputation-assuring governance policy, the compensation cost to the owner is $b^* = 0.0032$ (equation (8)) resulting from the payment $g(F_\rho)$ when the operator is unrevealed and thus $p_2 = F_\rho$. A normal professional operator's payoff from choosing $o_1 = s$ is $b^* + c = 0.0632$, produced entirely by the cost savings, c, from choosing policy m in period 2 and the bonus payment b^*. Choosing $o_1 = m$, results in the same payoff, in this case, produced by the cost savings, $c = 0.06$, from choosing policy m in period 1, and receiving $(b^* + c) = 0.0632$ in period 2 contingent on remaining unrevealed, which has a 5% probability, i.e., the operator's payoff from choosing policy m is $0.06 + 0.05 \times 0.0632 = 0.0632$. Thus, $o_1 = s$ is a best reply for the operator.

Table 2. Example

A. Parameters

Parameter	ρ	e	c	δ	R	r	Value l	Value h
Parameter Set I	0.125	0.111	0.060	0.05	0.010	0.1	0	1
Parameter Set II	0.250	0.111	0.060	0.05	0.010	0.1	0	1

B. Detailed operator payoff calculations

	Professional Management		Owner Management		
	$q_1 = h$	$q_1 = l$	$q_1 = h$	$q_1 = l$	
				Reform succeeds	Reform fails
Normal operator payoffs					
	$b^* + c$	0	$p_2^* - (e - c)$	$F_r - e - R$	$F_r - e - R + c$
Parameter Set I	0.0632	0	0.118	0.024	0.084
Parameter Set II	0.0632	0	0.237	0.024	0.084
Committed operator payoffs					
	b^*	NA	$p_2^* - e$	NA	NA
Parameter Set I	0.0032		0.058		
Parameter Set II	0.0032		0.177		

For the owner, the reputation assuring governance policy produces prices $p_1 = 1$ and $p_2 = F_\rho = 0.2875$, thus the owner's payoff equals $(1 - e) + (F_\rho - e - b^*) = 1.0623$ according to expression (9). In contrast, if the owner sets a no expected compensation policy, then, in the first period, $p_1 = F_\rho = 0.2875$ (equation (5)); in the second period, $p_2 = F_2 = 0.8761$ (equation (10)) if the firm is unrevealed, and $p_2 = F_r = 0.1450$ (equation (6)), if the firm is revealed. The resulting owner payoff is 0.4136 (equation (11)). Hence, the owner will strictly prefer paying reputation-assuring compensation and all equilibria are reputation equilibria.

Now consider Parameter Set I/professional management. The cost of the reputation-assuring governance policy, b^*, does not depend on outsider trust, and so is unchanged. However, because the base level of trust, ρ, is lower, under a no expected compensation policy, the period 1 good's price will be lower than under Parameter Set II. This price drop makes the cost of not assuring reputation even larger. Performing the same calculations as performed for Parameter Set II, we see that the payoff from a reputation assuring compensation policy is 0.9436 and the payoff from a no expected compensation policy is 0.1862, so, again, all equilibria are reputation equilibria. This is not surprising given the lower base level of trust in Parameter Set I compared with Parameter Set II and Proposition 1, which shows that low base levels of trust favor reputation equilibria under professional management.

Now consider Parameter Set II/owner management. In a reputation equilibrium, $P_2^*(\hbar_1^c, h) = F_\rho = 0.2875$ and $P_2^*(\hbar_1^c, l) = F_r = 0.145$ (Lemma 2). Since the operator receives the firm's profits, as we show in Table 2.B, a normal operator's expected payoff in period 2 is 0.237 $(= 0.288 - (0.111 - 0.060))$ if unrevealed, 0.024 $(= 0.145 - 0.111 - 0.010)$ if revealed and reform succeeds, and 0.084 $(= 0.024 + 0.060)$ if reform fails. Thus, the operator's expected payoff in period 2 is 0.237 if $o_1 = s$ versus 0.086 $(= 0.237 \times 0.05 + (0.024 \times 0.1 + 0.084 \times 0.9) \times 0.95))$ if $o_1 = m$. This gap is large enough to deter the operator from defecting to $o_1 = m$ to capture the cost saving $c = 0.060$ in period 1, so the equilibrium is a reputation equilibrium.

Under Parameter Set I/owner management, $F_\rho = 0.169$ and F_r is unchanged. Given these prices, following the arguments we just used to establish a reputation equilibrium under Parameter Set II, the operator's period 2 expected payoff is 0.118 if $o_1 = s$ and 0.080 if $o_1 = m$. The cost of revelation implied by these payoffs is too small to make up for the 0.060 the owner operator can capture in period 1 by choosing $o_1 = m$, so owner management does not support a reputation equilibrium. Because the base level of trust is lower in Parameter Set I, this example illustrates the logic behind Proposition 2, which shows that high base levels of trust favor reputation equilibria.[15] The example also highlights the contrasting implications of owner and professional management for firm reputation in a low trust environment.

4.3 Reform and reputation equilibria

To examine how reform impacts the existence of reputation equilibria, we will describe conditions for reputation equilibria in a no-reform setting in which reform is not possible. Because reform can only occur if the operator is normal, along any history which includes reform, rational customers must believe that the operator is certainly normal, i.e., $\mu_2^* = 0$. This belief combined with the fact that $o_2 = m$ is the strictly dominant period 2 policy for the operator (Lemma 1) implies that, in the no-reform setting, after revelation, the period 2 good's price $P_2^*(\hbar_1^c, l) = \delta$ and the firm cannot possibly operate profitably in any equilibrium. Thus, to simplify the analysis of the no-reform setting we assume that, following revelation, the firm shuts down after the good's price is set in period 2. This truncates at p_2, all period 2 histories that include $q_1 = l$ and does not add any new histories.

Under owner management, shutting down the firm after the operator is revealed, from the perspective of the operator's payment structure, is equivalent to replacing the operator after revelation because the operator's payoff in either case is zero after revelation. As a result the condition for reputation equilibria under owner management switches to part (b) of Lemma 2.

Under professional management, the operator's expected payoff remains zero after revelation, as it is in the baseline setting. Thus, the optimal reputation-assuring governance policy does not change when we switch to the no-reform

[15] In Parameter Set I, the equilibrium under owner management is a mixed strategy equilibrium in which the owner-manager randomizes between reputation assuring governance policies and no-expected compensation policies in period 1. The expressions defining the operating strategies are somewhat complex. However, since they are required for predicting the outcomes of the experiment, we develop these equilibria in Lemma A-5 in Appendix A.

setting, and the owner's expected payoff from picking a reputation-assuring governance policy continues to be represented by expression (9). Because, reform is no longer possible, the owner's expected payoff from a no expected compensation policy changes from expression (11) to

$$F_\rho - e + F_\rho \left(F_2 - e\right). \tag{14}$$

A little bit of algebra produces the following proposition.

Proposition 3 *In the no-reform setting*

a. *Under owner management, reputation equilibria exist if and only if*

$$\rho \geq 1 - \frac{\pi_1 - b^*}{1-\delta}. \tag{15}$$

b. *Under professional management, a reputation equilibrium exists if and only if*

$$\rho \leq 1 - \frac{b^*}{\delta + \pi_1} \times \frac{1}{1-\delta}. \tag{16}$$

c. *Under both owner management and professional management, the set of parameter values that support reputation equilibria in the setting with reform is a proper subset of the set of parameter values that support reputation equilibria in the no-reform setting*

Proposition 3 shows that the firm's ability to sustain a reputation is greater in the no-reform setting. The underlying logic is straightforward: Reform lowers the owner's loss from revelation. Hence, under professional management, reform shrinks the interval over which the owner is willing to bear the cost of reputation-assuring compensation. Under owner management, the profit generated via reform directly lowers the owner-operator's cost of opportunism.

Because the move to the no-reform setting expands the set of parameters that supports reputation equilibria, professional management continues to support reputation equilibria under both parameter sets in Table 2.A, and owner management does the same under Parameter Set II. Under Parameter Set I switching to the no-reform setting makes the owner operator's penalty for defecting from a reputation equilibrium sufficiently large to deter defection. Thus, once we switch to the no-reform setting, both governance structures support reputation equilibria for both parameters sets in Table 2.A.

5 An experiment to examine the link between governance structure and reputation

In our model professional management creates strikingly different incentives to maintain firm reputation than owner management. Importantly, under optimal governance policies, professional management better supports firm reputation in low trust environments. This is particularly true when reform is possible.

The key difference in the governance structures is the period 2 "reputation cost," i.e., the penalty for revelation, they generate for the operator. It is unclear (i) whether reputation costs will differ across the two governance structures in the real world in the way our model predicts, and (ii) whether real-world operators will respond to reputation cost differences in the way our model predicts. Adopting an experiment design that matches previous studies, we conduct a laboratory experiment focused on issue (ii). While this design choice narrows the scope our experiment relative to that of our model, it permits us to test our model's predictions about (a) differences in operator behavior arising from reputation cost differences for operators under owner and professional management *that exactly match the differences in our model*; (b) whether outsiders (customers) recognize the differences in operator incentives; (c) the penalties customers impose for revelation; and (d) the effects of reform.

We run an owner management with reform treatment and professional management with reform treatment for each parameter set in Table 2.A. Each treatment consists of two sessions, and in each session operators' period 2 payoffs are fixed according to Table 2.B so that, under each governance structure, operators face the same reputation cost tradeoff as in our model.

To assess the effect of reform, for each of the two parameter sets, we run an owner-management treatment in which reform was not possible. For this treatment, in accordance with our model, we fix the operator's payoffs at zero after revelation and those in Table 2.B if the operator remains unrevealed. We do not run matching professional management without reform treatments because, as we have shown, the operator's reputation cost and optimal policy do not change when we switch to the no-reform setting. Our design is effectively a 2 (parameter set) $\times$ 2 (governance structure) $\times$ 2 (reform setting) design relative to operator choices and goods prices. Table 3 summarizes our design. We will use the labels in the table to identify treatments, dropping the parameter set suffix when the discussion applies to both parameter sets.

Table 3. *Experimental treatments.*

	Parameter Set I			Parameter Set II		
Governance structure	Label	Sessions	Obs.	Label	Sessions	Obs.
Owner Management	OM-I	2	264	OM-II	2	264
Owner Management w/ Reform	OMR-I	2	264	OMR-II	2	264
Professional Management (w/ or w/o Reform)	PM-I	2	228	PM-II	2	264

5.1 Subject pool, instructions and payments

Subjects in our experiment were drawn from a volunteer pool of undergraduate business and MBA students at the University of Iowa. There were 18 to 24 subjects in each session. Sessions lasted 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 show-up fee) ranged from \$10.31 to \$32.00. They averaged \$21.45 with a standard deviation of \$4.37. Expected profits across roles were equalized by allowing customers to keep some of an endowment they received each period and setting different exchange rates for operators across the treatments.

The experiments were programmed in Z-Tree (Fischbacher, 2007). Upon arrival, subjects sat at separate computer terminals and received a set of instructions (provided in Appendix B), forms to record profits by period, and receipts to be filled in during the session. The instructions clearly explained the choices subjects and the experimenter would make in the experiment. The instructions also clearly showed the implications of these choices for subject payoffs. The instructions were read aloud and all questions were answered in public before each session.

At the beginning of each session, each subject was randomly assigned a role ("Green" player (customer) or "Blue" player (operator)) and remained in their roles throughout the session.[16] Each session consisted of 24 "rounds," and each round consisted of two-periods to match our model. Table 4 describes the sequence of events in each round of the experiment, with "|"s separating differences across ownership treatments and "*"s indicating unique features of our experiment that we will describe shortly.

Table 4. *Flow of each two-period game in the experiment.*

<table>
<tr><th rowspan="2">Period</th><th rowspan="2">Mover</th><th colspan="2">Action/Outcome</th></tr>
<tr><th>Owner Management</th><th>Professional Management</th></tr>
<tr><td rowspan="5">1</td><td>Experimenter</td><td colspan="2">Determines whether operator is committed or normal by setting production methods.</td></tr>
<tr><td>Stage I: Operator</td><td colspan="2">Chooses operating policy.</td></tr>
<tr><td>Stage II: Customer</td><td colspan="2">Sets price according to modified BDM procedure.*</td></tr>
<tr><td>Experimenter</td><td colspan="2">Randomly determines item quality if operator chose mixed policy. Reveals item quality.</td></tr>
<tr><td></td><td colspan="2">Customer paid based on good's quality, purchase price and whether good is purchased.</td></tr>
<tr><td></td><td></td><td>Operator paid firm's period 1 profit.</td><td>Operator paid 0 or c based on policy.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Experimenter</td><td colspan="2">Randomly determines whether reform succeeds after revelation if reform is available.</td></tr>
<tr><td>Replaces revealed operator in no-reform treatments.*</td><td>Replaces revealed operator.*</td></tr>
<tr><td></td><td>Stage I: Operator</td><td colspan="2">Uses equilibrium policy.*</td></tr>
<tr><td>2</td><td>Stage 2: Customer</td><td colspan="2">Sets price according to modified BDM procedure.*</td></tr>
<tr><td></td><td>Experimenter</td><td colspan="2">Randomly determines item quality if operator chose mixed policy. Reveals item quality.</td></tr>
<tr><td></td><td></td><td colspan="2">Customer paid based on good's quality, purchase price and whether good is purchased.
Operator paid according to Table 2.B.</td></tr>
</table>

* denotes a unique design feature explained later.

At the start of each round, subjects were randomly assigned to groups consisting of one customer and one operator (with random re-matching to start each new round). Then each operator was randomly assigned a set of operating policies or "methods," which effectively fixed the operator's type. A committed type could only use a safe policy (called

[16]While we will refer to subjects as customers and operators, following the standard in the literature (see e.g., Plott, 1982), these terms were not used during the experiment to avoid value-laden connotations. The neutral language allows us to test our hypotheses without bringing in external preconceptions and framing effects that can make preferences deviate from those induced by the payoffs and contracts in the game. For example, if we refer to producing a low-quality good as "reputation damage," subject behavior may be influenced by their experiences with reputation damage in other contexts in unpredictable ways, which can complicate strategic decision making by other subjects.

"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 customer. A fraction of operators (7/8 or 3/4 depending on the treatment) were assigned a normal type and could alternatively employ a mixed policy (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 customer) 95% of the time. All subjects knew the assignment rules and fractions of each operator type. While each operator knew his/her type, customers did not and they could only learn the type of the operator they were paired with indirectly if the operator produced a low quality item and thus was revealed.[17]

In each period, each operator made a production policy choice and the customers they were paired with set prices for the goods produced by the operators. Customers could not observe operators' choices. Prices were set using the modified BDM procedure we will describe shortly (Becker et al., 1964).

If the operator picked the safe policy the good's quality for the period was high. If a normal operator picked the mixed policy, the quality of the good for the period was determined via a random draw (with 5% probability of high quality) conducted by the experimenter. At the end of each period, the good's quality was revealed to the two subjects in a pair.

If the first period good was low quality (the operator was revealed), in treatments with reform, the experimenter determined the outcome of reform via a random draw with 10% probability of success, and the outcome was disclosed to the operator. In the OM treatments with reform the operator remained with the firm in period 2 after reform; in the PM treatments, the operator was replaced and we will shortly describe how this was operationalized. In the no-reform OM treatments a revealed operator's period 2 payoffs was set to zero, consistent with the firm shutting down.

In period 1 the operator received the firm's profit in the OM and OMR treatments, and was paid zero or c in the PM treatments if the chosen policy was safe or mixed, respectively. As we have stated previously, in period 2, the operators' in treatments with reform (OMR and PM) were paid according to Table 2.B, and the only change when we switched to the no-reform OM treatments was that revealed operators received zero payoffs in period 2. Customers' payments in each period were determined according to the BDM procedure; they received the value of the goods they purchased less the price they paid.

5.2 Unique experiment features

Our experiment has several unique features. They were clearly explained to subjects in the instructions (shown in Appendix B). Before turning to the features we have flagged in Table 4, we will describe the one that is not flagged: To ensure salience (i.e., that subjects' payoffs vary meaningfully with their choices (e.g., Plott, 1982)), each cash flow in Table 2 was scaled up by a factor of 1,000, so a cash flow of 1 in the model equaled 1,000 "francs" (the experimental currency unit) in the experiment. To create a meaningful difference across period 1 production policy choices, we

[17]Throughout each session, computer screens at the front and sides of the room displayed (1) the probability the Blue players (operators) were a committed or normal type, (2) the probability that each policy produces each item type, and (3) the period 2 equilibrium operating policy conditioned on whether the operator was revealed or not.

further scaled up the bonus b^* from 3.15 to 30.[18] The added scaling does not change optimal actions: The scaled up bonus continues to provide the operator a strong incentive to pick the safe policy in period 1. While the owner's compensation cost rises, because the owner's gain from a reputation-assuring bonus is sufficiently large under both parameter sets in Table 2, it is optimal for the owner to pay the scaled up bonus and ensure that the operator acts reputably.

5.2.1 The procedure for setting goods' prices

Since embedding a competitive goods market would be time consuming and costly, following Noe et al. (2012), we used a modified Becker et al. (1964) procedure (hereafter "BDM procedure") to set goods' prices. This procedure requires just one customer to simulate a competitive price and is designed to elicit the highest price a customer is willing to pay for a good.[19]

In the BDM procedure, the customer first 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 customer at the discounted price only if the limit price exceeds the discounted price. Otherwise, the experimenter keeps the good. When a customer 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 customer 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 customer limit prices.

5.2.2 Period 2 operator strategies

While normal operators were free to pick either policy in period 1, in period 2 of each round, they were required to use the mixed policy, the dominant strategy described in Lemma 1. This simplification, which was known to all subjects, allowed operators to focus all their attention on their period 1 choices, the only determinant of reputation in our setting. It also reduced strategic uncertainty faced by customers in period 2, which allows us to more cleanly assess the reason for price drops following revelation.

This simplification follows a long history of experimental research that fixes some acts or decisions in games to correspond to specific (often equilibrium) strategies to isolate and study other decisions that are of specific interest (e.g., Liberman, 1962; Messick, 1967; Fox, 1972; Shachat and Swarthout, 2008). By reducing strategic uncertainty it

[18] Setting the bonus to 30 also roughly equalizes the expected cost of managerial defection from the trust equilibrium across treatments. The bonus of 30 leads to a net expected cost of 25.50 when a professional manager defects from the trust equilibrium. This is comparable to the 22.24 incentive that an owner-manager has to maintain a trust equilibrium under Parameter Set I.

[19] On average, the BDM procedure elicits risk neutral valuations (Berg et al., 2005) which, in our context, correspond to competitive prices. The procedure 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). Recent experiments on financial decision making that use the BDM procedure include Frydman and Nave (2017) and Fuster et al. (2020).

should have promoted convergence of behavior (Lucas, 1986; Van Huyck et al., 1990), and by lowering subject decision costs it ought to have lowered subject errors (Smith and Walker, 1993). Moreover, in prior reputation experiments with settings like ours, experienced subjects nearly always follow the dominant strategy in the final period when there is no incentive to eschew opportunism (e.g., Brandts and Figueras, 2003, p. 96). Therefore, we expect that, as subjects in past experiments have done, our subjects too would have behaved opportunistically in (the final) period 2.[20]

5.2.3 Revealed operator replacement and owners under professional management

In our model, under professional management the owner picks the governance policy and the replacement for a revealed operator. In our experiment governance policy is fixed according to Table 2.B, so the owner's one remaining decision in the PM treatments is the replacement choice. There is also a need for a replacement period 2 operator. In the experiment, the experimenter took on the role of the replacement operator and, matching our model, no payment was made to either replaced or replacement operator. This simplification effectively eliminated the need for additional subjects to play owners and period 2 replacement operators.

In the OM no-reform treatments, as we have previously described, a revealed operator's period 2 payoff was set to zero. To enable us to observe an integral part of the incentive for reputable behavior— the prices customers are willing to pay for period 2 goods produced by revealed but unreformed firms — after an operator was revealed the experimenter set the (dominant) mixed policy in period 2 and customers priced the period 2 goods.

Because normal operators were required to use the mixed policy in period 2 in the experiment and so made no strategic choices in period 2, these two simplifications come at little cost but yield several benefits. First, in all treatments, our design matches prior experiments based on the KWMR reputation framework: subjects only play two roles—insider (operator) and outsider (customer)—and take only one type of action in each role.[21] Second, the design reduces strategic uncertainty and equalizes it across treatments. This reduces complexity and lowers subject decision costs, which ought to make it easier to diagnose differences between model predictions and experimental behavior (Davis and Holt, 1993). Third, we can implement the professional and owner management treatments in essentially the same setting, maximizing the likelihood that governance structure-based incentive differences drive outcomes rather than differences in the design of the treatments or subject instructions (Zizzo, 2010).

6 Evidence from our experiments

Recall that our model predicts reputation equilibria under professional management for both parameter sets in Table 2.A, and for Parameter Set II under owner management. In the no-reform setting, the model predicts reputation

[20]Subjects in our experiment were quite opportunistic even in period 1, when they had an incentive to avoid opportunism.

[21]Except for the number of periods in the game, our experiment is comparable to the experiments in Camerer and Weigelt (1988), Neral and Ochs (1992), Brandts and Figueras (2003), and Noe et al. (2012). In Camerer and Weigelt (1988), Neral and Ochs (1992), and Brandts and Figueras (2003) outsiders make lending decisions which serve as an *indicator of sufficient reputation* rather than set a precise measure, a good's price, as they do in our experiment and in Noe et al. (2012).

equilibria under both governance structures for both parameter sets. Table 5 summarizes the predictions and the equilibrium prices.

Table 5. *Equilibrium predictions for parameter sets in Table 2.A .*

	Parameter Set I			Parameter Set II	
	OM-I	PM-I	OMR-I	OM-II	OMR-II &PM-II
Reputation equilibrium	Yes	Yes	No	Yes	Yes
Probability of period 1 reputable behavior	1.000	1.000	0.802	1.000	1.000
Period 1 Price	1,000	1,000	835	1,000	1,000
Period 2 Price | Unrevealed	169	169	192	288	288
Period 2 Price | Revealed	50	145	145	50	145

Prior research strongly suggests that subject behavior in experiments will frequently deviate from predictions of reputation models (e.g., Camerer and Weigelt, 1988; Neral and Ochs, 1992; Brandts and Figueras, 2003; Noe et al., 2012). Brandts and Figueras (2003) suggest that the deviations increase when games are shorter. Thus, we do not expect subject behavior to conform exactly to our two-period (i.e., shortest possible) reputation game predictions. However, we want to see whether the predictions about reputation effects of governance structure and reform hold, *at least qualitatively*, *in spite of* expected behavioral deviations. Therefore, when examining the results of our experiment, we focus on addressing the following hypotheses that reflect our expectations:

Hypothesis 1 In period 1, normal operators will use the safe operating policy at similar rates in all treatments using Parameter Set II. In treatments using Parameter Set I, the safe policy will be used more frequently in period 1 in treatments PM-I and OM-I compared with treatment OMR-I.

Hypothesis 2 Customers will set similar prices for period 1 goods in all treatments using Parameter Set II. In treatments using Parameter Set I, period 1 goods' prices will be higher in treatments PM-I and OM-I compared with treatment OMR-I.

Hypothesis 3 Customers will set similar prices for period 2 goods from *unrevealed operators* in all treatments using Parameter Set II. In treatments using Parameter Set I, period 1 goods' prices from *unrevealed operators* will be lower in treatments PM-I and OM-I compared with treatment OMR-I.

Hypothesis 4 Customers will set lower period 2 prices for goods from revealed operators in all treatments. For revealed operators, period 2 goods' prices will be higher in treatments with reform than in no-reform treatments.

We also have a hypothesis comparisons for the same treatment protocol using different parameters:

Hypothesis 5 When we compare treatments using different parameter sets, but the same governance structure and reform protocol, we expect:

a. similar rates of use of the safe policy in period 1 in PM and OM treatments but lower usage rates in treatment OMR-I compared with OMR-II,

b. similar period 1 goods' prices in PM and OM treatments but lower period 1 goods' prices in treatment OMR-I compared with OMR-II

We will describe the evidence in the following order: Operator policy choices in period 1, period 1 goods' prices, and period 2 goods' prices. To simplify the exposition, we will refer to operators' period 1 policy choices, simply as policy choices.

6.1 Adoption of the reputable policy

The period 1 operating policy indicates whether firms behave reputably. We expect the operators who choose these policies to respond to monetary incentives. These incentives are tied to firms' governance structures; the availability of reform matters too. Therefore, we expect period 1 operating policies to vary systematically with governance structure and reform protocol according to Hypotheses 1 and 5.

Figure 2 shows the percentage of times normal-type operators make reputable policy choices by treatment. The figure also shows 95% confidence interval bars. To limit confounding effects arising from subject learning, the figure shows prices in the second half of the experiment.[22]

Normal operators often choose reputable policies, but do so significantly less often than the equilibrium prediction. In Treatment OMR-I, for which the prediction is for reputable policies to be chosen about 80% of the time, normal operators pick the safe policy about 50% of the time in our experiment. In the remaining treatments, for which the prediction is for reputable policy choices 100% of the time, we observe such policies only a maximum of 73% of the time, which occurs in treatment OM-I.

Prior experiments, which closely match our owner-manager treatments without reform, also produce low rates of reputable behavior when the equilibrium prediction is 100% reputable behavior. For example, in Noe et al. (2012) the frequency of reputable behavior is around 60%. In longer games, Camerer and Weigelt (1988) report reputable behavior with a frequency of under 80% when subjects are relatively inexperienced. Thus, while reputable policies are chosen in our experiment with a low frequency, this is not unexpected. Moreover, in Appendix C, we show that, over time, operators in our experiment gravitate towards choosing reputable policies when our model predicts a reputation equilibrium.

Consider differences across treatments, which speaks to the impact of governance structure and reform. Table 6 presents the frequencies with which normal operators make reputable policy choices in each treatment as well as formal tests of the differences across treatments. To minimize the confounding effects of subject learning, we present and compare policy choices in the second half of each session (see footnote 22). The observed variation across treatments is consistent with our model's predictions about the effect of governance structure, and the impact of reform in weakening commitment to maintain stakeholder trust, particularly under owner management.

[22] Using the entire data set leaves these results as well as the remaining results we report in this section essentially unchanged. As we find evidence that subjects learn about the game through experience, we are more comfortable using statistical tests based on the later periods in the experiment. In Appendix C we provide insights into the impact of subject learning.

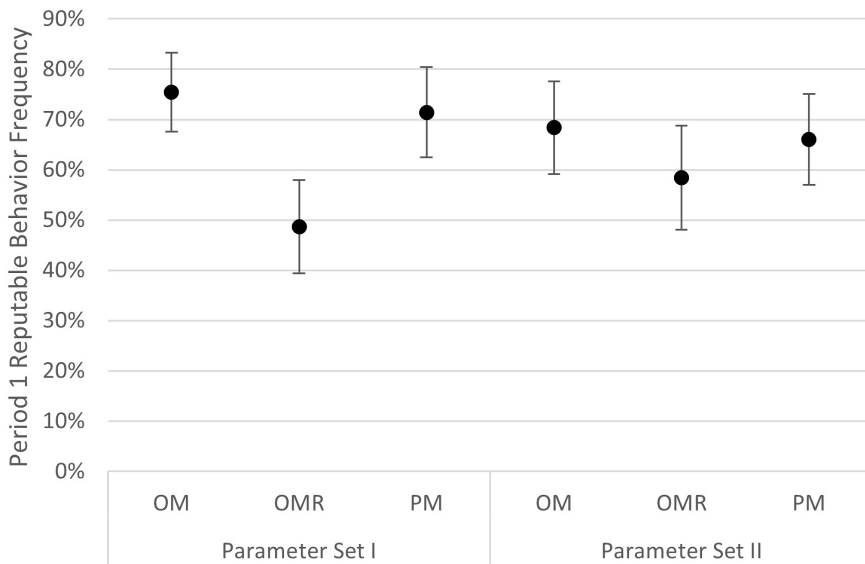


Figure 2. *Frequency of reputable behavior in the second half of each session.* This figure presents the frequency with which normal-type operators make reputable policy choices (in period 1).

Result 1 The variation in reputable policy choices across treatments conforms with Hypotheses 1 and 5 about the effects of governance structure and reform, i.e., operators respond in the manner we expect to the different incentives for reputable behavior created by governance structures and the opportunity to reform.

Consistent with Hypothesis 1, we find no significant differences between the frequencies of reputable period 1 policy choices between treatments using Parameter Set II. In treatment OMR-II, the frequency of reputable policy choices is (58.4%) which is not statistically significantly different than the frequencies in treatments OM-II (68.4%) or PM-II (66.0%). Thus, as we expect, governance structure and reform do not significantly impact the frequency of reputable behavior when the base level of trust is $\rho = 0.250$.

For the treatments using Parameter Set I, we find, consistent with Hypothesis 1, operators act reputably only 48.7% of the time in treatment OMR-I, which is statistically significantly lower than in treatment OM-I (t=4.35, p-value=0.00) and in treatment PM-I (t=3.43, p-value=0.00). Hence, professional management is more supportive of reputable behavior when the base level of trust is lowered to $\rho = 0.125$. Moreover, the ability to reform further weakens the ability of owner-managed firms to behave reputably.

Consistent with Hypothesis 5, we find no significant difference in the usage of the safe policy in period 1 between treatments PM-I and PM-II, or between OM-I and OM-II. As we expect, the safe policy is used less frequently in treatment OMR-I than in OMR-II (48.67% versus 58.43%). However, the difference is not statistically significant.

The pattern of period 1 policy choices we observe shows that, as the level of outsider trust falls, operator incentives that benefits owners under professional management are more likely to result in reputable policy choices than operator incentives owner management. Moreover, reform tends to undermine the ex ante incentive to make policy choices that

Table 6. *Incidence of reputable policy choices.* In this table we present the frequency with which normal-type operators choose the reputable policy (in period 1) during the second half of each session. ***, ** and * denote t-test significance at the 99%, 95% and 90% levels of confidence respectively. DoF indicates Degrees of Freedom = the number of combined observations - 2.

		Parameter Set		Parameter Set I vs II			
Governance structure		Parm. I	Parm. II	Difference	t-Stat.	p-Value	DoF
OM		75.42%	68.37%	-7.06%	-1.15	0.25	214
OMR		48.67%	58.43%	9.75%	1.38	0.17	200
PM		71.43%	66.04%	-5.39%	-0.83	0.41	202
OM	Difference	-26.75%***	-9.94%				
vs	t-Stat.	-4.35	-1.41				
OMR	p-Value	0.00	0.16				
	DoF	229	185				
OM	Difference	-4.00%	-2.33%				
vs	t-Stat.	-0.66	-0.35				
PM	p-Value	0.51	0.73				
	DoF	214	202				
OMR	Difference	22.76%***	7.61%				
vs	t-Stat.	3.43	1.09				
PM	p-Value	0.00	0.28				
	DoF	209	193				

maintain customer trust in a low trust environment.

6.2 Period 1 goods' prices

Period 1 goods' prices represent customer conjectures about period 1 quality. They measure firm reputation, and the gap between period 1 goods' prices and floor prices is the reward firms receive for the level of reputable period 1 behavior customers anticipate. We expect firm reputation and period 1 prices to vary systematically with governance structure and reform protocol according to Hypotheses 2 and 5.

Figure 3 illustrates period 1 prices (×s) under each treatment, average actual values of the goods (•s), and the predicted values of the goods (+s). The figure also shows 95% confidence interval bars for goods' prices and actual values. Table 7 shows tests for differences between period 1 prices and (1) floor prices, (2) predicted prices and (3) actual values. To limit confounding effects arising from subject learning, Figure 3 and Table 7 are based on prices in the second half of the experiment (see footnote 22).

Average period 1 prices are well below levels predicted by our model; 835 francs in treatment OMR-I and 1,000 francs in the remaining treatments. T-statistics from formal tests of these differences range from -9.52 to -13.78. Thus, it appears that customers anticipated the lower than predicted level of operator behavior in the experiment.

The discounts we observe relative to predicted period 1 prices are not unprecedented or unanticipated. They mirror outsider responses in prior experiments where the insiders are predicted to act reputably 100% of the time but fail to do so. For example, in the first period of the Noe et al. (2012) experiment, which closely matches our owner-management

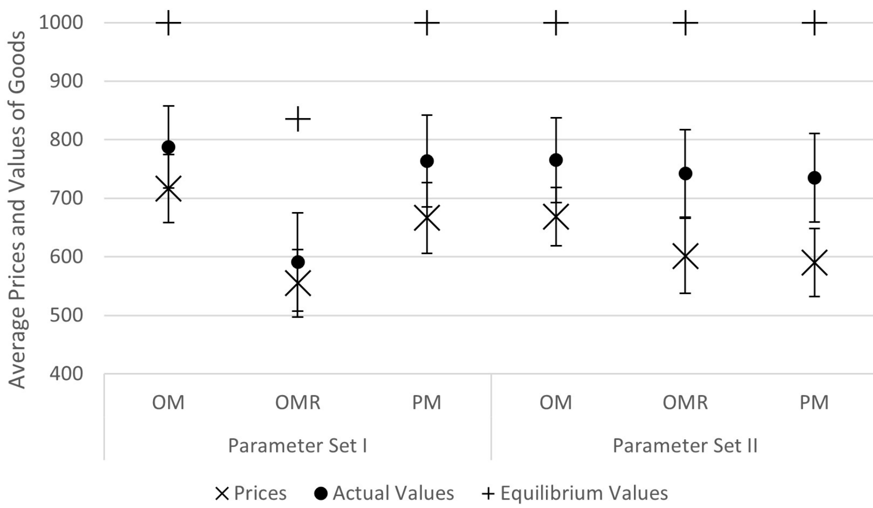


Figure 3. *Period 1 values and limit prices in the second half of each session.*

treatment without reform, the average price for goods is 651 francs compared to the predicted price of 1,000 francs. While outsiders' willingness to lend in Camerer and Weigelt (1988) serves as an indicator of sufficient reputation rather than a precise reputation measure like goods' prices, as few as 70% of lenders make loans compared to a 100% predicted rate in early periods of their experiment.

Judging by the difference between floor prices and prices in the experiment, it appears that customers anticipate reputable behavior from normal operators a significant fraction of the time. Specifically, period 1 prices are significantly higher than period 1 floor prices for both Parameter Set I (168.75 francs) and Parameter Set II (287.5 francs), as shown in Table 7 (with t-statistics ranging from 9.64 to 18.41). Notably, the prices customers set in the experiment are high enough to make firms profitable in period 1.

Customers generally under-price goods in the experiment, suggesting that they expect operators to behave more opportunistically than they actually do. Average underpricing ranges from 36.16 francs in treatment OMR-I to 144.38 in treatment PM-II. Notably, these differences are smaller in absolute terms than the differences with predicted or floor prices. The differences are also of less, if any, statistical significance: In treatments using Parameter Set I the difference between period 1 prices and the value of goods is either not statistically significant (OM-I and OMR-I) or only marginally significant (PM-I). Only in the treatments using Parameter Set II do we find consistent evidence of a significant difference. The relatively small differences between prices and the value of goods suggest that customers anticipate actual operator behavior quite well.

To formally examine Hypotheses 2 and 5, and the effect of governance structure and reform on prices, we compare period 1 goods' prices across treatments in the second half of the experiments (see footnote 22). The results are presented in Table 8.

As reflected in Hypothesis 2, for treatments using Parameter Set II, we expect the period 1 good's price to be

Table 7. *Customer conjectures of period 1 good quality versus floor prices, equilibrium prices and values.* In this table we present period 1 prices for goods in the second half of the experiment. ***, ** and * denote t-test significance at the 99%, 95% and 90% levels of confidence respectively. DoF indicates Degrees of Freedom = the number of combined observations - 2.

	Governance Structure and Parameter Set					
	OM-I	OMR-I	PM-I	OM-II	OMR-II	PM-II
Mean Price	716.73	554.75	666.39	668.27	601.66	590.47
Equilibrium Price	1000.00	853.30	1000.00	1000.00	1000.00	1000.00
Est. Price minus Eq,. Price	-283.27	-298.55	-333.61	-331.73	-398.34	-409.53
t-Stat.	-9.52***	-10.17***	-10.85***	-13.07***	-12.22***	-13.78***
p-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DoF	131	131	113	131	131	131
Floor Price	168.75	168.75	168.75	287.50	287.50	287.50
Est. Price minus Floor Price	547.98	386.00	497.64	380.77	314.16	302.97
t-Stat.	18.41***	13.14***	16.18***	15.00***	9.64***	10.19***
p-Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
DoF	131.00	131.00	113.00	131.00	131.00	131.00
Mean Value	787.88	590.91	763.16	765.15	742.42	734.85
Est. Price minus Value	-71.15	-36.16	-96.77	-96.88	-140.76	-144.38
t-Stat.	-1.63	-0.70	-1.82	-2.03	-2.76	-3.08
p-Value	0.1059	0.4864	0.0709*	0.0447**	0.0067***	0.0025***
DoF	131	131	113	131	131	113

unaffected by governance structure or reform. Consistent with this expectation, 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). However, contrary to our expectation, the difference between prices in OM-II and PM-II of 77.8 francs is statistically significant at the 95% level of confidence.

When we turn to Parameter Set I, consistent with Hypothesis 2, prices are not significantly different between treatments OM-I and PM-I. Moreover, as we expect, 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).

As we state in Hypothesis 5, we only expect to see a difference in period 1 prices when we compare treatments OMR-I and OMR-II. We do find that, as expected, period 1 prices are lower in treatment OMR-I. However, the difference is not statistically significant. Consistent with our expectation, there is no difference between prices in treatments OM-I and OM-II. However, contrary to the hypothesis, prices in treatment PM-I are significantly higher than in PM-II.

Overall, while period 1 prices do not conform exactly to each hypothesis, the pattern of price differences across treatments, particularly when comparing treatments using the same parameter set, indicates that customers recognize the systematic effects we expect governance structures and reform to have on operator behavior. We formally state this in the following result:

Result 2 The variation in period 1 prices across treatments generally conforms with Hypothesis 2 about customer behavior, i.e., customers do anticipate that governance structure and reform affect incentives to act reputably in a manner that aligns with our expectations.

Table 8. *Customer conjectures of period 1 good quality.* In this table we present period 1 prices for goods in the second half of the experiment. ***, ** and * denote t-test significance at the 99%, 95% and 90% levels of confidence respectively. DoF indicates Degrees of Freedom = the number of combined observations - 2.

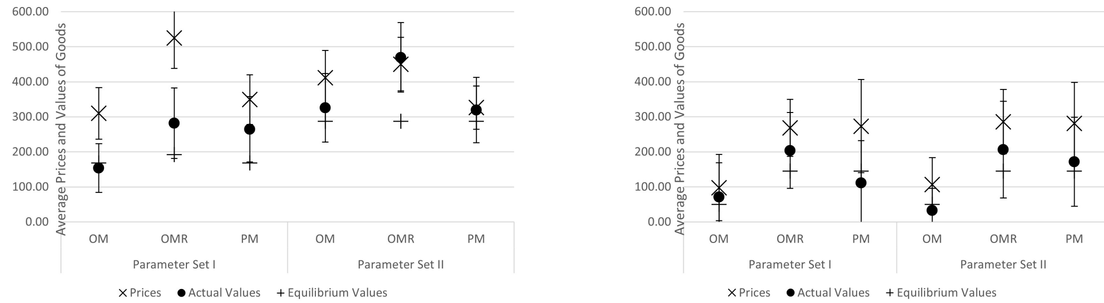
		Parameter Set		Parameter Set I vs II			
Governance structure		Parm. I	Parm. II	Difference	t-Stat.	p-Value	DoF
OM		716.73	668.27	-48.46	-1.24	0.22	262
OMR		554.75	601.66	46.91	1.07	0.29	262
PM		666.39	590.47	-75.92*	-1.77	0.08	244
OM	Difference	-161.98***	-66.61				
vs	t-Stat.	3.87	-1.61				
OMR	p-Value	0.00	0.11				
	DoF	262	262				
OM	Difference	-50.35	-77.80**				
vs	t-Stat.	-1.17	-1.99				
PM	p-Value	0.24	0.05				
	DoF	244	262				
OMR	Difference	111.64***	-11.19				
vs	t-Stat.	2.62	-0.25				
PM	p-Value	0.01	0.80				
	DoF	244	262				

6.3 Period 2 goods' prices

Period 2 goods' prices reflect customer trust after observing the quality of period 1 goods and reform. The gap between the period 2 prices following high and low quality period 1 goods is a key determinant of the reputation cost. We expect the gap between these prices to be smaller when firms can reform, we also expect the gap to depend on what customers infer from the period 1 goods' quality when they do not expect operators to behave reputably in period 1 as reflected in Hypotheses 3 and 4.

Figure 4 shows period 2 prices set by customers (×s) , goods' actual values (•s) , and goods' predicted values (+s) in the second half of each session (see footnote 22). Panel A shows prices when the operator is unrevealed, and Panel B shows prices after revelation, both after reform and when reform is not possible. The figure also shows 95% confidence interval bars for prices and goods' actual values.

As in period 1, period 2 prices tend to be higher than both predicted values and goods' actual values. Consider the difference between predicted values and prices. For unrevealed firms, with the exception of PM-II, the average gap ranges from 124 to 332 francs and is highly statistically significant. In PM-II, the gap is only 39 francs. Prices for goods from revealed firms are also uniformly higher than predicted values. With the exception of OM-I and OM-II



A. Unrevealed operators B. Revealed operators

Figure 4. *Period 2 values and limit prices in the second half of each session.*

where the gap is close to 50 francs, the gap ranges from 123 to 141 francs and is statistically significant. Hence, in contrast to period 1, in period 2 customers appear to expect operators to behave *more* reputably than they are predicted to.

Next compare prices and goods' actual values.[23] For unrevealed firms, prices exceed goods' values except in OMR-II, where goods are underpriced by 19 francs. The overpricing is most marked and is statistically significant in OM-I (156 francs) and OMR-I (243 francs). Otherwise it ranges from 7 to 86 francs. Goods from revealed firms are also uniformly overpriced. The overpricing ranges from 26 to 162 francs but is never statistically significant. Thus, it appears that, in contrast to period 1, customers frequently expect unrevealed operators to act more reputably than they actually do. However, customers tend not to make significant pricing errors once operators are revealed or have firms have reformed.

In Table 9, to test Hypothesis 4, we compare period 2 prices for revealed and unrevealed firms. Prices are always higher for unrevealed firms. The difference ranges from 45 francs in PM-II to 305 francs in OM-II. Only in PM-I and PM-II is the difference not statistically significant. Thus, as we expect, firms are generally rewarded by customers with higher goods' prices in period 2 when they are likely to have acted reputably. Interestingly, with the exception of PM-II, the reward in the experiment is larger than predicted by our model, though the reward is significantly larger only in treatment OMR-I.

Result 3 Consistent with Hypothesis 4, customers set higher period 2 goods' prices when operators remain unrevealed.

We present additional tests of Hypothesis 3 as well tests of Hypothesis 4 in Table 10 by comparing period 2 prices across treatments within each revelation state.[24] The pattern is generally consistent with the hypotheses though there are some unexpected differences.

[23]Because of relatively small sample sizes, the average realized values of goods in the experiment do not exactly match their expected values under the model parameters.

[24]We use the second half of the data for consistency with the analysis above. Every significant relationship in Table 10 remains significant and in the same direction when using all the data.

Table 9. *The penalty for being revealed.* This table presents the differences between period 2 prices for revealed and unrevealed firms in the second half of the experiment as well as the predicted values of the difference. ***, ** and * denote significance at the 99%, 95% and 90% levels of confidence respectively.

		Parameter Set I			Parameter Set II		
		OM	OMR	PM	OM	OMR	PM
Unrevealed Prices		309.75	524.68	349.28	411.60	450.45	326.25
Revealed Prices		97.86	268.17	273.26	106.71	286.06	281.00
Predicted Difference		118.75	47.20	23.75	237.5	142.5	142.5
Observations		132	132	114	120	132	132
Unrevealed vs	Difference	211.89**	256.51***	76.02	304.89***	164.39*	45.25
Revealed Prices	t-statistic	2.75	4.06	1.01	4.26	2.29	0.71
Actual Difference vs	Dif. vs Pred.	93.14	209.31***	52.27	67.39	21.89	-97.25
Predicted Difference	F-statistic	1.46	11.00	0.49	0.89	0.09	2.36

First, consider unrevealed firms under Parameter Set I (“Unrevealed” column, first row in each comparison set). According to Hypothesis 3, period 2 prices should be higher in OMR-I than OM-I and PM-I, while OM-I and PM-I should have similar prices. Indeed, OMR-I prices are 215 higher than OM-I and 175 higher than PM-I prices. Both difference are statistically significant (p-values 0.00 for both). The difference between OM-I and PM-I is 40 and is not statistically significant. All three comparisons support Hypothesis 3.

Second, consider unrevealed firms under Parameter Set II (“Unrevealed” column, second row in each comparison set). Hypothesis 3 states that period 2 prices should be similar across OM-II, OMR-II and PM-II. While the difference between OM-II and OMR-II is not statistically significant, PM-II has significantly lower prices than either OM-II (-85, p-value=0.09) and OMR-II (-124, p-value=0.01). Thus, only one of the three differences matches Hypothesis 3.

Finally, consider the effect of reform for revealed firms (“Revealed” column). Hypothesis 4 states that reform should increase prices for revealed firms relative to revealed, but unreformed, firms. This indeed the case. Comparing revealed firms in treatment OM to treatments OMR and PM (both of which allow reform), prices are always significantly higher with reform (170 to 179 higher with p-values all 0.04 or below). Further, there is no significant difference between the reform treatments (OMR and PM). Thus, all three comparisons are consistent with Hypothesis 4.

Overall, the period 2 prices tend to align with our expectations. The only departures from our expectations involve the PM treatments. While subjects overprice goods in the PM treatments just like they do in the remaining treatments, the level of overpricing in the PM treatments falls short of the levels in OM and OMR treatments. This could be an indication of less misplaced trust when firms are professionally managed.

Result 4 While there are some exceptions, comparisons of period 2 goods’ prices across treatments and reform protocol support Hypotheses 3 and 4. The mixed evidence comes primarily from the professional management (PM) treatments in which we observe lower levels of mispricing than in the remaining treatments.

Table 10. *Customer responses across treatments and parameter sets for revealed and unrevealed firms.* In this table we present period 2 prices for goods in the second half of the experiment. ***, ** and * denote t-test significance at the 99%, 95% and 90% levels of confidence respectively. DoF indicates Degrees of Freedom = the number of combined observations - 2.

			Revelation Status	
Treatment	Parameter Set		Unrevealed	Revealed
OM	I		309.75	97.86
	II		411.60	106.71
OMR	I		524.68	268.17
	II		450.45	286.06
PM	I		349.28	273.26
	II		326.25	281.00
OM vs OMR	I	Diff.	214.93***	170.31***
		t-stat	3.71	2.54
		p-value	0.00	0.01
		DoF	180	80
	II	Diff.	38.85	179.35***
		t-stat	0.69	2.92
		p-value	0.49	0.00
		DoF	185	63
OM vs PM	I	Diff.	39.53	175.40**
		t-stat	0.75	2.12
		p-value	0.46	0.04
		DoF	189	53
	II	Diff.	-85.35*	174.29**
		t-stat	-1.70	2.37
		p-value	0.09	0.02
		DoF	184	64
OMR vs PM	I	Diff.	-175.40***	5.09
		t-stat	-3.11	0.07
		p-value	0.00	0.95
		DoF	163	79
	II	Diff.	-124.20**	-5.06
		t-stat	-2.48	-0.07
		p-value	0.01	0.95
		DoF	193	67

7 Discussion

This paper considers the question of how governance structure—the identity of the agents setting operating policy—affects the sustainability of firm reputation with outsider stakeholders and their trust in firms' production standards. We characterize perfect Sequential Nash equilibria in a setting where stakeholders have imperfect information about the commitment of firms to reputable behavior. In this framework, we show that governance structure matters; both firms controlled by informed insider owners and firms controlled by uninformed outsider "common/universal owners" may opt for opportunistic policies promising short-term gains that potentially destroy stakeholder trust and firm reputation. However, the conditions for maintaining trust and reputation under the two governance structures are fundamentally different. Factors that favor trust/reputation sustainability under informed insider control reduce sustainability under uninformed outsider control and vice versa.

We also consider corporate reform and restructuring after detected opportunism and consider how reform affects the sustainability of trust/reputation. We show that, under both governance structures, the option to reform, by lowering the cost of losing trust/reputation, makes it more difficult for firms to commit to maintaining trust/reputation. However, uninformed outsider control, by separating the agents making the operating decisions that affect trust/reputation from the value engendered by reform, mitigates the adverse effects of corporate reform on trust/reputation sustainability.

Through a laboratory experiment, we investigate the robustness of our findings to behavioral deviations from rational expectations. In the experiment, stakeholder responses to firm behavior are produced by laboratory subjects' choices rather than by Bayesian updating. Although subject behavior is generally inconsistent with forward-looking rational expectations, the qualitative conclusions of our model are nevertheless supported by the experiment. Thus, our experiment provides evidence for the external validity of our theoretical predictions to deviations from rational expectations behavior.

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Appendix

Governance, Stakeholder Welfare, Crises and Recovery: An Experiment

A Proofs of results

Proof of Lemma 1. Since customers cannot observe the period 2 good's quality and the good's price reflects customers' expectation about its quality, the payoff to a normal operator who selects operating policy $o_2 \in \{m, s\}$ in period 2 at any $\hbar_2^o \in \mathcal{H}_2^o$ is

$$\phi_2(p_2, q_1) \quad o_2 = s, \tag{A.1}$$

$$\phi_2(p_2, q_1) + c \quad o_2 = m. \tag{A.2}$$

The result follows directly from inspecting the operator payoffs described by equation (A.2). □

Lemma A-1. *In any equilibrium in which $o_1^*(\hbar_1^o) = m$, (a) $\mu_1^*(\hbar_1^c) = \rho$ and $P_1^*(\hbar_1^c) = F_\rho$, where F_ρ is described in* (5) *(b) $\mu_2^*(\hbar_1^c, h) = \frac{\rho}{\rho+\delta(1-\rho)}$ and $P_2^*(\hbar_1^c, h) = \frac{\rho}{\rho+\delta(1-\rho)} + \delta\left(1 - \frac{\rho}{\rho+\delta(1-\rho)}\right) = F_2$, where*

$$F_2 := 1 + \delta - \frac{\delta}{F_\rho}. \tag{A.3}$$

Proof of Lemma A-1. Part (a). The claim about $\mu_1^*(\hbar_1^c)$ follows because, in period 1, the price is set before customers observe the action of the operator; so the probability customers assign to the operator being committed is their prior belief, ρ.

Consider P_1^*. The committed operator always chooses policy s and the normal operator sets policy m by hypothesis. Under the policy s, $q_1 = h$. Thus, the expected value of the period 1 good equals $\mu_1^*(\hbar_1^c) + \delta\,(1 - \mu_1^*(\hbar_1^c))$. Since $\mu_1^*(\hbar_1^c) = \rho$ the expected quality of the period 1 good equals

$\rho + \delta(1-\rho)$, which equals F_ρ defined in expression (5). The pricing condition for a sequential equilibrium (Definition 1.a) thus implies that $P_1^*(\hbar_1^c) = F_\rho$.

Now consider Part (b). When $o_1^*(\hbar_1^o) = m$, customers' period 2 history $\hbar_2^c = (\hbar_1^c, h)$ is reached both when the (i) operator is committed and when the (ii) operator is normal and the m policy results in $q_1 = h$. The probability of (i) is $\mu_1^*(\hbar_1^c)$, which equals ρ. The probability that the operator is normal, chooses policy m, and $\tilde{n}_1 = 1$, is $\delta(1-\rho)$. Thus, Bayes rule implies that

$$\mu_2^*(\hbar_1^c, h) = \frac{\rho}{\rho + \delta(1-\rho)}.$$

Consider P_2^*. Lemma 1 shows that a normal operator will set $o_2 = m$. Using the same arguments as used in part (a), we see that the pricing condition (Definition 1.a) implies that

$$P_2^*(\hbar_1^c, h) = 1 \times \frac{\rho}{\rho + \delta(1-\rho)} + \delta \times \left(1 - \frac{\rho}{\rho + \delta(1-\rho)}\right). \tag{A.4}$$

Next, note that equation (5) implies that

$$\rho = \frac{F_\rho - \delta}{1-\delta}. \tag{A.5}$$

Replacing the ρ terms on the right-hand side of equation (A.4) , with the right-hand side of equation (A.5) and simplifying verifies the expression for $P_2^*(\hbar_1^c, h)$ presented in this lemma. □

Lemma A-2. *In any equilibrium in which $o_1^*(\hbar_1^o) = s$, (a) $\mu_1^*(\hbar_1^c) = \rho$ and $P_1^*(\hbar_1^c) = 1$; (b) $\mu_2^*(\hbar_1^c, h) = \rho$ and $P_2^*(\hbar_1^c, h) = F_\rho$ (defined by equation* (5)*).*

Proof of Lemma A-2. Part (a) follows because, in period 1, the price is set before customers observe the actions of the operator; so the probability that customers assigns to the operator being committed at $\hbar_1^c$ is the customers' prior, ρ.

Now consider P_1^*. The committed operator always chooses operating policy s. By hypothesis the normal operator sets $o_1^*(\hbar_1^o) = s$. The s policy always yields an h quality good in period 1. So, $q_1 = h$. Hence, the good's value equals 1 and the pricing condition (Definition 1.a) implies that the customers' price at $\hbar_1^c$ equals 1.

Part (b) follows because, when $o_1^*(\hbar_1^o) = s$, the customer history $\hbar_2^c = (\hbar_1^c, h)$ is reached with probability 1. Thus Bayes rule implies that $\mu_1^*(\hbar_1^c) = \mu_2^*(\hbar_2^c)$.

Consider P_2^*. Lemma 1 shows that, at all period 2 histories of the normal operator, the normal operator plays m. Using the same argument as used in Lemma A-2.a, we see that, when the operator plays s expected good quality equals 1, and when the operator plays m, expected good quality equals δ. Thus, the pricing condition (Definition 1.a) implies that the price of the period 2 good, $P_2^*(\hbar_1^c, h)$, equals $1 \times \rho + \delta(1-\rho)$. □

Lemma A-3. *In any equilibrium, if $\hbar_2^c = (\hbar_1^c, l)$, then (a) $\mu^*(\hbar_2^c) = r$, and (b) $P_2^*(\hbar_2^c) = F_r$, where*

$$F_r := r + \delta\,(1-r). \tag{A.6}$$

Proof of Lemma A-3. Part (a) follows because $\hbar_2^c = (\hbar_1^c, l)$ implies that $q_1 = l$, so reform is initiated and is successful with prior probability r. When reform is successful, the (normal) operator must use policy s by assumption. When reform fails, Lemma 1 shows that the operator chooses policy m. The Lemma's specification of P_2^* follows from the same argument used to establish Part (a) of Lemma A-1 after replacing $t = 1$ with $t = 2$ and replacing ρ with r. □

Lemma A-4. *(a) In a setting in which the operator remains with the firm after reform, a no-reputation equilibrium exists if and only if*

$$\big(\phi_2(F_2, h) - \phi_2(F_r, l)\big) - \frac{c\,(1-(1-\delta)r)}{1-\delta} \leq 0,$$

(b) In a setting in which the operator is replaced after reform, a no-reputation equilibrium exists if and only if

$$\phi_2(F_2, h) - \frac{\delta\, c}{1-\delta} \leq 0,$$

(c) In a no-reputation equilibrium, beliefs and prices are given by Lemma A-1 and Lemma A-3, and operator strategies are $o_1^*(\hbar_1^o) = m$, for all $\hbar_1^o \in \mathcal{H}_1^o$, and $o_2^*(\hbar_1^o) = m$, for all $\hbar_2^o \in \mathcal{H}_2^o$.

Proof of Lemma A-4. For fixed payment structure, ϕ, histories in $\mathcal{H}_1^o$ vary only with respect to period-1 prices, $p_1 \in \mathbb{R}_+$. Because prices reflect customers' expectations and customer's cannot observe the chosen operating policy, in period 1, the difference between the payoff to a normal operator from the s and m policies is not affected by p_1. Hence, any policy that is a best response for the operator at a history $\hbar_1^o$, is a best reply for all $\hbar_1^o \in \mathcal{H}_1^o$.

Using the results of Lemmas 1, A-1 and A-3, if the operator remains with the firm after reform, we can define the operator's expected payoff when choosing the period 1 operating policy as

$$v_1^{\mathrm{o}}(o_1, p_1) = \phi_1(p_1) + \begin{cases} \phi_2(F_2, h) + c & o_1 = s. \\ c + \delta(\phi_2(F_2, h) + c) + (1-\delta)\Big(\phi_2(F_r, l) + c - rc\Big) & o_1 = m, \end{cases} \tag{A.7}$$

A comparison of these two payoffs establishes the first result in the lemma.

Using the results of Lemmas 1, A-1 and A-3, if the operator is replaced after reform, we can rewrite the period 1 operator's expected payoff as

$$v_1^{\mathrm{o}}(o_1, p_1) = \phi_1(p_1) + \begin{cases} \phi_2(F_2, h) + c & o_1 = s. \\ c + \delta(\phi_2(F_2, h) + c) & o_1 = m, \end{cases} \tag{A.8}$$

A comparison of these two payoffs establishes the second result in the lemma.

The third result in the lemma follows directly from Lemmas 1, A-1 and A-3 and the definition of a no-reputation equilibrium. □

Proof of Lemma 2. For fixed payment structure, ϕ, histories in $\mathcal{H}_1^o$ vary only with respect to period-1 prices, $p_1 \in \mathbb{R}_+$. Because prices reflect customers' expectations and customers cannot observe the chosen operating policy, in period 1, the difference between the payoff to a normal operator from the s and m policies is not affected by p_1. Hence, any policy that is a best response for the operator at a history $\hbar_1^o$, is a best reply for all $\hbar_1^o \in \mathcal{H}_1^o$.

Using the results of Lemmas 1, A-2 and A-3, if the operator remains with the firm after reform, we can rewrite the operator's expected payoff as

$$v_1^{\mathrm{o}}(o_1, p_1) = \phi_1(p_1) + \begin{cases} \phi_2(F_\rho, h) + c & o_1 = s. \\ c + \delta(\phi_2(F_\rho, h) + c) + (1-\delta)\Big(\phi_2(F_r, l) + c - rc\Big) & o_1 = m, \end{cases} \tag{A.9}$$

A comparison of these two payoffs establishes the first result in the lemma.

Using the results of Lemmas 1, A-2 and A-3, if the operator is replaced after reform, we can rewrite the period 1 operator's expected payoff as

$$v_1^{\mathrm{o}}(o_1, p_1) = \phi_1(p_1) + \begin{cases} \phi_2(F_\rho, h) + c & o_1 = s. \\ c + \delta(\phi_2(F_\rho, h) + c) & o_1 = m, \end{cases} \tag{A.10}$$

A comparison of these two payoffs establishes the second result in the lemma.

Note that F_2 is strictly higher than the period 1 good's price, F_ρ because

$$F_2 = 1 + \delta - \frac{\delta}{F_\rho} = F_\rho + \big(1 - F_\rho\big)\,\frac{F_\rho - \delta}{F_\rho} > F_\rho. \tag{A.11}$$

The fact that $F_\rho < F_2$ and monotonicity of ϕ_2 imply that it is always the case that $\phi_2(F_2, h) \geq \phi_2(F_\rho, h)$. A comparison of the reputation conditions in Lemma 2 with the corresponding no-reputation conditions in Lemma A-4 shows that, if a reputation condition is strictly satisfied, or $\phi_2(F_2, h) > \phi_2(F_\rho, h)$ then the no-reputation condition cannot be satisfied.

The fourth result in the lemma follows directly from Lemmas 1, A-2 and A-3 and the definition of a reputation equilibrium.

□

Proof of Proposition 1. All candidate equilibria supported by reputation-assuring governance policies are payoff equivalent as are all candidate equilibria supported by no expected compensation policies. Let $\mathscr{R}$ denote a candidate equilibrium supported by reputation-assuring governance policy and $\neg\mathscr{R}$ a candidate equilibrium supported by a no expected compensation policy. Then, substituting equilibrium-path operator strategies and good prices, defined in Lemmas 2 and A-4, into the owner's payoff function, expression (7), results in a well-defined function, denoted by $\hat{v}^{\mathrm{PM}}$, which maps the payoffs from $\mathscr{R}$ and $\neg\mathscr{R}$-candidate equilibria into owner payoffs. After an algebraic simplification that uses the relationship between F_ρ and ρ defined in equation (A.5), the resulting expressions are

$$\begin{aligned}\hat{v}^{\mathrm{PM}}(\mathscr{R}) &= 1-e+\left(F_\rho - e - b^*\right), \\ \hat{v}^{\mathrm{PM}}(\neg\mathscr{R}) &= \left(F_\rho - e\right)+\left(1-F_\rho\right)\,(F_r-e-R)+F_\rho\,(F_2-e)\,.\end{aligned} \tag{A.12}$$

Comparing $\hat{v}^{\mathrm{PM}}(\mathscr{R})$ and $\hat{v}^{\mathrm{PM}}(\neg\mathscr{R})$ yields

$$\begin{aligned} 1-e+F_\rho-e-b^* &\geq F_\rho-e+(1-F_\rho)(F_r-R-e)+F_\rho(F_2-e) \\ \iff \pi_1-b^* \geq (1-F_\rho)\pi_r+F_\rho\left(1+\delta-\frac{\delta}{F_\rho}-e\right) &\iff b_1^* \leq (1-F_\rho)(\pi_1-\pi_r+\delta), \end{aligned} \tag{A.13}$$

where $\pi_1 = 1-e$ denotes the period 1 profit if the good's price is 1, and $\pi_r = F_r - e - R$ denotes the period 2 profit if the firm is reformed.

Rearranging the last inequality (expression (A.13)) so as to put ρ on the left-hand side produces equation (12) in the proposition. If the inequality (12) is weakly satisfied, then reputation equilibria satisfy governance optimality. This establishes part (a). If the inequality is strictly satisfied, *only* reputation equilibria satisfy governance optimality. This establishes part (b.i). Part (b.ii) follows directly from part (c) of Lemma 2 after noting that, under professional management, $\phi_1(p_1)\equiv 0$, $\phi_2(p_2,l)\equiv 0$ for both the replaced the replacement manager, and that $\phi_2(p_2,h)=g^*(p_2)$. □

Proof of Proposition 2. Lemma 2 shows that, if the operator remains with the firm after reform, a reputation equilibrium exists if and only if

$$(1-\delta)\phi_2(F_\rho,h) \geq (1-\delta)\phi_2(F_r,l)+c\,(1-(1-\delta)r).$$

Substituting owner management payment structure, $\phi_2(p_2,h)=p_2-e$, $\phi_2(p_2,q_1=l)=p_2-e-R$, and $\phi_1(p_1)=p_1-e$, and noting that $c\,(1-(1-\delta)r)=\delta\,c+(1-\delta)c(1-r)=\delta\,c+(1-\delta)\hat{c}$, shows that

$$\begin{aligned}(1-\delta)(F_\rho - e) &\geq (1-\delta)\phi_2(F_r, l) + c\,(1-(1-\delta)r) \\ &\geq (1-\delta)(\pi_r + \hat{c}) + \delta\, c \\ &\iff F_\rho \geq e + \pi_r + \hat{c} + \frac{\delta\, c}{1-\delta},\end{aligned} \tag{A.14}$$

implies that the hypotheses of Lemma 2.a is satisfied, The fact that under the owner management payment structure, $p_2 \mapsto \phi_2(p_2, h)$ is strictly increasing shows that the hypothesis of Lemma 2.c is also satisfied. Thus, the proposition follows from Lemma 2. Rearranging equation (A.14) so as to put ρ on the left-hand side produces equation (13) in the proposition. □

Proof of Proposition 3. The proof of this result follows the same approach as used in the proofs of Propositions 1 and 2. First apply the payment structure for owner and professional; management respectively and then use Lemma 2 to characterize the conditions for a reputation equilibria.

Under owner management, picking the reputable policy in period 1 is a best response if and only if

$$\begin{aligned}1 - e + F_\rho - (e-c) \geq 1 - (e-c) + \delta(F_\rho - (e-c)) \\ \iff F_\rho - e \geq \delta(F_\rho - e) + \delta c \\ \iff F_\rho \geq 1 - \pi_1 + b^*.\end{aligned} \tag{A.15}$$

Under professional management, the owner choosing reputation-assuring compensation is a best response if and only if

$$\begin{aligned}1 - e + F_\rho - e - b^* \geq F_\rho - e + F_\rho(F_2 - e) \\ \iff \pi_1 - b^* \geq F_\rho\left(1 + \delta - \frac{\delta}{F_\rho} - e\right) \\ \iff b_1^* \leq (1 - F_\rho)(\pi_1 + \delta).\end{aligned} \tag{A.16}$$

The expressions in the proposition follow from rearranging the expressions so as to put ρ on the left-hand side of the inequalities. □

Lemma A-5. *When the firm is controlled by an owner-operator, in a mixed equilibrium:*

1. $p_1^* = \frac{F_\rho - \delta}{p_2^* - \delta}$.
2. *If the owner-operator remains unrevealed,* $p_2^* = 1 - \pi_1 + b^* + \pi_r + g$.

3. *If the owner-operator is normal, the owner picks policy m with probability* $\eta = \frac{1-p_1^*}{(1-\rho)(1-\delta)}$.

Proof of Lemma A-5. To be willing to randomize, the owner-operator must be indifferent between policies s and m. Her expected payoff from setting $o_1 = s$:

$$p_1^* - e + p_2^* - I, \tag{A.17}$$

Her expected payoff from setting $o_1 = m$ equals:

$$p_1^* - I + \delta(p_2^* - I) + (1-\delta)\Big(r(F_r - e) + (1-r)(F_r - I) - R\Big). \tag{A.18}$$

The price in each period equals the total probability of a high quality good. Since beliefs and, thus, prices conform to Bayes' rule. Thus, the period 2 price conditioned on the owner-operator remaining unrevealed in period 1 equals:

$$\begin{aligned} p_2^* = \frac{\rho}{p_1^*} + \left(1 - \frac{\rho}{p_1^*}\right)\delta = \delta + \frac{\rho(1-\delta)}{p_1^*} &= \delta + \frac{F_\rho - \delta}{p_1^*} \\ \iff p_1^* &= \frac{F_\rho - \delta}{p_2^* - \delta}. \end{aligned} \tag{A.19}$$

Equating the two expected payoffs, (A.17) and (A.18), we obtain

$$\begin{aligned} p_1^* - e + p_2^* - I = p_1^* - I + \delta(p_2^* - I) + (1-\delta)\Big(r(F_r - e) + (1-r)(F_r - I) - R\Big) \\ \iff p_2^* - e = \delta(p_2^* - I) + (1-\delta)(\pi_r + g) \\ \iff (1-\delta)(p_2^* - e) = \delta c + (1-\delta)(\pi_r + g) \\ \iff p_2^* = 1 - \pi_1 + b^* + \pi_r + g. \end{aligned} \tag{A.20}$$

□

B Subject instructions

This appendix contains instructions for all three treatments under Parameter Set I. Differences are set off by "**((**" followed by **OM:** for Owner Management, **OMR:** for Owner Management with Reform or **PM:** for Professional management; and closed by "**))**." Parameter Set II instructions differ in describing the fraction of managers who have Method 2 (the vulnerable production technology) available and changes manager payoffs in accordance with the parameter set.

INSTRUCTIONS

General

You are about to participate in an experiment on decision making. If you follow these instructions carefully and make good decisions, you might earn a considerable amount of money, which will be paid to you in cash at the end of the experiment.

At the beginning of the experiment, all players are assigned a type: Blue or Green. You will remain Blue or Green throughout the experiment. Next, one Blue and one Green Player are randomly assigned to a 2-player group. These players will interact with each other for two periods. Then, players are randomly re-assigned to new groups for two more periods. This process repeats until the end of the experiment.

The currency used in these games is francs. Each period, you receive franc payoffs that are yours to keep. At the end of the experiment, you will exchange francs for dollars. Your individual exchange rate will be displayed on your computer terminal after the experiment starts. Do not reveal this number to anyone. At the end of the experiment, your francs will be converted to dollars at this rate, and you will be paid in dollars. Note that the more francs you earn, the more dollars you earn regardless of the exchange rate.

Stages of the Game

Each period is divided into two stages.

Briefly, in Stage I, the Blue Player makes decisions about producing an item and sells it to the experimenter. In Stage II, the Green Player will have an opportunity to buy the item from the experimenter. There are two types of items: Round, worth 1,000 francs to the Green Player and Square, worth 0 francs to the Green Player.

Because it will make it easier to understand, we describe the Stages in reverse order.

Stage II Instructions

Green Player Decision

In Stage II, the Green Player sets a "Limit Price" for an item and *may* buy the item. If he or she does buy the item, it will be at a "Discounted Price" that is less than or equal to the Limit Price.

If the Green Player buys the item, he or she will receive a "Redemption Value" of 1,000 francs for a Round item and 0 francs for a Square item.

The item type is determined in Stage I but the type will not be known by the Green Player until after he or she establishes the Limit Price in Stage II.

Procedures

The Limit Price and the Discounted Price for the item will be determined as follows.

1. Limit Price: The Green Player will be asked to indicate the *highest* price he or she is willing to pay for the item. This determines the ***Limit Price***. The Limit Price must be between 0 and 1,000 (inclusive). The Green Player is asked to enter the price and press "OK" to continue.

2. Discounted Price: The computer program will determine a ***Discounted Price*** by drawing a random number between 0 and 1,000 (inclusive) to be the Discounted Price.

If the random draw is ***less than or equal to*** the Limit Price, the Green Player will buy the item at the Discounted Price from the experimenter and receive the Redemption Value.

If the random draw is ***greater than*** the Limit Price indicated by the Green Player, then the Green Player will not buy the item.

Thus, the Limit Price defines the highest price that the Green Player will pay for the item. If he or she buys the item it will be at a Discounted Price less than or equal to the Limit Price.

Payoff Determination

The Green Player starts each period with working capital of 1,000 francs. This allows the Green Player to pay up to 1,000 francs for an Item. Three quarters (75%) of the working capital will be deducted at the end of the period. The Green Player's payoffs are determined as follows:

If the Discounted Price is greater than the Limit Price:

Period Payoff = 1,000 – 750 = 250.

If the Discounted Price is less than the Limit Price:

Period Payoff = 1,000 + Redemption Value – Discounted Price – 750.

Notice that buying the item increases your payoff whenever the Redemption Value is higher than the Discounted Price AND you buy the item (that is, the Limit Price is higher than the Discounted Price).

Notes on this Procedure

If you are a Green Player, it is in your best interest to be accurate; that is, the best thing you can do is state truthfully the highest price you would be willing to pay for the item as the Limit Price. If the price stated is too high or too low, then you pass up opportunities that you would prefer.

Suppose you are a Green Player and you are certain that the Item will be Round. Then, you should set a Limit Price of 1,000. If you set it less, say 800, then whenever the random draw is between 800 and 1,000, you will not purchase the item even though the item is worth more to you than the discounted price. For example, if the Discounted Price is 900, you are better off buying the item (Payoff = 1000+1000-900-750 = 350) than not buying the item (Payoff = 1000-750 = 250). The only way to insure that you will always buy the item when the Discounted Price is less than the value is to set the Limit Price at 1,000.

Similarly, if you are certain that the Item will be Square, then you should set a Limit Price of 0. If you set it more, say 200, then whenever the random draw is between 0 and 200, you end up buying the item even though it is worthless to you. For example, if the Discounted Price is 100, you are worse off buying the item (Payoff = 1000+0-100-750 = 150) than not buying the item (Payoff = 1000-750 = 250). The only way to insure that you will never buy the item when the Discounted Price is more than the value is to set the Limit Price at 0.

Similar arguments imply that, if, on average, you expect the item value to be X francs (e.g., 500), then you should set a Limit Price equal to X (e.g., 500). If so, you always buy the item when the Discounted Price is less than what you think it is worth on average and never buy it if the Discounted Price is more than what you think it is worth.

We will discuss Stage I next. Before doing that, are there any questions about the Green Player's actions in Stage II and the Green Player's payoffs?

<u>Stage I Instructions</u>

In Stage I, the Blue Player selects a "production method." Methods available and the earnings received by the Blue Player vary as described below.

Determining Available Production Methods

In the first period of a group interaction, the computer randomly determines the production methods available to the Blue Player.

In the first period, 1/8 (12.5%) of the Blue Players MUST produce according to the following method in BOTH periods:

- **Method 1: Sure**, which always produces a Round Item

In the first period, the other 7/8 (87.5%) of the Blue Players can CHOOSE between producing according to:

- **Method 1: Sure**, which always produces a Round Item.

- **Method 2: Mixed**, which produces a Round Item 1/20 (5%) of the time and a Square Item 19/20 (95%) of the time.

In the second period, these Blue Payers will be restricted to a single production method as follows:

- ((**OM:** They MUST produce according to **Method 2 Mixed** in the second period of the group interaction.))
- ((**OMR & PM:** If these Blue Players produce a Round Item in the first period of a group interaction, they MUST produce according to **Method 2 Mixed** in the second period of the group interaction.))
- ((**OMR & PM:** If these Blue Players produce a Square Item in the first period of a group interaction, the computer will randomly re-draw production methods for the second period of the group interaction. In this case, 1/10 (10%) of the Blue Players MUST produce according to **Method 1: Sure** and 9/10 (90%) MUST produce according to **Method 2: Mixed** in the second period of the group interaction.))

Payoff Determination

The Blue Player's payoffs are determined by a "Sale Price" set by the experimenter and a method payment in each period.

In the first period of a group interaction, the Sale Price equals ((**OM & OMR:** the Limit Price set by the Green Player)) ((**PM:** 111)). Thus, the payoff is ((OM & OMR: the Limit Price)) ((PM: 111)) minus a method payment that depends on the method chosen. Specifically:

Period 1 Payoff		
Method:	Method 1: Sure	Method 2: Mixed
Availability:	Always	7/8 (87.5%) of the time
+ Sale Price - Method Payment	((**OM & OMR:** Limit Price)) ((**PM:** 111)) -111	((**OM & OMR:** Limit Price)) ((**PM:** 111)) -51
Total Payoff	((**OM & OMR:** Limit Price - 111)) ((**PM:** 0))	((**OM & OMR:** Limit Price - 51)) ((**PM:** 60))

For example, suppose the Limit Price was 500 in Period 1. Your payoff would be:

- ((**OM & OMR:** 500-111=389)) ((**PM:** 111-111=0)) if **Method 1: Sure** was available and chosen.
- ((**OM & OMR:** 500-51=449)) ((**PM:** 111-51=60)) if **Method 2: Mixed** was available and chosen.

In the second period of the group interaction, the Blue Player is always restricted to one production method. The Sale Price is set by the experimenter depending on the Item Type produced in Period 1 ((**OMR & PM:** and the redraw outcome. In addition, if the Period 1 Item was Square, the experimenter will charge a cost to redraw production methods)).

The Blue Player's payoffs are summarized in the following table:

((OM:

Period 2 Payoff			
Period 1 Item:	Round		Square
Method:	Method 1: Sure	Method 2: Mixed	Method 2: Mixed
Availability:	If only Method 1 was available in Period 1	If both Methods were available in Period 1	Always
+ Sale Price	169	169	51
- Method Payment	-111	-51	-51
Total Payoff	58	118	0

))

((OMR:

Period 2 Payoff				
Period 1 Item:	Round (No Redraw)		Square (Redraw)	
Method:	Method 1: Sure	Method 2: Mixed	Method 1: Sure	Method 2: Mixed
Availability:	If only Method 1 was available in Period 1	If both Methods were available in Period 1	1/10 (10%) of the time	9/10 (90%) of the time
+ Sale Price	192	192	145	145
- Method Payment	-111	-51	-111	-51
- Redraw Cost	0	0	-10	10
Total Payoff	81	141	24	84

))

((PM:

Period 2 Payoff				
Period 1 Item:	Round (No Redraw)		Square (Redraw)	
Method:	Method 1: Sure	Method 2: Mixed	Method 1: Sure	Method 2: Mixed
Availability:	If only Method 1 was available in Period 1	If both Methods were available in Period 1	1/10 (10%) of the time	9/10 (90%) of the time
+ Sale Price	141	141	121	121
- Method Payment	-111	-51	-111	-51
- Redraw Cost	0	0	-10	70
Total Payoff	30	90	0	0

))

In Period 2 after a Round Item in Period 1, your payoff would be:

- **((OM:** 58**))** **((OMR:** 81**))** **((PM:** 30**))** if **Method 1: Sure** becomes the only available method in Period 2 because it was the only available method in Period 1.
- **((OM:** 118**))** **((OMR:** 141**))** **((PM:** 90**))** if **Method 2: Mixed** becomes the only available method in Period 2 because both methods were available in Period 1 and a Round item was produced.

In Period 2 after a Square Item in Period 1 **((OMR & BMR:** and a redraw in Period 2**))**, your payoff would be:

- **((OM:** 0 with **Method 2: Mixed** becoming the only available method.**))**
- **((OMR:** 24 if **Method 1: Sure** becomes the only available method as a result of the redraw.**))**
- **((PM:** 0 if **Method 1: Sure** becomes the only available method as a result of the redraw.**))**
- **((OMR:** 84 if **Method 2: Mixed** becomes the only available method as a result of the redraw.**))**
- **((PM:** 0 if **Method 2: Mixed** becomes the only available method as a result of the redraw.**))**

We will discuss how player types and groups are determined next. Before doing that, are there any questions about the Blue Player's actions in Stage I and the Blue Player's payoffs?

Group, Player Type and Technology Determination

At the beginning of the experiment, you are assigned a player type: "Blue" or "Green." You remain this type of player for the entire experiment. Every 2 periods, one Blue and one Green Player are matched randomly to play the game for two periods. Everyone is re-assigned to new groups every 2 periods. Thus, in periods 1 and 2, you will be with one group. In period 3, you will be randomly re-assigned to new groups for periods 3 and 4, etc.

The computer draws new Production Methods at the beginning of each group interaction (that is, every 2 periods) as follows:

1. 1/8 (12.5%) of the Blue Players will ONLY be able to produce using "**Method 1: Sure**."

2. 7/8 (87.5%) of the Blue Players on average will be able to produce using EITHER "**Method 1: Sure**" OR "**Method 2: Mixed**."

((OM: In**))** **((OMR & PM:** If no redraw occurs in**))** Period 2 of a group interaction, "**Method 1: Sure**" remains the only available production method if it was the only available method in Period 1. "**Method 2: Mixed**" becomes the only available production method if both methods were available in Period 1.

((OMR & PM: If a redraw occurs in Period 2 of a group interaction because a Square item was produced in Period 1, "**Method 1: Sure**" becomes the only available production method 1/10 (10%) of the time and "**Method 2: Mixed**" becomes the only available production method 9/10 (90%) of the time.**))**

Neither the Methods available nor the Method actually chosen are revealed to the Green Player. The Item type is revealed after Period 1 **((OMR & PM:** and whether methods were redrawn is revealed between periods**))**. So, in Period 2, there are the following possibilities:

1. The Blue Player produced a Round Item in Period 1. Thus, the Green Player does not know whether "**Method 1: Sure**" or "**Method 2: Mixed**" was used in Period 1 nor which is the only available method in Period 2. (Recall, **Method 1: Sure** is always available and, sometimes, **Method 2: Mixed** produces a Round Item in Period 1.)

2. **((OM:** The Blue Player produced a Square Item in Period 1. Thus, the Green Player knows that "**Method 2: Mixed**" was available and used in Period 1 AND **Method 2: Mixed** will be the only method available in Period 2.)**))**

3. **((OMR & PM:** The Blue Player produced a Square Item in Period 1 and a redraw occurred. Thus, the Green Player knows that "**Method 2: Mixed**" was available and used in Period 1, but does not know the method available in Period 2. (Recall that, after a redraw, 1 in

10 times, only **Method 1: Sure** is available and 9 in 10 times only **Method 2: Mixed** is available.)))

End of Period Results

The computer program reports results to you at the end of each period. Beginning in the next period a history of results appears in two windows. The left window shows the publicly available information given to all players in your group. Note that this will NOT give the Methods available to or used by the Blue Player. The right window gives your private information and shows your payoff. You can scroll through these windows and record results as you wish. In particular, you may want to fill in your earnings on your receipt each period.

End of Experiment Rules

The computer will total your earnings in francs at the end of the experiment. It multiplies this amount by the exchange rate to determine the amount of dollars you receive. Fill this number in on your receipt. You will be paid this amount of dollars in cash.

Are there any questions?

Summary Sheet

Methods are drawn randomly each time groups are reassigned as follows:

1. Initially, 1/8 of the Blue Players will have ONLY "**Method 1: Sure**" available.
2. The other 7/8 of the Blue Players will have both "**Method 1: Sure**" and "**Method 2: Mixed**" available.

Within a group:

1. If the Period 1 item is Round and "**Method 1: Sure**" was the only method available, it remains the only available method in Period 2.
2. If the Period 1 item was Round and both methods were available, "**Method 2: Mixed**" becomes the only available method in Period 2.
3. ((**OM:** If the item produced in Period 1 was Square then, "**Method 2: Mixed**" becomes the only available method in Period 2.))

4. **((OMR & PM:** If the item produced in Period 1 was Square then, methods are redrawn in Period 2.

   4.1. "**Method 1: Sure**" will be the only method 1/10 times.

   4.2. "**Method 2 Mixed**" will be the only method the other 9/10 times.**))**

Neither the methods available nor the method actually used in any given period will be revealed to the Green Player. Only the Item type will be revealed.

The game proceeds as follows:

1. Players are randomly assigned to groups every two periods. The Blue Player is assigned newly drawn Methods.

2. Stage I

   2.1. The Blue Player chooses a method.

   2.2. The Blue Player receives a payment as follows:

      - In the first period of a group interaction, the Blue Player receives: **((OM & OMR:** the Limit Price of the item minus 111 if **Method 1: Sure** is used OR the Limit Price minus 51 if **Method 2: Mixed** is used.
        - **((PM:** 0 if **Method 1: Sure** is used.**))**
        - **((PM:** 60 if **Method 2: Mixed** is used.**))**
      - In the second period of a group interaction, the Blue Player receives:
        - **((OM:** 58**))** **((OMR:** 81**))** **((PM:** 30**))** if a Round item was produced in Period 1 and Method 1: Sure is used in Period 2.
        - **((OM:** 118**))** **((OMR:** 141**))** **((PM:** 90**))** if a Round item was produced in Period 1 and Method 2: Mixed is used in Period 2.
        - **((OM:** 0 if a Square item was produced in Period 1.**))**
        - **((OMR:** 24 if a Square item was produced in Period 1 and Method 1: Sure is used in Period 2.**))**
        - **((OMR:** 84 if a Square item was produced in Period 1 and Method 2: Mixed is used in Period 2.**))**
        - **((PM:** 0 if a Square item was produced in Period 1 and Method 1: Sure is used in Period 2.**))**

- **((PM:** 0 if a Square item was produced in Period 1 and Method 2: Mixed is used in Period 2.))

3. Stage II

   3.1. The Green Player receives working capital of 1,000 each period.

   3.2. The Green Player will be told whether Methods have been newly drawn, re-drawn or be restricted to a single method from the prior period.

   3.3. Prices are determined:

   - The Green Player decides the most he or she is willing to pay for the item and sets the Limit Price.
   - The computer draws a random Discounted Price between 0 and 1,000.
   - If the Discounted Price is less than or equal to the Limit Price, the Green Player will buy the item at the Discounted Price and receive the Redemption Value (1000 for Round and 0 for Square).

   3.4. In all cases, the Green Player returns 75% of the working capital (750).

You are free to make as much money as you can according to these rules.

C Learning and experience weighted attraction in the experiment

Prior research on reputation in laboratory settings documents that (1) subject behavior deviates systematically from predictions of a rational choice equilibrium benchmark and (2) as subjects gain experience, their strategies better approximate equilibrium predictions (e.g., Brandts and Figueras, 2003; Noe et al., 2012). The main purpose of our experiment is to see whether our theory survives such systematic behavioral deviations. We document this in the main body of the paper. Here, we ask whether the experience moves behavior toward equilibrium predictions as documented in prior research.

C.1 Operator choices as a Markov process

We study how operator choices evolve using two methods. First, we model them as a Markov process (cf. Axelrod, 1987; Erev and Roth, 1998) and ask whether state transitions evolve toward equilibrium predictions. There are three possible operator condition–choice pairs: (secure, reliable), (insecure, reliable), (insecure, vulnerable). We use these three pairs as 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.[1] 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 C.1. Panel B of Table C.1 provides estimates conditioned on the previous round's outcome. Overall, the evidence in Table C.1 indicates a tendency for reputable behavior to increase with operator experience.

Table C.1: *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 χ^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

	Paremter Set 1			Paremter Set 2		
Treatment	Round 1	Overall	SS	Round 1	Overall	SS
OM	61.9%	72.6%	74.0%	61.1%	68.2%	68.7%
obs.	21	241	#N/A	18	198	#N/A
OMR	50.0%	50.2%	50.2%	50.0%	56.8%	57.2%
obs.	20	225	#N/A	18	199	#N/A
PM	46.7%	69.7%	72.8%	47.1%	59.6%	61.3%
obs.	15	201	#N/A	17	208	#N/A

Panel B: Frequency of reputation building conditioned on previous round's outcome

		Outcome in previous round				
	State:	Secure	Reputation	Opportunistic		
	Good's Quality:	High	High	Low	High	
	Treatment					Chi2 (p-value)
Parameter Set 1	OM	80.0%	78.5%	61.1%	0.0%	12.10 (0.007)
	OMR	30.8%	61.5%	46.4%	0.0%	13.12 (0.004)
	PM	59.1%	83.9%	51.0%	33.3%	22.38 (0.000)
Parameter Set 2	OM	58.7%	75.3%	66.7%	0.0%	6.36 (0.095)
	OMR	48.7%	62.2%	58.6%	0.0%	4.70 (0.195)
	PM	52.3%	85.2%	31.5%	20.0%	46.31 (0.000)

[1] Of course, the operator has no control over transitions to the strategy in the secure state. 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.

C.2 Experience weighted attraction

We also estimate regression models of subject behavior. Again, we are asking whether behavior moves toward equilibrium behavior with experience. We model subject choices 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.

C.2.1 Experience weighted attraction for operators

To model operator behavior, along the lines of Erev and Roth (1998) and Camerer et al. (2002), we define the attraction to the reputation, opportunism and secure strategies as follows:

$$\begin{aligned}
A_{s,t}^{Reputation} &= A_{s,t-1}^{Reputation} + \Phi_{s,t-1}^{Reputation}\left[\pi_{s,t-1}^{Reputation} - \delta E(\pi_{s,t-1}^{Defection}) - \min\left(\pi_{s,t-1}^{i} - \delta E(\pi_{s,t-1}^{j})\right)\right], \\
A_{s,t}^{Opportunism} &= A_{s,t-1}^{Defection} + \Phi_{s,t-1}^{Defection}\left[\pi_{s,t-1}^{Defection} - \delta E(\pi_{s,t-1}^{Reputation}) - \min\left(\pi_{s,t-1}^{i} - \delta E(\pi_{s,t-1}^{j})\right)\right], \text{ and} \\
A_{s,t}^{Secure} &= A_{s,t-1}^{Secure} + \Phi_{s,t-1}^{Secure}\left[\pi_{s,t-1}^{Secure} - \delta E(\pi_{s,t-1}^{Secure}) - \min\left(\pi_{s,t-1}^{i} - \delta E(\pi_{s,t-1}^{j})\right)\right],
\end{aligned} \tag{C.21}$$

where t indexes rounds (each consisting of two periods), $A_{s,t}^{i}$ is the attraction that strategy i holds for subject s in round t (with $A_{s,1}^{i} = 0$); $\Phi_{s,t-1}^{i}$ is an indicator function equal to 1 if subject s plays strategy i in round $t-1$; $\pi_{s,t-1}^{i}$ is the (two-period overall) profit received by subject s who played strategy i in round $t-1$; $E(\pi_{s,t-1}^{\neg i})$ is the profit subject s would have expected to receive by playing the best alternative strategy to i in period $t-1$; and δ is a weighting function for the strategies not played. Subtracting the minimum possible profit difference both normalizes the attractions and insures that attractions are never negative. If $\delta = 0$, the subject weights only payoffs actually received in updating attractions. If $\delta = 1$, the subject weights strategies played equally with the forgone earnings of unplayed strategies.

To see the intuition behind these attraction measures, consider a simple example. Suppose an owner-manager of an insecure firm plays the reputation strategy in treatment OM-I. The payoff to the strategy is: $p_0 - 111 + 118$. The expected payoff from the opportunism strategy is: $p_0 - 60 + 0.05 \times 118$. In this case, the lowest possible payoff to any strategy is -53. So, if $\delta = 0$, the increment to attraction is: $p_0 - 111 + 118 + 53 = p_0 + 60$. If $\delta = 1$, the subject considers the expected payoff to the defection strategy and the lowest difference in expected payoffs between strategies is -58. So, the increment to attraction becomes $p_0 - 111 + 118 - (p_0 - 51 + 0.05 \times 118) + 58 = 110.1$.

Given the attractions at the beginning of a round, the propensity to play a strategy is given by:

$$q^i_{s,t} = \frac{A^i_{s,t}}{\sum_j A^j_{s,t}}. \tag{C.22}$$

Note that, as defined, higher (lower) payoffs from playing the reputation strategy in the past add to (subtract from) the propensity to play it again. Similarly, lower (higher) payoffs to playing the opportunism strategy in the past adds to (subtract from) the propensity to play the reputation strategy currently. Thus, a greater propensity for reputable behavior is driven by either high past payoffs to the reputation strategy or low past payoffs to opportunism.

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."[2] Our estimates employ robust standard errors clustered by subject to control for repeated observations.[3] We present the estimates in Table C.2.

In Table C.2 we present logit models of operator behavior. The estimates in the table suggest that (i) consistent with our model's prediction, adding reform reduces reputable behavior under Parameter Set I and there is no significant difference between the OM and PM treatments in fostering reputation. Men are somewhat more prone to behave reputably under Parameter Set I.[4] (ii) operators are more prone to choose the reliable technology when this choice has led to higher payoffs in previous rounds. (iii) professional managers are more responsive to past profitability than owner-managers.

C.2.2 Explaining customer conjectures in period 1

For customers, we change the attraction measures slightly because of the continuous strategy space. We measure attraction as either (1) average period 1 net profits received by customers in prior interactions as a result of buying goods or (2) average prior period 1 values observed by customers

[2]We note that, because propensities are probabilities, alternative specifications of these models would be to use the log-odds ratio of the reliable technology choice propensity as the independent variable. While the results mirror those displayed in Table C.2, we lose 28% of the observations because the propensities are either 0 or 1.

[3]Fixed effects models cannot be used because each subject participates in only one treatment.

[4]In unreported regressions aggregating across treatments, men remain somewhat more prone to form reputations 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.

Table C.2: *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 governance structure treatments. Experience weighted attraction (EWA) regressions include separate propensities to play the reputation strategy in each treatment as defined in equations (C.21) and (C.22) with $\delta = 0$ or $\delta = 1$. Robust standard errors clustered by subject appear in parentheses below each estimate.

			Gross Profit EWA		Net Profit EWA	
	Parameter Set		Parameter Set		Parameter Set	
	I	II	I	II	I	II
Constant	0.66***	0.69***	-0.57	-0.03	-0.39	-0.06
	(0.24)	(0.25)	(0.41)	(0.37)	(0.39)	(0.45)
Gender	0.53*	0.17	0.45**	0.08	0.56**	-0.02
(1=Male)	(0.28)	(0.28)	(0.20)	(0.20)	(0.24)	(0.23)
Owner-Mgr.	-0.84***	-0.48*	-0.24	-0.47	-0.30	-0.30
w/ Reform	(0.30)	(0.29)	(0.46)	(0.41)	(0.46)	(0.50)
Professional Mgr.	-0.15	-0.40	-0.77	-1.21***	-1.39	-1.61***
	(0.40)	(0.36)	(0.70)	(0.47)	(0.91)	(0.55)
Exp. Wtd. Propensity			2.09***	1.39***	1.26***	1.21**
x Owner-Mgr.			(0.66)	(0.54)	(0.47)	(0.53)
Exp. Wtd. Propensity			1.52***	1.76***	1.11*	1.17**
x Owner-Mgr. w/ Reform			(0.51)	(0.54)	(0.63)	(0.54)
Exp. Wtd. Propensity			2.94***	3.09***	3.06***	3.74***
x Professional Mgr.			(0.76)	(0.54)	(0.92)	(0.60)
Obs.	667	605	667	605	667	605
Psuedo R2	4.43%	0.87%	11.84%	9.45%	8.50%	9.98%

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

in prior rounds. Specifically, we define the "attraction" of a good as either:

$$A_{s,t}^{good} = \sum_{n=1}^{t-1} \frac{\Phi_{s,n}^{i} \left(V_{s,n}^{good} - DP_{s,n}^{good} \right)}{t-1} \tag{C.23}$$

or

$$A_{s,t}^{good} = \sum_{n=1}^{t-1} \frac{V_{s,n}^{good}}{t-1} \tag{C.24}$$

where $A_{s,t}^{good}$ is subject s's attraction to the good in round t, $V_{s,n}^{good}$ equals the good's value in round n, $\Phi_{s,n}^{i}$ is an indicator function equal to 1 if subject s purchased the good in round n, and $DP_{s,n}^{good}$ is the good's discounted price for subject s in round n. We refer to the first measure as "Average Prior Net Profit Attraction." It averages prior net profits, weighting un-purchased goods by 0 and purchased goods by their value relative to their purchase prices (analogous to $\delta = 0$ in equation C.22). Thus, it considers not just the value of goods purchased, but also the cost of purchasing them. This measure does not capture the effect of goods not purchased. The second, "Average Prior Value Attraction," is the prior average good value. It is the analog of equation (C.21) with $\delta = 1$ because goods not purchased have the same weight as purchased goods.[5]

Table C.3 presents estimates of the effect of treatments, parameter sets and experience on period 1 prices.[6] The estimates uniformly indicate that experience matters. 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. Average Prior Values always has a large and statistically significant positive effect on prices in both parameter sets. 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 customer strategies toward setting higher good prices suggests that the feedback between customer 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.

[5]We note that this also happens to be the method of moments estimator for a Beta-Binomial Distribution for the probability of a high quality good based on prior observations.

[6]Because, in theory, prices directly convey probabilities of high quality items, we could construct a logistic version of the regressions using OLS on the implied logistic variable defined as $\ln\left(\frac{P/1000}{1-P/1000}\right)$. However, if we do this, we lose 36% of the observations because subjects either set prices at 0 or 1000.

Table C.3: *Censored normal regressions explaining period 1 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 governance 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. ***, ** and * denote significance at the 99%, 95% and 90% levels of confidence, respectively.

			Average Prior Net Profit Attraction		Average Prior Value Attraction	
	Parameter Set		Parameter Set		Parameter Set	
	I	II	I	II	I	II
Constant	704.15***	759.76***	540.03***	704.04***	119.00	416.77**
	(112.30)	(100.35)	(93.44)	(132.96)	(164.59)	(163.00)
Gender	-48.07	-135.84	-74.04	-129.39	-56.42	-82.46
(1=Male)	(83.45)	(83.84)	(72.09)	(90.13)	(73.37)	(76.20)
Round Number	8.02**	4.94*	7.41**	4.34	8.96**	2.98
	(3.42)	(2.87)	(3.78)	(2.91)	(3.59)	(3.07)
Owner-Mgr.	-215.63**	-98.53	-115.73	-148.14	54.08	-335.57
w/ Reform	(105.40)	(111.94)	(106.33)	(166.53)	(188.91)	(262.44)
Professional Mgr.	-104.89	-143.75	-28.87	-134.22	168.22	-188.76
	(112.12)	(97.45)	(127.02)	(132.67)	(201.16)	(199.58)
Attraction			1.07***	0.18	0.80***	0.42**
x Owner-Mgr.			(0.36)	(0.23)	(0.21)	(0.18)
Attraction x Owner-			0.44***	0.64*	0.48***	0.88***
Mgr. w/ Reform			(0.14)	(0.37)	(0.16)	(0.30)
Attraction			0.41*	0.49	0.41***	0.58***
x Professional Mgr.			(0.21)	(0.33)	(0.16)	(0.21)
Obs.	756	792	693	726	693	726
Left Censored	76	96	71	88	71	88
Right Censored	191	196	174	178	174	178
Psuedo R2	0.41%	0.29%	1.46%	0.70%	1.35%	1.40%

C.2.3 Explaining customer conjectures in period 2

Table C.4 presents estimates of experience weighted attraction (EWA) models for period 2 prices. Consistent with our model's predictions, revelation results in a significant price drop of around 320 francs under both parameter sets. The direct effects of reform are broadly in line with the model's predictions. Prices are higher for revealed firms in the professional management and owner manager with reform treatments. For unrevealed firms, as the model predicts, period 2 prices are higher only when we add reform to owner management under Parameter Set I. The estimates incorporating EWA models uniformly indicate that experience matters. As is the case with period 1 goods' prices, customers generally tend to raise (lower) their bid prices for goods after observing higher (lower) quality goods in the past.

Overall, the analysis shows that (1) the intuition underlying our model survives significant behavioral deviations from optimizing behavior and (2) over time, behaviors moves toward those predicted, increasing the tendency toward the equilibria predicted by our model.

Table C.4: *Censored normal regressions explaining period 1 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 governance 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. "***," "**," "*" denote significance at the 99%, 95% and 90% levels of confidence respectively.

			Average Prior Net Profit Attraction				Average Prior Value			
			Revealed Firms		Unrevealed Firms		Revealed Firms		Unrevealed Firms	
	Parameter Set		Parameter Set		Parameter Set		Parameter Set		Parameter Set	
	I	II	I	II	I	II	I	II	I	II
Constant	250.31**	426.53***	-127.52	-205.38	-65.97	384.94**	-115.73	-186.83	-166.68	202.93
	(118.65)	(117.85)	(205.00)	(220.85)	(234.78)	(164.58)	(184.05)	(224.01)	(201.56)	(128.10)
Gender	12.87	71.04	-107.06	38.92	114.26	84.80	-75.21	-8.32	119.41	93.74
(1 = Male)	(90.97)	(92.93)	(130.68)	(167.45)	(141.46)	(110.35)	(122.43)	(178.77)	(119.91)	(96.90)
Period	-8.31*	-5.71	0.81	4.22	7.83	-0.59	3.82	3.32	4.89	-2.66
	(4.38)	(3.68)	(9.34)	(6.65)	(6.94)	(5.60)	(8.98)	(6.46)	(6.91)	(5.24)
Owner-Mgr.	348.09***	60.76	350.07*	333.60**	398.63*	-30.89	212.47	372.68**	315.48*	-172.67
w/ Reform	(115.24)	(109.51)	(190.01)	(151.18)	(219.92)	(153.14)	(178.15)	(173.97)	(190.06)	(158.43)
Professional Mgr.	216.39*	-11.47	399.74	314.97**	148.95	-111.77	331.64	254.66*	210.43	-16.60
	(128.11)	(86.71)	(266.20)	(152.90)	(235.90)	(125.23)	(212.54)	(153.35)	(183.71)	(139.42)
Revealed	-314.29***	-327.30***								
	(72.22)	(84.76)								
Attraction			-3.24**	220.41	-0.34	-0.11	-0.46	-0.08	1.17**	0.71**
x Owner-Mgr.			(1.50)	#N/A	(0.52)	(0.37)	(0.61)	(0.50)	(0.47)	(0.33)
Attraction x Owner-			0.18	-0.35	0.22	0.47	0.34*	0.11	0.74***	1.07***
Mgr. w/ Reform			(0.64)	(0.44)	(0.32)	(0.44)	(0.18)	(0.21)	(0.21)	(0.31)
Attraction			-0.78	1.07*	-0.32	0.25	0.86**	0.46	0.56*	0.30
x Professional Mgr.			(0.64)	(0.63)	(0.57)	(0.28)	(0.37)	(0.37)	(0.33)	(0.20)
Obs.	736	212	135	154	338	482	135	154	338	182
Left Censored	252	96	53	56	96	111	53	56	96	111
Right Censored	96	119	8	12	60	77	8	12	60	77
Psuedo R2	0.96%	0.63%	1.34%	1.69%	0.62%	0.24%	1.81%	1.25%	1.58%	1.52%

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