Ownership, governance, and the brand-capital firm

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Abstract

We model a "brand-capital" firm whose sole asset is its reputation with consumers. The firm is operated by professional non-owner-management. We show that, to secure its reputation, the brand-capital firm must (a) have a potentially viable oversight system to curb managerial opportunism, (b) incentivize management with deferred compensation conditioned on past product prices and (c) be owned by outsiders who are uninformed about the oversight system. We demonstrate that the calculus of reputation for the brand-capital firm differs considerably from classic economic models of reputation formation under incomplete information. Differences include the nature of contracting mechanisms that can support reputation, the role of owner information in facilitating contracting, and the incentive to invest in oversight systems.

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1 Introduction

Many firms can aptly be described as "brand-capital firms," firms whose value is driven by brand reputation.[1] Brand-capital firms are often large, diffusely held, and professionally managed. Their brands' reputations are "corporate" and rarely attach to specific blockholders or managers. In most cases customers, who would be hard pressed to name a single firm employee, pay significant premia to buy products they associate with brand-capital firms. Yet the quality of the products, and hence the firms' brand capital, are directly influenced by the "reputationless" managers' actions, and frequently damaged by their short-term opportunism.

Thus, brand-capital firms appear to have reputations though their owners and management are reputationless. This raises a natural question, the one we plan to address: can reputation preservation for such firms can be rationalized by the "classic" finite-horizon incomplete information model of reputation formation (Kreps and Wilson, 1982; Milgrom and Roberts, 1982)? The answer might appear on first inspection to be no. It is well known that, in the classic setting, in order to avoid the unraveling by backward induction (the chain-store paradox), incomplete information is required. Since the owners of brand capital firms are passive and do not make the operating decisions that determine product reputation, incomplete information about their preferences would not support reputational equilibria. The managers who do make operating decisions are frequently anonymous; attribution of opportunistic actions to specific managers is difficult; and the reputational capital of such managers is negligible compared to corporate resources they control, and thus, their scope for opportunistic behavior.

However, if we think more deeply about locus of reputation for brand capital firms, we see that typically it revolves around some sort of "oversight system." We interpret oversight system broadly to encompass any mechanism designed to prevent short-term opportunism. Oversight systems involve investment in corporate culture, accounting systems, and risk management systems. Firms can mitigate opportunism through fostering a high-integrity culture. Such a culture can be engendered by hiring agents with "integrity," e.g., agents who will not trade-off product quality for cost savings (Erhard et al., 2016). Alternatively, as suggested by Hodgson (1996) and evidently implemented, for example, by Toyota through the 'Toyota Way" culture (Liker, 2004), firms may actually inculcate pro-social preferences (Bénabou and Tirole, 2006) that discourage opportunistic actions. As well as embracing culture, oversight systems also include accounting systems, which, by making transactions observable and verifiable, check opportunism. More specifically, corporate

[1] Nakamura (2009) finds that the stock of corporate intangible assets is worth approximately three trillion dollars and has roughly the same value as the stock of tangible assets. Gaines-Ross (2008) estimates that reputation accounts for more than 60% of firm value. Many sources for the value of reputation have been considered: improved employee motivation and retention (Edmans, 2011), better customer retention (Armour et al., 2010), higher product prices (Milgrom and Roberts, 1982, 1986; Allen, 1984), higher profitability (Roberts and Dowling, 2002), or better financing terms (Srivastava et al., 1997; Billet et al., 2014).

risk management embraces managing the brand-value risk generated by managerial opportunism. Thus, preventing short-term opportunism is an important objective for risk management systems (e.g., Protiviti Consulting, 2016), for example, the quality control systems at Toyota, the financial risk-management systems at J.P. Morgan, and the ethical risk-management systems at Seimens. Empirical evidence suggests that these systems can be effective (Ellul and Yerramilli, 2013). Moreover, the effectiveness some of these mechanisms for controlling opportunism, notably corporate culture, appear to be enhanced by the diffuse ownership structure that typifies brand-capital firms (Guiso et al., 2015).

Because these oversight systems are imperfect (as many recent corporate scandals illustrate) the oversight system of the brand capital firm is a natural locus for incomplete information.[2] Moreover, because managers actually work under the system, they "learn" about the system through interacting with it. Thus, managers are better able to judge whether the firm's commitment to integrity is sincere or simply window-dressing, whether the accounting system can really detect substitution of inferior quality inputs, whether the firm's ethics regulations can actually block managers from bribing local officials, etc. In this setting, brand-capital firm managers' actions, like the actions of reputed agents in the classic model, affect the oversight system's reputation. However, brand-capital firm managers do not "own" the consequences of these effects, which are borne by the owners of the brand capital firm. Any "stake" these managers have in their firms' reputation must be produced by compensation they are provided by outside uninformed owners.

In this framework, we model reputation formation in brand-capital firms. Our basic results are that (a) reputation equilibria, similar to the reputation equilibria derived in the classic models, can be supported for brand capital firms however (b) the conditions required for reputation equilibria are radically different, and sometimes diametrically opposed, to the conditions imposed by the classic model.

In our model, the owner–manager relationship is plagued by the standard incomplete-contracts agency conflict: The manager can opportunistically divert firm resources, and neither the diversion nor firm cash flows can be verified directly. However, product prices are verifiable and contractible, which permits the firm to write performance-sensitive contracts to curb diversion.[3] Diversion stochastically lowers the quality of the firm's products. Product quality can only be observed with a lag, and low quality products damage the firm's brand capital. Because of the delay in observing quality, compensation must be deferred to incentivize the manager. Consequently,

[2]Recent high profile examples of oversight system failures include, Lululemon's "too sheer" yoga pants problem, Toyota's braking systems problem, and Volkswagen's emissions problem

[3]Many papers have been developed in this framework (e.g., Hart and Moore, 1994; DeMarzo and Fishman, 2007; Clementi and Hopenhayn, 2006). The assumption that market prices, and thus revenue, are verifiable while cash flows are not is common (e.g., Garvey et al., 1998) and simply reflects the public nature of the goods market. A model yielding the same basic insights could also have been developed in a hidden-action framework with costly unobservable effort and complete contracting on firm cash flows.

the standard unraveling, or "chain-store paradox," problem makes it impossible to control the opportunism of the reputationless professional non-owner manager purely through principal–agent incentive compensation.

To resolve the unraveling problem, the brand-capital firm must have an oversight system of the sort that has been discussed in recent research on corporate governance. Such systems complement compensation and play a significant, if not dominant role, in controlling managerial opportunism (Garicano and Rayo, 2016; Kashyap et al., 2008; Ellul and Yerramilli, 2013). In our analysis the oversight system is imperfect and all agents, including customers, have beliefs about its expected effectiveness. If the manager discovers a flaw in the oversight system, he can undertake opportunistic actions. Such actions, if observed, reveal that the oversight system is flawed and, thus, induce customers to lower their rating of the system. The customers' beliefs about oversight systems influence product prices. This allows brand-capital firms a way around the unraveling problem because beliefs can change in the final period in response to the manager's penultimate period actions.

To protect against a downgrade of the oversight system's rating by customers, when the likelihood of a flaw in the system is sufficiently large, owners will supplement the checks on opportunism provided by the oversight system with managerial compensation designed to deter opportunism even if the system is flawed. In this case, compensation takes the form of deferred payments conditioned on the past product price history. The optimal contracts resemble efficiency wage contracts in Shapiro and Stiglitz (1984) in that they fix compensation above the manager's reservation wage in order to provide him with an incentive to value employment continuation. Optimal hiring and retention polices specify that the manager will be terminated if and only if product prices signal poor quality consequent to opportunism. Because both the oversight system and compensation policy affect the quality of firm output through their effects on managerial opportunism, both also affect the product-market reputation of the firm, captured in our model by product prices.

To contrast the analysis of the brand-capital firm with classic economic models of reputation formation under incomplete information, we develop a modified version of our model which we refer to as the "owner-manager model." In the owner-manager model, the roles of the owner and manager in the brand-capital model are fused. Thus, as in the classic models, the agent forming firm reputation owns the reputation capital her actions create. At a technical level, the owner-manager model "works" much like the classic reputation models, with outsiders' rating of the oversight system substituting for outsiders' beliefs about the reputation controlling agent's "type" in the classic models. In the owner-manager model, as is the case in the classic reputation models, the central conflict is between the ex ante and ex post incentives of the owner-manager. Ex ante, the owner-manager, realizing that anticipated opportunism will be capitalized in product prices, aims to commit to reputable behavior. However, ex post, the owner-manager might prefer to act opportunistically. The counterweight to the temptation to act opportunistically is the possible loss of

future reputation rents. For this paper, the key insight from the owner-manager model is that even ex ante, although commitment to reputable behavior is optimal, unlike the non-managing owner of a brand-capital firm, the owner-manager anticipates recouping some losses from opportunism through also capturing its gains.

We demonstrate that reputation formation in owner-managed and brand capital firms is fundamentally different. First, under owner management, although supporting reputation equilibria requires at least a partially effective oversight system, it does not require contracting technology. In a manner akin to that in the classic reputation models, the owner-manager's ex post incentive to preserve reputation rents alone induces her to preserve the firm's reputation when the oversight system's rating is high. In contrast, supporting reputation equilibria for brand capital firms requires both a (partially effective) oversight system and a contracting technology. The brand-capital firm's owners must augment the oversight system with reputation-assuring managerial compensation so as to commit to maintain the firm's reputation. To accommodate contracting, there must exist some verifiable variable correlated with firm performance and some mechanism for verifying the contract with the manager. Hence, the brand-capital form of organization requires at least a minimal degree of institutional sophistication. Moreover, the brand-capital firm's owners offer reputation-assuring managerial compensation only when the oversight system's rating is low. This effect breaks the mechanical link between oversight-system rating and product-market quality/reputation which characterizes owner management.

Second, contracting mechanisms that support reputation equilibria in owner-managed and brand-capital firms are quite different. If contracting is restricted by limited liability, it is not possible to design contracts with payments made solely from firm revenue to punish the owner-manager sufficiently for damaging the firm's reputation to align her ex ante and ex post incentives. Instead, as is well understood, the owner-manager must post a "performance bond" which she forgoes if the firm's reputation is damaged. The owner-manager will post such a bond when the oversight system's rating is low and thus her ex post incentive to preserve the firm's reputation is weak. In contrast, the brand-capital firm's owners can commit to preserving the firm's reputation through the manager's employment contract, which is paid solely out of firm revenue. Moreover, since the ex ante and ex post incentives of the non-managing owners are not misaligned and the performance bond can at best commit them to paying reputation-ensuring compensation to the manager, the brand-capital firm will not post a performance bond.

Third, committing to costly reputation-assuring compensation *requires* that non-owner managers be uninformed. If non-owner managers are informed, the owners' compensation decision would affect the market's beliefs about the actual effectiveness of the oversight system. In such a setting, because revelation is fatal, reputation-assuring compensation could only be supported by pooling equilibria. Because non-owner managers do not gain even ex post from opportunism, stan-

dard belief refinements would call for a benign market interpretation of deviations from reputation-ensuring compensation—the owner knows the oversight system is effective and thus reputation-assuring compensation is not required. However, under this interpretation, the failure to adopt reputation-ensuring compensation would signal a completely effective oversight system and thus produce a high product-market prices without reputation ensuring compensation, making pooling unsustainable. This inability to make informed commitments contrasts with the owner-manager model because an owner-manager's decision to drop a costly quality-assuring mechanisms can reasonably be interpreted as indicating that the owner-manager aims to profit from opportunistic actions.

Thus, one prediction of our model is that, uninformed supervisory control, the sort of control exercised in brand-capital firms, is positively associated with the level of managerial compensation. In our setting this is a "feature" not a "bug." Commitment to high reputation-assuring compensation in some cases raises the welfare of owners. This commitment is credible only when owners are uninformed.

Fourth, the rewards for investing in oversight differ qualitatively between brand-capital and owner-managed firms—for brand capital firms, the relation between the expected effectiveness of the oversight system and firm value is convex, while, for owner-managed firms, it is typically concave. When effective oversight is very costly, e.g., when the actions of managers are complex and hard to assess, the brand capital firm will invest less in oversight than the owner-managed firm, substituting high reputation assuring compensation for effective oversight. When the costs of increasing the effectiveness of oversight are low, the brand-capital firm will invest more than owner-managed firms, and ensure that the oversight system is perfectly effective.

Related literature

This paper's key point of departure from the literature on reputation formation under incomplete information is that, in our analysis, the agent whose actions affect reputation has no reputation and does not own the economic rents produced by the reputation she affects. Outside of this difference, our framework follows the literature. Our market/information structure assumptions for the most part track the classic papers in this area—-Kreps and Wilson (1982) and Milgrom and Roberts (1986). This classic framework was also adopted by Maksimovic and Titman (1991) to a financial economics context. In fact, our owner-manager model, which we use to benchmark the effects of delegated management on brand capital firms, is fairly close to their formulation.

Two features of our analysis depart from the classic models (and thus also Maksimovic and Titman (1991)) but are consistent with more recent developments in this literature. One departure is that we, like Board and Meyer-ter Vehn (2013), posit a noisy relation between agent opportunism and output quality. Another departure is that, in our model, firm reputation relies on a "trans-

individual" attribute of the firm—its oversight system's rating. Kreps (1996) sketches a model in which corporate culture is a trans-individual attribute of firms and Tadelis (1999), Hakenes and Peitz (2007), and Cremer (1986) also consider trans-individual firm reputation.

This paper's point of departure from standard models of owner/manager contracting is that we augment the standard model with an oversight system that partially restricts managerial opportunism. For the most part, interest in the effect of internal oversight on managerial opportunism post-dates the financial crisis and has been focused on the effect of risk-management systems on risk taking by financial firms (Garicano and Rayo, 2016; Kashyap et al., 2008; Ellul and Yerramilli, 2013). However, some earlier papers considered oversight in broader contexts (Walsh and Seward, 1990). Also, in practice, risk-management officers of firms are typically tasked with managing both financial and brand risk. Thus, per se, the idea that oversight systems exist and can restrict opportunism is not novel. However, we believe that our focus on the substitutability/complementarity between oversight and compensation as well as on the inferential effects about oversight systems is novel.

2 Model

Consider an economy populated by risk-neutral agents. The economy operates for the set of dates $\mathscr{T} = \{0,1,2,\ldots T\}$, $T \geq 2$. We refer to the interval of time between adjacent dates $t-1$ and t as "period t." Agents are "patient" and do not discount future cash flows.[4] There is no storage technology. Thus, any cash flow received in a period must be spent in that period, and a good produced in period t, a "period t good," must be sold and consumed during the period.

In this economy there is a brand-capital firm. This firm is owned by a single agent called "the owner," who is the sole residual claimant of its cash flows.[5] The owner does not have the human capital necessary to control the firm's operations and thus hires a professional manager for this task. The manager is drawn from a continuum of managers with identical abilities and preferences, both of which are common knowledge. Thus, the firm's reputation is not dependent on the professional manager's characteristics, and the owner has all the bargaining power in compensation negotiations. To simplify the analysis, we normalize the manager's per-period reservation wage to zero. The zero reservation assumption lowers the minimum level of managerial compensation and thus reduces the likelihood of reputable firm behavior. In this sense, our assumptions are conservative.

The firm's output is sold to a continuum of consumers, whose preferences are common knowledge: they assign a value of 1 to a high-quality good and 0 to a low-quality good. Consumers

[4] We adopt the finite-horizon formulation to facilitate comparison with the classic reputation papers (e.g., Kreps and Wilson, 1982; Milgrom and Roberts, 1982). Given the finite horizon, zero discounting is assumed without loss of generality.

[5] In our analysis, an owner neither extracts private benefits nor exerts personal effort on monitoring, so the assumption of a single owner simply makes the discussions of the results more compact.

engage in Bertrand competition to set a price for the output at the beginning of each period. Prices represent bids for a good that will be filled if the good is produced. The prices are verifiable and contractible. Consistent with the Bertrand competition assumption, we assume that consumer bids equal their expected valuation of the good.[6]

After observing p_t, the period t good's price, the owner decides whether the firm should operate or shut down for the period.[7] If the firm operates, it produces one unit of a good that could be either high quality, h, or low quality, l. All agents learn a good's quality after consumers purchase it. Consequently, the period t good's quality is common knowledge at the beginning of period $t+1$. However, quality is neither verifiable nor contractible. The firm produces no output if it doesn't operate. Hence, the firm's revenue is p_t if it operates in period t and zero if it doesn't.

If the owner decides the firm should operate in a period, she must provide operating capital equal to e for the period, where e is the cost of a reliable production technology for the period.[8] The manager can choose between the reliable technology and a cheaper but vulnerable technology that costs $I < e$ for the period. The reliable technology always produces a high quality good while the vulnerable technology produces a high-quality good with probability $\delta \in (0,1)$ and a low-quality good with probability $1-\delta$. The manager's technology choice is unobservable, and he can unobservably divert $c = e - I$, the entire cost saving from implementing the vulnerable technology, for personal consumption.[9] The manager cannot divert more than c and deplete the firm's funds below I. This assumption captures the idea that "excessive" diversion becomes observable. For example, if a manager took the owner's entire capital infusion and diverted it to personal consumption, no workers would be hired, no contracts signed, no supplies purchased. Such a high level of diversion would be obvious and, thus, actionable in a court of law. However, the diversion of marginal funds accompanied by hiring lower quality workers or buying lower quality supplies is undetectable. To ensure that outsiders cannot detect diversion of funds by the manager, we assume that the firm's cash flow—revenue less the cost of production—is not observable or contractible.

[6]Bidding expected value is not the only consumer bidding strategy consistent with rational expectations. A "trivial" equilibrium also exists in which consumers believe the good is worthless and bid 0 for the good, in which case the good is not produced and, because consumer orders are never filled, Bayes rule cannot applied to consumer's beliefs.

[7]We have chosen a pricing-production sequence featuring "forward prices" for goods to block pathological equilibria where an owner may shut down the firm to avoid paying compensation. In essence, shutting down production suppresses information regarding the manager's performance at the cost of losing all operating profits for the period. We can obtain qualitatively similar results, albeit at the cost of increased notation and analytical complexity, if we instead assume that the owner bears a cost for temporarily shutting down and restarting the firm.

[8]We assume this for brevity. The owner never has an incentive to inject more than e in any period since the extra funds cannot improve product quality. The owner also never wants to inject less than e since this is less profitable than not operating, and also has no advantage over not operating from the perspective of producing information about the nature of the firm's oversight system.

[9]We assume an extreme division of gains from opportunism in the interest of simplicity. Our results are not dependent on such an extreme division. All that we require is that the manager captures *part* of the gain from opportunism, thus depriving the owner from capturing the *entire* gain.

The timing of actions in the model is summarized by Figure 1.

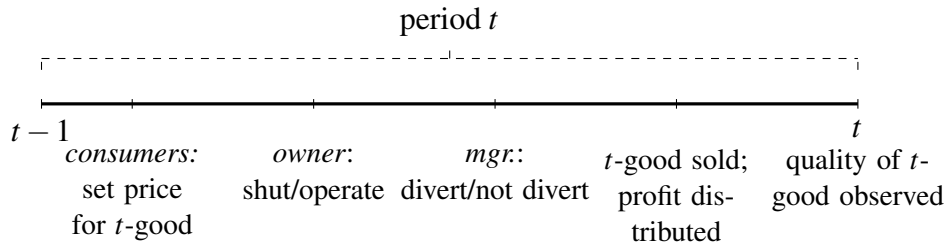


Figure 1: *Time Line*. This figure presents the sequence of actions within time period t.

The owner can offer the manager a compensation contract. The contract's terms are set at the beginning of period 1.[10] All agents, including consumers, can observe the contract's terms.[11] Under the contract, in period t the manager is paid B_t, which is a function of goods' prices in the current and previous periods. We focus solely on contracts where payments are non-negative, non-decreasing in past prices, and satisfy the limited liability condition, $B_t \leq p_t$. These restrictions on contract designs are standard (e.g., Innes, 1990; Nachman and Noe, 1995; DeMarzo and Duffie, 1999).

The firm has an oversight system to manage risk, including restricting diversion. A perfectly effective oversight system would prevent diversion with certainty and thus completely resolve agency conflicts between the owner and manager. However, oversight systems are often imperfect and, as numerous corporate scandals attest, "insiders" subject to the constraints imposed by oversight systems often succeed in circumventing them. Recent examples of oversight system failures include Lululemon's "too sheer" yoga pants problem, Toyota's braking systems problem, and Volkswagen's emissions problem. While attempting to circumvent oversight systems, insiders are likely to learn more about the actual effectiveness of these systems than firm owners.[12] For example, insiders at Volkswagen identified and exploited flaws in its oversight system for a considerable period, and judging by its stock price's reaction to the emissions cheating revelation, shareholders

[10] We make this assumption without any loss of generality. In an earlier version of this paper we derive the optimal contract when the owner cannot commit to a long-term contract, but can only contract on a payment in the subsequent period. The optimal compensation under this more restrictive condition is identical to the optimal compensation we derive below. Also, as we demonstrate later, the owner's welfare cannot be increased by contracting payments at date t dependent on revenues realized at or before t.

[11] Consistent with this assumption, in a letter to customers following the recent scandal arising from the opening of unauthorized bank accounts by Wells Fargo employees, its CEO advertised key features of employee compensation designed to incentivize them to focus solely on customer interests.

[12] In like fashion, university administrators, legislators and regulators, software designers, etc. know how their systems "should" work. However, students, tax accountants, and hackers, i.e., those subjected to the systems, know more–they know if the systems actually work. This perspective on the inherent information superiority of operators over their supervisors regarding the security of oversight systems reflects the general view, succinctly stated by Peter Drucker (Drucker, 1998) that "knowledge workers must know more about their job than their boss does—or what good are they?"

were surprised to learn that the firm's oversight systems had been circumvented. Hence, we posit that: (i) the firm's oversight system may fail and permit diversion, and (ii) the manager has better knowledge of the oversight system's effectiveness than the owner or consumers.

More specifically, we assume that the firm's oversight system can either be "secure," type-$\mathcal{S}$ or "insecure," type-$\mathcal{I}$. If the system is type-$\mathcal{S}$, the manager cannot divert *any* funds. If the oversight system is type-$\mathcal{I}$, the manager can divert c. To simplify the discussion, we will sometimes use the phrase *the manager diverts* without any qualifications to represent the manager's choice of the following strategy: choose the vulnerable technology when the oversight system is insecure and choose the reliable technology when the oversight system is secure. Similarly, we will use the phrase *the manager does not divert* to represent the manager choosing the reliable technology both when the oversight system is secure and when it is insecure.

To capture the manager's information advantage with regard to the oversight system, we assume that the manager alone observes the oversight system's type at date 0.[13] The owner and consumers, whom we collectively refer to as "outsiders," have a common prior distribution over the oversight system's types and, at the start of period 1 they believe that the firm is type-$\mathcal{S}$ with probability ρ_1. One can think of ρ_1 as a measure of outsiders' initial assessment of the effectiveness of the oversight system, i.e., the oversight system's "effectiveness rating." For now we assume that ρ_1 is exogenous. Later, we examine the owner's optimal choice of ρ_1. The outsiders' rating is updated to ρ_t in period t based on the events that occurred in previous periods. The quality of the firm's goods provides information that prompts updates. For instance, since the vulnerable technology is only used when the manager diverts, and the manager can divert only if the oversight system is insecure, outsiders can infer that the oversight system is type-$\mathcal{I}$ once they observe low quality output. When this occurs, we will say the firm is "revealed." Otherwise the firm is "unrevealed".

We impose the following restrictions to focus on model parameters that yields interesting results:

Assumption 1.

$$\rho_1 + (1-\rho_1)\delta \geq e.$$

Assumption 2.

$$I > \delta > 0.$$

Assumption 1 ensures that, even if consumers believe that the manager will always divert when the oversight system is insecure, the price they bid in period 1 will cover the cost of production.

[13] Our modeling assumption that the manager is fully informed about the security of the oversight system is not essential. This assumption that the manager knows the "type" of the firm, is similar to the assumption in (e.g., Maksimovic and Titman, 1991). We make it in the interest of simplicity. The results could all be derived under the assumption that the manager has a private noisy signal of the oversight system's type.

Assumption 2 ensures that the vulnerable technology always produces a high-quality good with positive probability, but, if consumers anticipate the use of the vulnerable technology, production will be unprofitable for the owner. Together Assumptions 1 and 2 ensure that the increase in value engendered by choosing high quality output, $1-\delta$, exceeds the increased cost of high quality output, c. Thus, the reliable technology is socially efficient.

To enable us to use more compact mathematical expressions, define P_t as

$$P_t = \rho_t + (1-\rho_t)\,\delta. \tag{1}$$

P_t represents the probability, conditioned on diversion in period t, of the firm remaining unrevealed at the start of period $t+1$ if it was unrevealed in period t. Since the firm remains unrevealed if and only if it produces high quality output in period t, P_t also equals the probability outsiders assign to high quality output in period t conditioned on diversion. Thus, P_t represents the minimum or *floor price* that an unrevealed firm will receive at date t. If outsiders conjecture that the manager will not divert in period t, then the period t good's price, p_t will exceed the floor price, P_t. Because p_t equals consumers' expectation of the t-goods value, p_t can be thought of as representing the firm's product-market reputation.

Since there is a one-to-one relation between P_t and the oversight system's effectiveness rating, ρ_t, we can define Bayesian updating in terms of P_t as follows: When outsiders conjecture that the manager will divert yet the period t good is high quality, the period $t+1$ floor price, P_{t+1}, will equal $\Gamma[P_t]$, where

$$\Gamma[P_t] = 1 + \delta - \frac{\delta}{P_t}. \tag{2}$$

If either (a) the firm does not operate in period t or (b) consumers conjecture that the manager will not divert in period t and the period-t good's quality is high, consumers learn no new information about the oversight system, and thus $P_{t+1} = P_t$. If the firm is revealed by a low quality output in period t, $P_{t+1} = \delta$ and the floor price in subsequent periods will also equal δ.

Note that $\Gamma[P_t] > P_t$, i.e., if outsiders believe that the manager will divert in period t but the period t good's quality is high, the floor price is revised upward. Moreover, if the firm operates in period t, period $t+1$'s *expected* floor price equals period t's floor price, i.e.,

$$P_t\,\Gamma[P_t] + (1-P_t)\,\delta = P_t. \tag{3}$$

Figure 2 illustrates the dynamics of the floor price conditioned on conjectured managerial behavior.

2.1 Equilibrium

For a specific compensation contract, we define an equilibrium as a Bayesian Nash equilibrium, i.e., a set of owner and manager actions, prices for goods, and beliefs in each period such that:

a. the owner's shut down/operate strategy is incentive compatible,

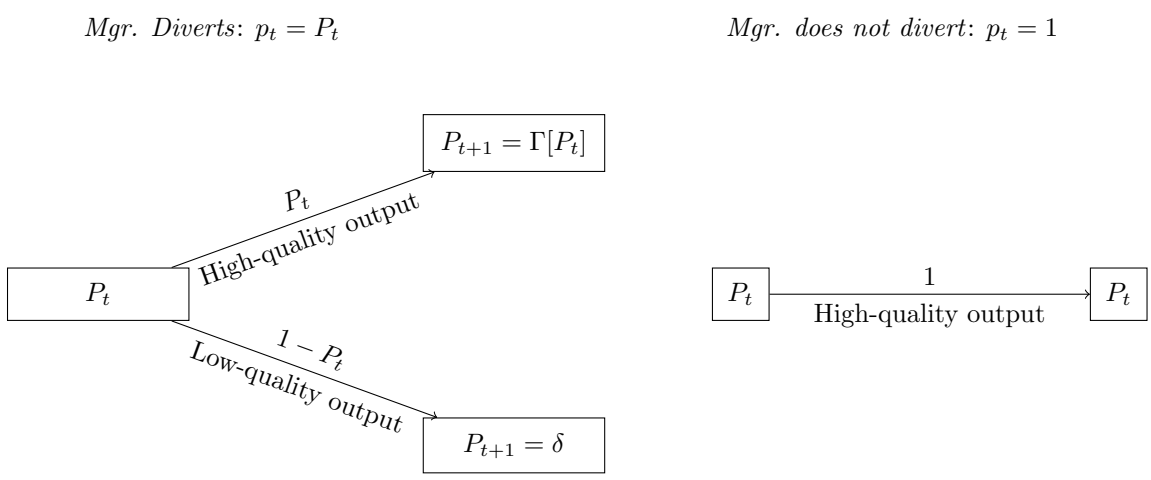


Figure 2: Prices, p_t and floor prices, P_t, based on outsiders' expectations of whether the manager will divert when the oversight system is insecure.

b. the owner's hiring/replacement strategy is incentive compatible
c. the manager's divert/not divert strategy is incentive compatible,
d. consumers set prices equal to the goods' expected quality conditioned on the owner's and manager's strategies, and
e. belief updating by consumers and the owner is consistent with Bayes' rule.

A solution to the model is a contract and an associated equilibrium such that there exists no other contract with an associated equilibrium that produces a higher ex ante expected payoff for the owner.

By assumption, producing high quality goods is socially efficient. Competition between consumers ensures that the surplus generated by high quality production is captured by the owner and manager. Absent the agency conflict caused by unobservable diversion, the owner could capture the entire surplus. Thus, the first-best solution, whether viewed from the perspective of the firm's owner or society is to produce high quality output. As will be apparent from the analysis that follows, diversion, which results in a positive probability of low quality, is always the optimal policy for the manager in the last period. Thus, the most Pareto efficient potentially implementable operating policy involves producing high quality output in all periods before the last period. Such a production policy requires the manager to eschew diversion in all periods before the last period. In this case, rational expectations implies that $p_t = 1, t = 1, \ldots T-1$. We will refer to an equilibrium in which the firm follows this policy as a *reputation equilibrium*.

3 Compensation and firm reputation

To determine conditions under which reputation equilibria exist, we first have to examine the manager's behavior when the oversight system is type-$\mathbb{J}$. The manager cannot earn rents from a personal reputation since his preferences and ability are common knowledge. Nor can he earn rents from ability since he must compete with managers of identical abilities. Consequently, the manager's only income sources are diversion and incentive compensation under the contract with the owner. Therefore, only incentive compensation can induce the manager to forgo diversion.

The effectiveness of incentive compensation is limited. Compensation paid in periods prior to period t cannot influence the manager's period t incentives. Moreover, a period t incentive payment cannot prevent diversion in period t itself: because consumers cannot observe the manager's technology choice, both the period t good's price and the period t incentive payment will be insensitive to the manager's period t action. Hence, the owner must defer compensation, and her key control variable is timing—when to pay the manager and when to replace the manager. Therefore, we answer the following questions: (i) What is the optimal timing of incentive payments? (ii) How are these payments structured? (iii) What is the optimal timing of managerial replacement? (iv) For how many periods will the manager behave reputably?

3.1 The timing of managerial replacement and payments

Our first characterization, Lemma 1, is straightforward but useful in developing the deeper propositions presented below.

Lemma 1. *(i) The manager will divert in period T.*
(ii) The manager will divert in every period after the firm is revealed.
(iii) The firm will shut down after its oversight system is revealed, i.e., the owner will not fund the firm's operation in any subsequent period once the oversight system is revealed.

Claim (i) follows directly from the limited effectiveness of incentive compensation: the owner cannot defer compensation beyond period T, since it is the last period, and a period T payment cannot incentivize the manager in period T itself. Thus, the manager's expected payoff is highest if he diverts. Claim (ii) demonstrates the necessity of an oversight system that has a non-zero effectiveness rating for a brand-capital firm to maintain its reputation. In doing so, it demonstrates why principal-agent theory-based incentive compensation alone cannot speak to the reputation of brand-capital firms. The intuition behind Claim (ii) is frequently encountered in reputation models—*unraveling*. Once the firm is revealed and it is common knowledge that the oversight system is ineffective, consumers will fix the price of the period T good at δ, the lowest possible price, since they know the manager will divert in period T. Therefore, any compensation the manager receives in period T will be fixed and insensitive to his period $T-1$ action. These

arguments extend backwards to any period after the firm is first revealed. Claim (iii) follows directly from Claim (ii) and Assumption 2 because production is unprofitable once consumers price goods at δ.

In each period, the manager's action is driven by the cost and benefit of diversion. The benefit is an increase in current period consumption. The cost is the possibility that diversion, by triggering revelation, will eliminate future diversion opportunities and compensation payments. These costs are proportional to the manager's continuation value. Define $v_M(t)$ as the manager's value function when the control structure is insecure and the firm has not been revealed up to period t. Since the expected value of the manager's payoffs is the sum of his current period payoff and continuation value,

$$v_M(t) = B_t + \max\left[v_M(t+1), \delta\, v_M(t+1) + c)\right]. \tag{4}$$

The first term in the maximum expression reflects the manager's expected payoff if he does not divert in period t. The second term reflects his expected payoff if he diverts. By comparing the two terms in the maximum expression in equation (4), it follows that the manager is more likely to forgo diversion in period t when $v_M(t+1)$ is large. Since $B_t \geq 0$,

$$v_M(t) \geq \max\left[v_M(t+1), \delta\, v_M(t+1) + c\right] \geq v_M(t+1). \tag{5}$$

The function v_M is weakly decreasing in t because with each passing period the manager has fewer periods in which he can expect to receive a payoff. Since v_M falls with time, the manager's incentive to divert increases over time. Consequently, the set of periods in which the manager diverts is always an order interval. Denote the last period in which the manager does not divert by t^+. We refer to t^+ as the *reputation cutoff period*, and we refer to a compensation policy that deters diversion through period t^+ as a t^+*-policy*. We interpret $t^+ = 0$ as representing the case where the manager diverts in all periods. By Lemma 1, $t^+ < T$. From equation (4) and the monotonicity of v_M, it follows that the manager will not divert in period $t \leq t^+$ if and only if

$$(1-\delta)\, v_M(t^+ + 1) \geq c. \tag{6}$$

By Lemma 1 the manager is always effectively replaced following revelation since the firm ceases to operate. Expression (6) shows that replacement is suboptimal while the firm remains unrevealed: Anticipated future replacement will lower the manager's continuation value, and thus make it harder to satisfy inequality (6), the incentive compatibility condition for non-diversion. Moreover, since replacement managers have identical ability and preferences, there is no other incentive in the model for replacing the manager.

Now consider the timing of payments. We demonstrate in the following proposition that optimal contract payments depend only on whether the firm is revealed. The firm is unrevealed in a given period if and only if the price in that date, p_t satisfies $p_t \geq P_1$. Thus, an optimal contracted payment can always be found in the set of potential contracts with the property that they specify,

in each period, a payment, which we call $b_t \geq 0$, conditioned on $p_t \geq P_1$ and a payment of 0 if $p_t < P_1$. Moreover, optimal implementation of a reputation cutoff period of $t^+ > 0$ will specify a single positive payment, represented by $b^*(t^+ + 1)$, to the manager in period $t^+ + 1$ in the event that $p_{t^+ + 1} \geq P_1$. If the firm implements the reputation cutoff period of $t^+ = 0$, i.e., it opts for not ensuring reputation in any period, then the optimal contract is clearly zero payments to the manager in any period. Since all contracts implement some reputation cutoff period, an optimal compensation contract will be associated with reputation cutoff period t^+. Thus, the proposition below shows that the optimal contracted payments to the manager implementing reputation cutoff period t^+, which we represent by $B^*[t^+]$, satisfy

$$B_t^*[t^+](t) = \begin{cases} b^*(t+1) > 0 & \text{if } P_{t^+ + 1} \geq P_1 \text{ and } t^+ \geq 1 \text{ and } t = t^+ + 1 \\ 0 & \text{otherwise.} \end{cases} \tag{7}$$

The specific value of $b^*(t+1)$ is fixed to ensure that the manager incentive compatibility constraint, inequality (6), is binding. These results are recorded in the next proposition.

Proposition 1. *There exists an optimal compensation policy with the following characteristics:*

a. *There exists an optimal reputation cutoff period $t_*^+ \in \{0, 1, \ldots T-1\}$ such that the compensation policy, $\{B_t^*[t^+]\}_{t \in \mathscr{T}}$, has the form specified in equation* (7)*. Thus, the manager is paid a single incentive payment $b^*(t_*^+ + 1)$ made in period $t_*^+ + 1$ contingent only on the good's price in period $t_*^+ + 1$ being at least equal to the period 1 floor price, P_1. Under this policy, when the oversight system is insecure, the manager never diverts during or before period t_*^+ and always diverts after period t_*^+. Moreover, no policy that provides positive payments in more than one period is optimal.*

b. *The single incentive payment under this policy is given by*

$$b^*(t_*^+ + 1) = \frac{c\,\delta^{T - t_*^+}}{1 - \delta}.$$

c. *Under this policy, the firm always operates when it is unrevealed.*

d. *The optimal reputation cutoff period, t_*^+ is the period following the largest $t^+ \in \{1, \ldots, T-2\}$ such that*

$$\frac{(1 - P_1)(1 - e) + ((1 - P_1)(e - \delta) - c)\,\delta^{T - (t^+ + 1)}}{1 - \delta} \geq 0. \tag{8}$$

If no such t^+ exists, then $t_*^+ = 0$.

Although the proof of Proposition 1 is fairly tedious, its underlying logic is straightforward. First, consider part (a). Given a unique reputation cutoff period, t^+, the optimal t^+-policy must minimize expected payments to the manager over all t^+-policies. The payments are made both when the oversight system is secure as well as when it is insecure. When the oversight system is secure, incentive payments are unnecessary. Thus, the owner would prefer to pay the manager only when the oversight system is insecure, but cannot do so since she does not know the system's

type. When the oversight system is insecure, the payments must satisfy the incentive constraint, condition (6). Consequently, an optimal t^+ policy minimizes payments conditioned on the oversight system being secure subject to the condition that when the system is insecure, the incentive constraint is binding.

Since payments made at or before period t^+ do not contribute to satisfying condition (6), an optimal t^+-policy will not specify payments before period $t^+ + 1$. Now consider a payment in period $t^+ + 2$. The owner knows that, after period t^+, the manager will divert when the oversight system is insecure but cannot if the system is secure. Moreover, if period $t^+ + 1$ diversion results in the firm being revealed, the manager will not receive an incentive payment at $t^+ + 2$. So a period $t^+ + 2$ incentive payment is more likely to be made when the oversight system is secure. In contrast, since the manager does not divert in period t^+, a period $t^+ + 1$ incentive payment is equally likely whether the oversight system is secure or insecure, and hence is less wasteful than a period $t^+ + 2$ payment. Therefore, a period $t^+ + 2$ incentive payment is not optimal. The same logic extends obviously to even later periods. Therefore, as claimed in part (a), optimal t^+ contracts take the form of a bullet payment made in period $t^+ + 1$. Since the optimal contracts specified in part (b) produce positive owner profits in every period in which the firm is unrevealed, it is always optimal, as asserted in part (c), for the owner to operate the firm while it is unrevealed.

Given parts (a), (b), and (c), the optimal contracting problem reduces to the problem of solving for the optimal reputation cutoff period, t_*^+. This is a simple optimization problem. Solving this problem shows that the gain from extending the non-diversion period from $t^+ - 1$ to t^+, which we refer to as a t^+-shift, is given by expression (8). This expression viewed as a function of t^+ is monotonic, either weakly increasing or weakly decreasing depending on the sign of $(1 - P_1)(e - \delta) - c$. Thus, as asserted in part (d), the optimal choice of the reputation cutoff period can simply be determined by finding the last period in which such an extension of the non-diversion period generates a positive gain. The possibility that the owner may only use compensation to prevent diversion for a few periods contrasts with the optimal contracts in Edmans et al. (2012) where optimal compensation completely eliminates managerial short-termism.

3.2 Reputation equilibria for a brand-capital firm

We can now identify conditions for a reputation equilibrium. Expression (8) demonstrates that, when the initial floor price, P_1, is low enough to satisfy $(1 - P_1)(e - \delta) - c \geq 0$, all t^+-shifts increase firm value. The owner-manager will choose $t^+ = T - 1$ and thus offer the sole incentive payment in period T. In contrast, expression (8) is negative for values of t^+ approaching T when P_1 approaches one. Thus, the owner will offer the bonus payment in a period before T, meaning that the manager will divert in at least one period before period T. Expression (8) also implies that the cost of reputation-ensuring compensation decreases to 0 as the owner's horizon, T, increases

without bound. Thus, for a sufficiently long horizon, T, there will always exist at least one period in which the owner will offer the manager incentive compensation. These results are summarized in Proposition 2 below.

Proposition 2. *Reputation formation in a brand-capital firm has the following characteristics:*

(i) Whenever

$$P_1 < 1 - \left(\frac{\delta c}{1-\delta}\right)\left(\frac{1}{1-e+\delta}\right), \tag{9}$$

the owner will offer the manager a single incentive payment paid conditional on the firm remaining unrevealed at the start of period T. The bonus payment will equal $(\delta c)/(1-\delta)$. When the oversight system is insecure, the manager will not divert in any period before T.

(ii) Whenever P_1 is sufficiently high, the owner will never offer the manager a bonus payment conditioned on remaining unrevealed until period T. When the oversight system is insecure, the manager will always divert in some period before period T.

(iii) For any set of admissible parameters of the model excluding T, there exists T^* such that if $T > T^*$, the owner will offer reputation-ensuring incentive compensation in at least one period.

Proposition 2 provides several important insights: Partially effective oversight systems, even when management and ownership are separated and owners are uninformed, can support reputation equilibria. When the floor price P_1 is sufficiently low, the non-managing owner will complement the oversight system with incentive compensation to reassure consumers about product quality. The floor price will be low when ρ_1, the oversight system's initial rating is low. Thus, in this case, product market reputation measured by p_t and the oversight system's effectiveness rating measured by ρ_t are not monotonically related. In contrast, if the oversight system's rating is sufficiently high, it is optimal for the owner to eschew incentive compensation, and instead rely on the oversight system to maintain product quality. Over this range, product market reputation is monotonically increasing in the oversight system's rating and the oversight system crowds out incentive compensation. However, as in Marinovic and Varas (2015), increased reliance on the oversight system is accompanied by increased short-termism which, in our analysis, takes the form of diversion.

Proposition 2 demonstrates that a the owner of a brand-capital firm will either commit to maintaining its reputation by offering the manager incentive compensation or will completely eschew incentive compensation and rely solely on the firm's oversight system to protect its reputation. It is never optimal for the owner to try and "learn" the oversight system's type before settling on a compensation policy. The only way the owner can learn the oversight system's type is to let the manager divert. Consider a candidate equilibrium in which the manager is allowed to divert with positive probability for the first k periods. Then, in period $k+1$, the floor price $P_{k+1} > P_1$ following the production of an uninterrupted sequence of high quality goods or $P_{k+1} = \delta$ otherwise. In

the latter case, by Lemma 1, the firm ceases to operate after the first incidence of a low quality good. In the former case, Propositions 1 and 2 can be viewed as characterizing equilibria in the sub-game starting in period $k+1$. Thus, if experimentation is optimal at date 0 when the floor price is P_1, by the logic underlying Propositions 1 and 2, the owner has even less incentive to settle on a contract that pays incentive compensation when the floor price is $P_{k+1} > P_1$. Moreover, suppose the owner does offer incentive compensation, because of the monotonicity of the manager's value function, the manager will eschew diversion in all period prior to period $k+1$, which undermines the possibility of owner learning. In an earlier version of this paper we derive the optimal contract when the owner cannot commit to a long-term contract, but can only contract on a payment in the subsequent period. This approach formally addresses the possibility of learning by the owner. The optimal compensation and the equilibrium decisions under this more restrictive condition are identical to those characterized in Propositions 1 and 2.

4 The ex ante choice of oversight policy and the role of outsider governance

We now consider the effect of altering our assumptions about governance policies of the brand-capital firm. The policies we consider embrace the following two aspects of governance: the ex ante reputation of the oversight system, ρ_1, a fixed parameter in the analysis thus far, and the owner's information endowment, which we have assumed to be the same as that of uninformed consumers.

4.1 The two-period case

To simplify our investigation of these governance policies, we will rely on a useful implication of Proposition 2.i: The number of periods the firm operates does not affect either whether a reputation equilibrium exists or the compensation policy followed by the firm in a reputation equilibrium. The underlying reason is that if offering deferred compensation is optimal at all, the gain from further incrementing the deferral period is decreasing as t increases. Hence, if incrementing the deferral period from period $T-1$ to T benefits the owner, then the owner must benefit from all deferrals and thus reputation equilibria maximize the owner's payoff. The compensation offered in period T to deter diversion depends only on the manager's continuation value in period $T-1$, which is not affected by the game's history before $T-1$. Thus, the optimal size of the deferred payment is the same regardless of how may periods precede $T-1$. Given that our focus henceforth will be on the ability of governance policies to support reputation equilibria, we can simplify our analysis and exposition by assuming that $T=2$, and thus the firm operates only for periods $t=1$ and $t=2$, without any loss of generality. Under this assumption, Proposition 2.i implies that if (9) is satisfied, an incentive payment of $b_2^* = \frac{\delta c}{1-\delta}$ in period 2 ensures that the firm will use the reliable technology in period 1. Otherwise, the owner will not offer incentive compensation and the manager will

divert in period 1. If diversion is detected, the firm will shut down in period 2. Otherwise, the firm will operate in period 2.

4.2 Oversight policy for the brand-capital firm

Firms influence the effectiveness of their oversight systems. Since oversight requires resources, altering oversight systems is likely to involve some expense. One can think of such alterations as fixing the firm's *oversight policy*. Because, a non-managing owner exercises supervisory authority in the brand-capital firm, she will fix oversight policy. This amounts to choosing, ex ante, an initial rating for the oversight system, ρ_1, and incurring the cost associated with this choice. A complete model of oversight policy would require identifying the cost function for the oversight system's initial effectiveness rating. However, there is scant evidence to aid us in this identification. Having no a priori reason to favor one cost function specification over another, we aim for a "neutral" cost function. Thus, we assume the cost of raising the oversight system's rating is a simple increasing affine function, i.e., the cost function, $\mathscr{C}$, is given by

$$\mathscr{C}(\rho_1) = \gamma \max[\rho_1 - \rho^0, 0], \quad \rho_1 \in [\rho^0, 1]. \tag{10}$$

where $\gamma > 0$ is the marginal cost parameter and ρ^0 is the lowest feasible value for the outsiders' prior that satisfies Assumption 1.

As can be seen from Proposition 2, for a given choice of ρ_1 the brand-capital firm will choose between two policies—pay reputation assuring compensation or rely entirely on the oversight system. Thus, ignoring the costs of increasing the effectiveness of the oversight system, the value of the firm, gross of the costs of investing in oversight, equals the maximum over its value over these two policies. Under the policy of paying reputation-assuring compensation, gross firm value is given by

$$(1-e) + \left(P_1(\rho_1) - e - \frac{c\delta}{1-\delta}\right) = (1-\delta)\rho_1 + \left(1 - 2e + \delta - \frac{c\,\delta}{1+\delta}\right).$$

If the firm adopts the policy of relying only on the oversight system then the value of the firm is given by

$$P_1 - e + P_1\Big(\Gamma(P_1) - e\Big) = P_1(2 - e + \delta) - e - \delta = (2 - e + \delta)(1-\delta)\rho_1 - (e-\delta)(1+\delta). \tag{11}$$

Thus, the value of the brand-management firm, gross of investment in the oversight technology, which we represent by V^o is given by the maximum of the two expressions above:

$$V^o(\rho_1) = \max\left[(1-\delta)\rho_1 + \left(1 - 2e + \delta - \frac{c\,\delta}{1+\delta}\right), (2 - e + \delta)(1-\delta)\rho_1 - (e-\delta)(1+\delta)\right]. \tag{12}$$

The ex ante value of the brand-capital firm, which we represent by v, equals the gross value, V^o, less the cost of improving the oversight system, $\mathscr{C}$, where

$$v(\rho_1) = V^o(\rho_1) - \mathscr{C}(\rho_1), \quad \rho_1 \in [\rho^0, 1]. \tag{13}$$

The two terms defining the maximum in the definition of V^o are affine in ρ_1 and thus the maximum that defines V^o is convex in ρ_1. Since $\mathscr{C}$ is affine in ρ_1, the convexity of V^o implies that v is convex. This result is recorded below

Lemma 2. *The brand-capital firm's ex ante value, v, is a convex function of ρ_1, the oversight system's initial effectiveness rating.*

Lemma 2 implies that, since v is convex in the oversight system's rating, one of the extreme policies: setting $\rho_1 = \rho^0$ or $\rho_1 = 1$ maximizes firm value. Which policy will be optimal depends on γ, the marginal cost of raising the oversight system's rating. When γ is sufficiently low, for example $\gamma < 1 - \delta - c$, it is optimal to set $\rho_1 = 1$ and completely block all diversion. In contrast, when γ is sufficiently high, it is clear that setting $\rho_1 = \rho^0$ is optimal. In this case, at the endogenously optimal choice of $\rho_1 = \rho^o$, whether the firm pays reputation-ensuring compensation depends on whether the conditions for a reputation equilibrium provided by Proposition 2.i are satisfied. Because, by definition, at ρ_0, the floor price equals e, the following condition is necessary and sufficient for the firm to pay reputation-ensuring compensation at $\rho_1 = \rho^0$:

$$c \leq \frac{(1-\delta)(1-e)(1-e+\delta)}{\delta}. \tag{14}$$

Thus, when condition (14) is satisfied, regardless of the marginal cost of improving the oversight system the brand-capital firm will always deter managerial short-term opportunism in all but perhaps the final period. When the marginal cost is sufficiently low, investing in augmenting the oversight system is attractive. Thus, the firm will establish a secure oversight system that will deter opportunism in every period. When the marginal cost of improving the oversight system is high, investing in augmenting the oversight system is not attractive. However, inequality (14) ensures that, in this case, the firm will pay reputation-assuring compensation. In either case, short-term opportunism is deterred for all periods but perhaps the final period.

4.3 Outsider governance and the problem of informed commitment

Note that outsider ownership for brand-capital firms in our model closely tracks the standard definition of outsider used in legal guidelines, e.g., exchange listing conditions for board composition. These guidelines typically define an outside director as an agent who (a) is not an officer of the firm and (b) extracts no material benefit from the firm's action other than through share-ownership. In our analysis, (a) is satisfied by assumption and, since diversion is the only source of material gain not conditioned on share ownership and managers have a monopoly on diversion, satisfying (a) implies that (b) is satisfied.

The fundamental informational assumption we make about the brand-capital firm is simply that an outside owner is an uninformed outsider. It is worth noting that the owner is "uninformed" in a rather narrow technical sense. We are not assuming that the owner lacks understanding of the

firm's business model, the firm's technology, etc. The model abstracts from these factors. Nor do we assume that the owner is naive. Rather the owner is a rational Bayesian agent who lacks one bit of information that markets also lack—whether management can circumvent the oversight system.

This information gap has obvious costs. Because the owner is uninformed, she cannot condition compensation on the oversight system's true state. Hence, when it is very likely that the system is secure, and thus the floor price is very high, the owner will gamble on the oversight system working. However, if the owner knew the oversight system's type, it would seem that she could improve on this solution by compensating the manager if and only if the oversight system is insecure. We will show that this rather compelling and intuitive reasoning is incorrect when agents are rational: If the owner knows the oversight system's state and acts on her knowledge, consumers, knowing that the owner knows, will also be able to infer that the oversight system is insecure, which causes the reputation equilibrium to unravel.

While the logic behind this conclusion is fairly simple, modeling an informed non-managing owner is somewhat complex at a technical level. If the non-managing owner has private information, the compensation policy she sets, in addition to affecting the manager's incentives, also has an "inferential effect"—consumers can use the compensation choice to infer the owner's private information. Thus, we have a signaling game where compensation policy is the "message" sent by the owner who knows the oversight system's type (secure or insecure). A good's price is the uninformed consumers' response. Signaling games usually generate many equilibria, some of which are intuitively implausible. There is an extensive literature on refining the set of equilibria in static signaling games in which the informed agent's message space and type space are finite. In order to rely on this literature, we restrict the insider owner's message space to the following three alternatives: (i) operating and not offering incentive compensation, NC, (ii) operating and offering the optimal incentive contract described in Section 4.1, C, or (iii) shutting the firm down, SH. Because, in period 2, compensation is ineffective and managerial incentives are not affected by consumer beliefs, we are left with a static single-period signaling game. In this setting, we use the perfect Bayesian equilibrium (PBE) as our solution concept and refine the set of equilibria using the standard D1 refinement.

The technical details of this development are tedious, and we defer them to the appendix. However, our basic result is both striking and quite intuitive: A firm with an informed owner cannot sustain its reputation and brand capital.

Proposition 3. *Suppose that the owner is privately informed about the oversight system's type. Then, in any perfect Bayesian equilibria satisfying the D1 refinement:*

(i) The manager will never receive incentive compensation.

(ii) The manager will always choose the vulnerable technology in period 1 when the oversight system is insecure.

Proposition 3 rests on two arguments. First, for compensation to ensure reputation, the period 2 good's price must be sensitive to the manager's period 1 action. However, if the informed owner only offers incentive compensation when the oversight system is insecure, the offer of incentive compensation by revealing that the oversight system is insecure fixes the period 2 good's price at δ. Hence, the manager's period 2 compensation will be insensitive to his period 1 action. It follows that no equilibrium can exist in which the owner only pays reputation-ensuring incentive compensation when the oversight system is insecure. Thus, if incentive compensation is offered in an equilibrium, it must be offered both when the oversight system is secure and when it is insecure. In this case, not offering incentive compensation is off the equilibrium path.

Second, to support equilibria in which the owner pays incentive compensation, consumer beliefs about the type (secure or insecure) defecting from incentive compensation would have to generate low prices, i.e., consumers would have to believe that not offering incentive compensation signals an insecure oversight system. Since diversion is not possible under a secure oversight system, an informed non-managing owner has a *greater* incentive to defect from incentive compensation than when the oversight system is secure than when it is insecure. For this reason, the beliefs required to support such equilibria fail to satisfy the D1 refinement, i.e., informed commitment to reputation-assuring mechanisms fails when outside owners are informed.

Proposition 3 shows that, to assure a firm's brand-capital, supervisory control must rest with informational outsiders. In our model, this is accomplished simply by separating ownership and management. In practice, of course, owners can be involved in day-to-day management even if they are incapable of managing brand-capital firms on their own. However, as the diffusion of share ownership increases, the marginal gain from involvement to any specific shareholder relative to the shareholder's effort costs will fall and, at some level of diffusion, this effect will make involvement suboptimal. Also note that informational separation is only required for those decisions which relate specifically to managerial control and oversight. Thus, restrictions that limit the involvement of informational insiders in compensation and retention decisions could also enforce informational separation. This sort of regime roughly corresponds to the form of governance promoted by advocates of "corporate democracy" and mandated by many countries and stock exchanges, e.g., the Sarbanes-Oxley act.

5 Separating ownership and management in the brand-capital firm

In our model, the brand-capital firm's owner is separated from management along two dimensions: (a) informationally—the owner has less information about the actual effectiveness of the firm's oversight system and (b) operationally—the owner does not operate the firm. In Section 4.3 we considered the role of informational separation. We now examine the role of operational separation by developing a simple model of an owner-managed firm in which the roles of owner and

manager are fused. Since this model is close to the classic models of firm reputation, it is a suitable benchmark for our analysis of the brand-capital firm. We demonstrate that reputation under owner-management differs markedly from reputation in a brand-capital firm along several important dimensions.

5.1 The owner-management model

The owner-managed model is identical to the two period model in Section 4.1 except for the modifications necessary to fuse the roles of owner and manager: (i) the owner-manager's information set is the union of the information sets of the brand-capital firm's owner and the manager, i.e., the owner-manager is an informational insider, even with regard to the oversight system's effectiveness; (ii) in addition to being the sole residual claimant of firm cash flows, the owner-manager controls the production technology and decides whether to divert funds she allocated for production; (iii) consumers cannot observe the owner-manager's technology and diversion choices; (iv) the owner-manager cannot divert funds if the oversight system is secure. Because the roles of owner and manager are both taken by a single agent, there is no role for a compensation contract.

Fusing the roles of owner and manager eliminates a key difference between our model and classic models of firm reputation because now, as in the classic models, the "reputation-controlling agent" whose actions fix reputation owns the reputational rents. However, the owner-managed model retains the second premise that distinguishes our model from the classic models—reputation is motivated by uncertainty about the oversight system's "type" rather than the reputation-controlling agent's type. In the brand-capital model this premise has a great deal of force because the reputation-controlling agent can be "detached" from the firm through termination. For example, this premise explains why, in the brand-capital firm setting, replacing the manager after observed opportunism will not restore or improve the firm's reputation. However, in the owner-manager setting this premise has little force because the owner cannot be "detached" from the firm. Thus, as the analysis that follows demonstrates, at a technical level, the owner-manager model "works" much like the classic reputation models, with outsiders' rating of the oversight system substituting for outsider beliefs about the reputation-controlling agent's type in the classic models.

5.2 Reputation under owner management

The fundamental insight of the classic reputation models is that the desire to preserve reputational rents alone, without resort to contracts, can enable a firm to maintain its reputation. We demonstrate that, in contrast to a brand-capital firm, this is also the case for an owner-managed firm. Moreover, unlike the brand-capital firm, the owner-managed firm maintains its reputation when outsiders' rating of its oversight system is high. These results are not surprising given the technical similarity between the owner-managed and classic model.

Consider the owner-manager's choice in period 1 when (a) consumers expect a high-quality good in the period and (b) the oversight system is insecure. The owner-manager's expected payoff from choosing the reliable technology in period 1 equals $1-e+p_2-I$. If she diverts instead, the firm will be revealed with probability $1-\delta$. In this event, consumers will only offer a price of δ in period 2 and thus the firm will shut down. Therefore, the owner-manager's expected payoff from diverting in period 1 is $1-e+\delta(p_2-I)+c$. It follows that the owner-manager will choose the reliable technology in period 1 if and only if

$$(1-\delta)(p_2-I) \geq c. \tag{15}$$

Since equilibrium prices are updated according to Bayes' rule, in equilibrium, $p_2 \geq P_1$, the initial floor price. Consequently, when P_1 is sufficiently high, the owner-manager will choose the reliable technology in period 1 and there will exist only reputation equilibria.

Proposition 4. *Under owner-management, if the initial floor price satisfies the following condition:*

$$P_1 > I + \frac{c}{1-\delta} \tag{16}$$

there exist only reputation equilibria in which the owner-manager chooses the reliable technology in period 1.[14]

5.3 Conditions for reputation equilibria: the owner-managed vs. the brand-capital firm

Proposition 4 demonstrates that owner-managed firms can maintain reputations if and only if the initial floor price is sufficiently high. Since the initial floor price is positively dependent on the oversight system's initial effectiveness rating, ρ_1, this result implies that, under owner management, reputation equilibria are sustained if and only if the oversight system's initial effectiveness rating is high. This result contrasts directly with the results of Proposition 2 which show that, for the brand-capital firm, reputation equilibria are supported only when the floor price, and thus the oversight system's initial effectiveness rating, is low. Combining Proposition 2 and 4 thus immediately yields the following comparison between the conditions for reputation equilibria in the brand-capital and owner-managed models:

Proposition 5. *(i) When*

$$P_1 < \min\left[1-\frac{c}{e-\delta}, I+\frac{c}{1-\delta}\right], \tag{17}$$

[14]The same condition ensures reputation equilibria when $T > 2$. To see this note that, for the same reasons that $(1-\delta)(p_2-I)$ represents the owner's opportunity cost of diverting in period 1 in expression (15), when $T > 2$, the opportunity cost of diverting in period $T-1$ is $(1-\delta)(p_T-I)$. This opportunity cost is higher in earlier periods since the owner forgoes more periods of profitable production if the firm fails to produce a high-quality good. In contrast, the owner's gain from diverting in a given period remains fixed at c. Thus, if the owner finds it profitable to eschew diverting in period $T-1$, she will also find this choice optimal in every prior period.

then a brand-capital firm supports reputation equilibria and an owner-managed firm does not.

(ii) If P_1 is sufficiently high, then an owner-managed firm supports reputation equilibria and a brand-capital firm does not.

Proposition 5 demonstrates that an owner-managed firm and a brand-capital firm support reputable behavior under very different conditions. The key parameter determining the reputational efficiency of these two forms of operating control is the oversight system's initial effectiveness rating. What drives the effect of operating control on reputation? The owner-manager's decision problem is one of optimal harvesting. If she opportunistically harvests the reputation to raise current period profit, she may eliminate future gains that flow from the reputation. When the oversight system's rating is low, future reputational rents are small relative to the current gain from opportunism. Therefore, the owner-manager is unlikely to maintain the firm's reputation. In a brand-capital firm the owner is a victim, even ex post, not the beneficiary, of opportunism. To limit expropriation by the manager, the owner has to pay the manager incentive compensation. The same payment assures consumers of quality. When the oversight system is actually secure (insecure), the compensation is irrelevant (effective). Thus, when the oversight system's rating is low, the compensation is cost effective and the non-manager owner will deploy compensation and thereby ensure reputation. When the oversight system's rating is high, reputation assuring compensation is not cost effective. In this case, the owner will rely solely on the oversight system which is an imperfect deterrent to managerial opportunism.

5.4 Oversight policy in the owner managed firm

Previously, we demonstrated that, when the brand-capital firm can alter the effectiveness of its oversight system, it will either pick the lowest feasible level of effectiveness for the oversight system or improve its effectiveness to a level that completely blocks opportunism. We now demonstrate that an owner-managed firm will tend not to make such extreme choices. Moreover, when the oversight policy is endogenous, diversion can occur with lower frequency at a brand-capital firm than an owner-managed one.

To formally assess the effect of separating ownership and management on oversight policy, we need to characterize equilibrium behavior of the owner-managed firm as a function of the oversight system's effectiveness rating, ρ_1. In Proposition 4, we characterized equilibrium behavior when ρ_1 is high enough to support a reputation equilibria. Now we need to also consider cases where it does not. First, we need to surmount one technical complication. In contrast to the classic reputation models, in our model, even after diversion there is some probability that output will be high quality. For this reason, for some parameterizations, pure strategy equilibria exist in which diversion always occurs in period 1 when the oversight system is insecure. In the appendix we

derive the necessary and sufficient condition for the existence of these pure-strategy all-diversion equilibria under owner-management. The condition is rather complex and developing it here would be a distraction. So we impose the following restriction on the parameter space which is sufficient to rule out the all-diversion equilibria:

$$c + 2I < 1. \tag{18}$$

When condition (18) is satisfied, if the parameters do not support a reputation equilibrium they support a mixed strategy equilibrium. In these mixed equilibria, the owner-manager randomizes between diverting and not diverting in period 1 when the oversight system is insecure. Since the owner-manager must be indifferent between diverting and not diverting, and the goods' prices, p_1 and p_2 satisfy Bayes' rule

$$\begin{aligned} c &= (1-\delta)(p_2 - I), \\ p_2 &= \frac{\rho_1}{p_1} + \left[1 - \frac{\rho_1}{p_1}\right]\delta. \end{aligned} \tag{19}$$

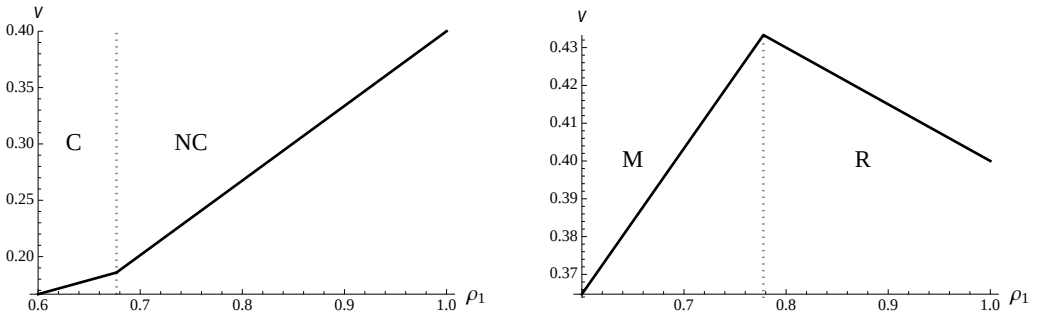
Note that firm value conditioned on an insecure oversight system equals its value under no diversion, $p_1 - e + p_2 - I$ since the owner-manager is indifferent between diverting and not diverting. Also note that the firm's value with a secure oversight system is $p_1 - e + p_2 - e$. Then solving equation (19), it follows that the marginal increase in the owner-managed firm's value from raising ρ_1 in a mixed equilibrium is given by

$$\frac{(1-\delta)^2}{c + (I-\delta)(1-\delta)} - c. \tag{20}$$

Simple algebra demonstrates that the expression (20) is larger than $1 - \delta - c$, the marginal benefit from ρ_1 in a reputation equilibrium, so long as $1 \geq I + \frac{c}{1-\delta}$. This condition is always satisfied in our model. Hence, given that the cost of improving the oversight system is linear, as the following Lemma demonstrates, in contrast to a convex relation between firm value and ρ_1 for a brand-capital firm, under owner management the relation is concave.

Lemma 3. *If $c + 2I < 1$, the firm's ex ante value under owner management is a concave function of the oversight system's effectiveness.*

As we have described in the discussion preceding Lemma 3, the concave relation between the value of the owner-managed firm and the quality of the oversight system results from the relation between the rating of the oversight system and reputation equilibria. A high effectiveness rating for the oversight system supports reputation equilibria in which diversion is unlikely and does not occur until the last period. When the oversight system's rating is low, reputation equilibria cannot be supported. Instead, there exist mixed strategy equilibria in which the probability of diversion is large and thus the marginal benefit from improved oversight is large. Because of the lower ex ante cost of diversion associated with a high oversight system rating, the marginal gain from improving oversight falls with the rating of its oversight system. This contrasts with the brand-capital firm,



A. Brand-capital firm. B. Owner-managed firm.

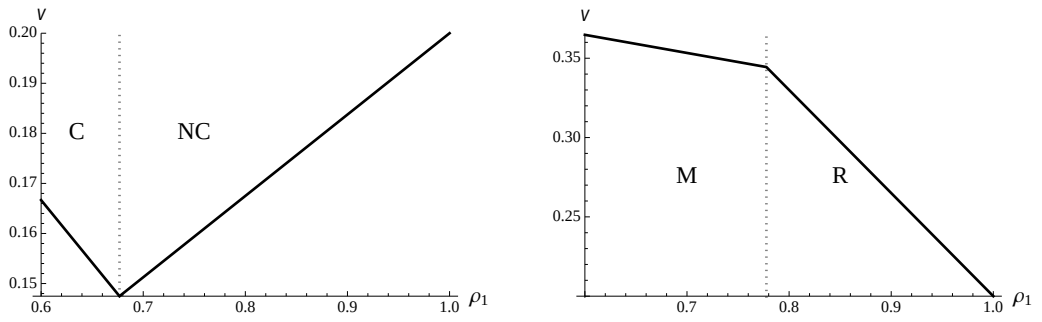
Figure 3: *Oversight policy when* $\gamma = 0.50$. In the figure, ex ante firm value, v is plotted against the expected initial effectiveness of the oversight system when the marginal cost of strengthening the oversight system is given by $\gamma = 0.50$. The other parameters of the model are fixed at $I = 0.3, c = 0.4, \delta = 0.25$. In Panel A, the region over which the firm pays reputation ensuring compensation is labeled "C"and the region over which the firm relies on the oversight system is labeled "NC." In Panel B, the region were a reputation equilibrium obtains is labeled "R" and the region over which the owner-manager plays a mixed strategy that involves diversion is labeled "M."

for which a low oversight system rating supports reputation equilibria while a high rating supports equilibria in which diversion can occur in all periods. Hence, as we demonstrate in Lemma 2, the relation between the brand-capital firm's value and the rating of its oversight system is convex. In the following figures we illustrate the contrasting implications of Lemmas 2 and 3 for the oversight policy and product quality.

Strengthening the oversight system and raising ρ_1 is beneficial for both the brand-capital as well as the owner-managed firm. This is so whether or not the firms are in a reputation equilibrium. Hence, under both modes of operating control, when the marginal cost of raising ρ_1 is sufficiently low, for example $\gamma < 1 - \delta - c$, it is optimal to set $\rho_1 = 1$ and completely block all diversion. For higher values of γ, because the functional form of ex ante value is radically different for brand-capital and owner-managed firms, the optimal level of ρ_1 can vary dramatically with the mode of operating control.

In Figure 3, we set $\gamma = 0.5$. The marginal cost of strengthening the oversight system is sufficiently low for the optimal level of ρ_1 to equal 1 for a brand-capital firm. Thus, in both periods 1 and 2, all diversion is blocked by the oversight system. The optimal level of ρ_1 is much lower under owner management. Value is maximized when ρ_1 is set at the lowest value that satisfies the necessary and sufficient condition (16) for reputation equilibrium in Proposition 4. Hence, in the owner-managed firm, under the optimal ρ_1, although reputation ensures no diversion in period 1, diversion occurs with a positive probability in period 2.

In Figure 4 we double the value of γ. For the brand-capital firm, it is still optimal to set $\rho_1 = 1$. Under owner management it is optimal to set $\rho_1 = \rho^0$, which supports only mixing equilibria.



A. Brand-capital firm. B. Owner-managed firm.

Figure 4: *Oversight policy when* $\gamma = 1.00$. In the figure, ex ante firm value, v is plotted against the expected initial effectiveness of the oversight system when the marginal cost of strengthening the oversight system is given by $\gamma = 1.0$. The other parameters of the model are fixed at $I = 0.3, c = 0.4, \delta = 0.25$. In Panel A, the region over which the firm pays reputation ensuring compensation is labeled "C"and the region over which the firm relies on the oversight system is labeled "NC." In Panel B, the region were a reputation equilibrium obtains is labeled "R" and the region over which the owner-manager plays a mixed strategy that involves diversion is labeled "M."

Hence, once again diversion occurs with a higher probability under owner management, in this case with positive probability at both dates.

To understand Figures 3 and 4 note that, when the oversight system's rating is high, owner-management supports reputation equilibria. In addition, it is always the case that the owner-manager can capture opportunism gains in the final period if the oversight system is insecure. In contrast, the non-managing owner can only sustain reputable behavior by paying reputation-assuring compensation. Moreover, the non-managing owner does not capture any of the gains from opportunism. Thus, for the non-managing owner, strengthening the oversight system either increases period 1 product prices or reduces managerial rents. Both of these benefits are absent for the owner-manager when the rating of the oversight system is high. In period 2, a more effective oversight increases product prices both under owner and non-owner management. However, under owner management, part of the gain from increased product prices is neutralized by the reduction in owner-manager gains from opportunism, which only accrue if the oversight system is insecure. Thus, the brand-capital firm has a greater incentive to invest in strengthening the oversight system than the owner-managed firm. Strengthening the oversight system reduces opportunism not only in period 1 but also in the final period, period 2. Hence, for a range of marginal costs, the brand capital firm will invest sufficiently in oversight to deter opportunism in both periods 1 and 2 while the owner-managed firm will not invest in augmenting the control system, relying on reputation equilibrium to ensure quality in period 1 and permitting diversion in period 2.

This may also be the case when γ rises to a sufficiently high level. In this case, it is clear that setting $\rho_1 = \rho^0$ is optimal under both forms of operating control. When ρ^0 is sufficiently low,

Propositions 2 and 4 demonstrate that the brand-capital firm will play the reputational equilibrium while the owner-managed firm will face a positive probability of diversion in both periods 1 and 2.

5.5 The "non-problem" of ex post commitment under owner management

We have shown that an informed non-managing owner of a brand-capital firm cannot commit to ensure her firm's reputation by using incentive compensation. Is the non-viability of informed ex post commitment through contracting a product of our approach to modeling reputation or it is specific to the separation of ownership and management that characterize the brand-capital firm? To answer these questions, we first identify a contracting mechanism that can commit an owner-manager to maintain her firm's reputation. We show that, unlike the brand-capital firm, the owner-managed firm cannot commit to maintain its reputation using a contract whose payoffs are made entirely from firm revenue. Moreover, we show that the non-viability of informed commitment in the brand-capital firm is caused by operational separation by demonstrating that informed commitment is possible under owner management. Ironically perhaps, informed commitment is possible under owner management precisely because an attempt by an informed owner-manager to alter the constraints on opportunism are viewed much more suspiciously by consumers because they know that the owner-manager stands to gain from opportunism.

Contracting mechanisms that commit the owner-manager to maintaining her firm's reputation must either punish her for diverting or reward her for eschewing diversion. Punishment mechanisms involve the owner contracting with third parties to pay a "fine" if good prices reveal the firm as insecure. Since the period 1 price is not affected by the owner's period 1 actions, the fine would be imposed based on period 2 prices, which would affect the owner's incentives in period 1 alone. However, if the firm is revealed at the start of period 2, the owner's optimal operating strategy is to shut down the firm in period 2, ensuring a 0 cash flow. Thus, if contracting is restricted by limited liability, such "punishment contracts" are infeasible.

A more promising commitment approach is a reward mechanism. One such mechanism, which we term a "performance bond," works as follows: The owner-manager deposits D in an account at date 0. The owner-manager is paid back D in period 2 if the firm is unrevealed and the period 2 good's price equals at least P_1. The deposit is forfeit otherwise. Suppose it costs $\phi \geq 0$ at date 0 to set up this bond. If the oversight system is insecure, the bond will prevent the owner-manager from diverting in period 1 so long as

$$1 - e + P_1 - I + D \geq 1 - e + c + \delta(\gamma + P_1 - I). \tag{21}$$

Thus, the bond will be effective in preventing period 1 diversion when

$$P_1 + D \geq I + \frac{c}{1-\delta}. \tag{22}$$

Hence, once a sufficiently large bond is posted, the owner-manager will commit to maintaining her firm's reputation.

We now examine the inferential effects of posting the bond. Consider a candidate equilibrium in which the owner-manager adopts the mechanism both when the oversight system is secure and insecure. Hence, the failure to adopt the mechanism is off the equilibrium path. Let v^*_{OM} represent the value of the owner-manager's claim in equilibrium. Then, conditioned on the oversight system's type

$$\begin{aligned} v^*_{OM}(\mathcal{I}) &= -\phi - D + 1 - e + (D + P_1 - I) = 1 - e - \phi + (P_1 - I), \\ v^*_{OM}(\mathcal{S}) &= -\phi - D + 1 - e + (D + P_1 - e) = 1 - e - \phi + (P_1 - e). \end{aligned} \tag{23}$$

Let (p_1, p_2) represent any consumer price responses to the off-the-equilibrium-path decision not to adopt the quality-assuring mechanism under the assumption that the owner-manager operates in both periods. The owner-manager's payoffs from deviation under the price response (p_1, p_2), conditional on the oversight system's type, are given by

$$\begin{aligned} v_{OM,\mathcal{I}}(p_1, p_2) &= (p_1 - e) + (p_2 - I) + \max[c - (1 - \delta)(p_2 - I), 0], \\ v_{OM,\mathcal{S}}(p_1, p_2) &= (p_1 - e) + (p_2 - e). \end{aligned} \tag{24}$$

The maximum term in the definition of $v_{OM,\mathcal{I}}$ reflects the ability of the owner-manager to capture gains by diversion when the oversight system is insecure. Equations (23) and (24) imply that

$$v_{OM,\mathcal{I}}(p_1, p_2) - v^*_{OM}(\mathcal{I}) = [v_{OM,\mathcal{S}}(p_1, p_2) - v^*_{OM}(\mathcal{S})] + \max[c - (1 - \delta)(p_2 - I), 0] \geq v_{OM,\mathcal{S}}(p_1, p_2) - v^*_{OM}(\mathcal{S}).$$

Thus,

$$\begin{aligned} &\{(p_1, p_2) : v_{OM,\mathcal{S}}(p_1, p_2) \geq v^*_{OM}(\mathcal{S})\} \subset \{(p_1, p_2) : v_{OM,\mathcal{I}}(p_1, p_2) \geq v^*_{OM}(\mathcal{I})\} \text{ and} \\ &\qquad \{(p_1, p_2) : v_{OM,\mathcal{S}}(p_1, p_2) > v^*_{OM}(\mathcal{S})\} \subset \{(p_1, p_2) : v_{OM,\mathcal{I}}(p_1, p_2) \geq v^*_{OM}(\mathcal{I})\}. \end{aligned} \tag{25}$$

Expression (25) shows that, in contrast to the brand-capital firm, the owner-managed firm has *more* to gain from taking the off-equilibrium-path action and failing to adopt quality-assuring mechanisms when the oversight system is *insecure*. For this reason, refinement arguments work in opposite directions when applied to owner-managed and brand-capital firms: While the off-equilibrium beliefs required for supporting the adoption of a quality-assuring mechanism—beliefs that put significant weight on deviations from the equilibrium signaling insecurity of the oversight system—are inconsistent with refinement criteria for the brand-capital firm, these beliefs are favored by refinement criteria when the firm is owner managed.

The reason for the reversal is straightforward: The owner-manager captures ex post opportunism gains from diversion. Thus, dropping mechanisms that block opportunism is suspicious. For this reason, it is natural for consumers to have off-equilibrium beliefs that make dropping quality-assuring mechanisms unattractive to the owner-manager. In contrast, when a non-managing owner is informed, her gain from reputation-ensuring compensation is lower when the oversight system is secure than when it is insecure. Hence, standard equilibrium refinements dictate that the failure to adopt a quality-assuring contract is a positive signal about the oversight system. It follows that the non-viability of informed commitment for brand capital firms identified in Section 4.3

is not a general feature of firm reputation formation but rather a specific characteristic of brand-capital firms. This result points to yet another fundamental difference in a reputational context between brand-capital firms, which are characterized by delegated management and informational separation, and owner-managed firms.

5.6 Ex ante commitment under owner management

As we have seen, brand-capital firms differ fundamentally from owner-managed firms in their ability to commit ex post. We now consider ex ante commitment. We will show that, while both brand-capital firms and owner-managed firms, under the same restrictions, can make ex ante commitments to reputable behavior, their incentives to make such commitments are fundamentally different—owner-managers would like to commit ex ante to quality while brand-capital firm owners have no incentive to commit ex ante.

First consider the owner-managed firm. The agency conflict under owner management is between the owner's ex ante and ex post selves. Ex ante, the owner-manager can gain both by imposing penalties on his ex post self when his ex post self acts in ways that lower ex ante value and by rewarding his ex post self when it acts in ways that increase ex ante value. Thus, ex ante the owner-manager has an incentive to adopt quality assuring mechanisms when such mechanisms are feasible. It follows from condition (22) that the owner-manager can commit to ensuring her firm's reputation by posting a bond even when the oversight system's rating is too low to satisfy condition (16) for reputation equilibria under owner management presented in Proposition 4. Hence, a performance bond will allow the owner-managed firm to safeguard its reputation both when its rating system is high as well as when it is low. Note, however, that the owner-manager must have date 0 funds of at least $e + D + \phi$ to cover the cost of posting the bond as well as operating the firm. Hence, only an owner-manager with sufficiently deep pockets will be able to capitalize on the reputation enhancing benefits of such a performance bond. Since, ex ante, high quality output maximizes firm value, when the cost of establishing the performance bond, ϕ, is sufficiently small, the owner can gain from posting the bond.

The brand capital firm *could* also post a performance bond to ensure reputable behavior. In the brand-capital firm's case this amounts to a performance bond conditioned on paying reputation-ensuring compensation to the manager. However, for the brand-capital firm, the ex ante and ex post incentives of the uninformed owner are not misaligned. Thus, even if the brand-capital firm has the resources required to post a performance bond, it will never do so. To see this, note that the only policy decision made by the owner is whether to pay period 2 compensation conditional on whether the firm is revealed at the start of period 2, and thus based on the manager's actions in period 1. This decision is chosen to maximizes the owner's ex ante payoff. If a performance bond effectively changes the owner's policy, it would simply lower the owner's payoff because it would

impose the positive contracting cost ϕ and distort policy. Even if it is ineffective, it will lower the owner's payoff by imposing the contracting cost.

Thus, the very standard argument in the reputation literature—that limited liability or capital constraint restrictions are required to prevent the reputation problem from being resolved through contracts—does not apply to brand-capital firms. Relaxing liability and capital constraints on contracting, will not lead brand-capital firms to adopt policies that increase the likelihood of reputable behavior.

6 Conclusion and extensions

We model reputation for a brand-capital firm, which in our model has three key characteristics: Its operations are completely controlled by a reputationless professional manager who has inside information about the firm's oversight system. The oversight system constrains the manager's opportunism. The firm's owner is the sole residual claimant of its cash flows. We show that the brand-capital firm can commit to maintain its reputation only if (i) consumers believe it has a viable oversight system that will sometimes block opportunism, (ii) outsiders place a low rating on the oversight system's effectiveness, (iii) the owner sets up a compensation contract that defers the manager's compensation till the end of his tenure with the firm, (iv) the owner is an outsider in terms of her knowledge about the oversight system.

To highlight the novel insights provided by our analysis of the brand-capital firm, we benchmark it against an owner-managed firm, which is technically similar to firms in the classic models of reputation; outsiders' rating of the owner-managed firm's control system plays the role that is occupied by outsiders' perceptions of insiders' characteristics in the classic models. In contrast to the brand-capital firm, in the owner-managed firm there is no separation between owner and manager because the two roles are fused. The fusing of the owner and manager's roles fundamentally changes the calculus of firm reputation in several important ways:

a. For brand capital firms, reputation equilibria are supported by a low oversight system rating while for owner-managed firms reputation equilibria are supported by a high rating.
b. For brand capital firms, informed commitment to quality assuring compensation is impossible because of the inferential effects of commitment. For owner-managed firms, inferential effects do not block commitment via contracting mechanisms.
c. Owner-managed firms have an incentive to employ bonding mechanisms to make ex ante commitments to product quality while brand capital firms do not.
d. The marginal gains from augmenting the quality of the oversight system are increasing for brand capital firms and deceasing for owner-managed firms.

The analysis in this paper can be extended. One easy but perhaps not very insightful extension of this analysis would be to drop our assumption that the term of the manager is coextensive with

the life of the firm. Kreps (1996) and Cremer (1986) describe how a short-lived professional manager may be induced to maintain the reputation of a long but finitely-lived firm. Their intuition is easily extended to our brand-capital firm. For example, suppose managers live only two periods but the firm can operate for $T > 2$ periods. Assume the firm employs a new manager each period, each manager is employed only in the first and is paid in the second period of his life if the firm maintains its reputation. It is clear from our analysis that a sufficiently high payment will induce each manager to eschew diversion. The owner will be willing to make the now periodic payments so long as the price gain from reputation is larger then the cost of the incentive compensation. This tradeoff will favor the maintenance of firm reputation when the firm's initial reputation is sufficiently low and thus the expected gain from maintaining reputation is large. The owner will still be unable to prevent diversion in period T since she will cannot incentivize the period T manager with deferred compensation.

Another direction of extension would be to allow for "corporate reputation reform," intervention by owners to improve the oversight system after manager actions revealed that it was insecure. Corporate reform would lower the ex post costs to owner-managers from opportunistic actions and thus could reduce their incentives to eschew opportunism, non-owner-managers, who optimally would be terminated after revelation, incentives would not be affected by the reform option. Thus, in contrast to the owner-managed firm, the option to reform would not have adverse incentive effects for the brand-capital firm. Another extension would be to assume a competitive labor market that valued honesty. In this setting, potential managers would have a motivation to build a reputation for being honest even if they were not and this motivation could discourage opportunism. Oversight systems make honest behavior a weaker signal of agents' internal preference for honesty. Thus, oversight system investment by owners might "crowd out" managerial incentives for reputation building.

References

Franklin Allen. Reputation and product quality. *The RAND Journal of Economics*, 15(3):311–327, 1984.

John Armour, Colin Mayer, and Andrea Polo. Regulatory sanctions and reputational damage in financial markets. Oxford Legal Studies Research Paper, 2010.

Roland Bénabou and Jean Tirole. Incentives and prosocial behavior. *The American Economic Review*, 96(5):1652–1678, 2006.

Matthew T. Billet, Zhan Jiang, and Lopo Rego. Glamour brands and glamour stocks. *Journal of Economic Behavior and Organization*, 107:744–759, 2014.

Simon Board and Moritz Meyer-ter Vehn. Reputation for quality. *Econometrica*, 81(6):2381–2462, 2013.

Gian Luca Clementi and Hugo A. Hopenhayn. A theory of financing constraints and firm dynamics. *The Quarterly Journal of Economics*, 121(1):229–265, 2006.

Jacques Cremer. Cooperation in ongoing organizations. *Quarterly Journal of Economics*, 101(1): 33–49, 1986.

Peter DeMarzo and Darrell Duffie. A liquidity-based model of security design. *Econometrica*, 67 (1):65–99, 1999.

Peter M. DeMarzo and Michael J. Fishman. Optimal long-term financial contracting. *The Review of Financial Studies*, 20(6):2079–2128, 2007.

Peter Drucker. Management's new paradigms. *Forbes*, 10:98, 1998.

Alex Edmans. Does the stock market fully value intangibles? employee satisfaction and equity prices. *Journal of Financial Economics*, 101:621–640, 2011.

Alex Edmans, Xavier Gabaix, Tomasz Sadzik, and Yuliy Sannikov. Dynamic ceo compensation. *Journal of Finance*, 67(5):1603–1647, 2012.

Andrew Ellul and Vijay Yerramilli. Stronger risk controls, lower risk: Evidence from u.s. bank holding companies. *The Journal of Finance*, 68(5):1757–1803, 2013.

Werner Erhard, Michael C Jensen, and Steve Zaffron. Integrity: A positive model that incorporates the normative phenomena of morality, ethics, and legality. Abridged (English Language Version), 2016.

Leslie Gaines-Ross. *Corporate Reputation: 12 Steps to Safeguarding and Recovering Reputation*. John Wiley & Sons, Inc., Hoboken, NJ, 2008.

Luis Garicano and Luis Rayo. Why organizations fail: models and cases. *Journal of Economic Literature*, 54(1):137–192, 2016.

Gerald T. Garvey, Simon Grant, and Stephen P. King. Talking down the firm: Short-term market manipulation and optimal management compensation. *International Journal of Industrial Organization*, 16(5):555 – 570, 1998.

Luigi Guiso, Paola Sapienza, and Luigi Zingales. The value of corporate culture. *Journal of Financial Economics*, 117(1):60 – 76, 2015. {NBER} Conference on the Causes and Consequences of Corporate Culture.

Hendrik Hakenes and Martin Peitz. Observable reputation trading. *International Economic Review*, 48(2):693–730, 2007.

Oliver Hart and John Moore. A theory of debt based on the inalienability of human capital. *The Quarterly Journal of Economics*, 109(4):841–879, 1994.

Geoffrey M. Hodgson. *Corporate culture and the nature of the firm*, pages 249–269. Springer Netherlands, Dordrecht, 1996.

Robert D. Innes. Limited liability and incentive contracting with ex-ante action choices. *Journal of Economic Theory*, 52(1):45–67, 1990.

Anil K Kashyap, Raghuram G Rajan, and Jeremy C Stein. Rethinking capital regulation. Federal Reserve bank of Kansas City Symposium: Maintaining stability in a changing financial system, August 21–23 2008.

David M Kreps. Corporate culture and economic theory. In Peter Buckley and Jonathan Michie, editors, *Firms, Organizations, and Markets*, pages 221–275. Oxford University Press, 1996.

David M Kreps and Robert Wilson. Reputation and imperfect information. *Journal of Economic Theory*, 27(2):253–279, 1982.

Jeffrey Liker. *The Toyota-Way: 14 Management Principles from the World's Greatest Manufacturer*. McGraw-Hill Companies, Inc., 2004.

Vojislav Maksimovic and Sheridan Titman. Financial policy and reputation for product quality. *Review of Financial Studies*, 4(1):175–200, 1991.

Ican Marinovic and Felipe Varas. Ceo horizon and optimal pay duration. Stanford University working paper, 2015.

Paul Milgrom and John Roberts. Predation, reputation, and entry deterrence. *Journal of Economic Theory*, 27(2):280–312, 1982.

Paul Milgrom and John Roberts. Price and advertising signals of product quality. *The Journal of Political Economy*, 94(4):796–821, 1986.

David C. Nachman and Thomas H. Noe. Operating efficiency and output insensitive employment contracts for capital management. *Economic Theory*, 5(2):315–335, 1995.

Leonard I Nakamura. Intangible assets and national income accounting: measuring a scientific revolution. Federal Reserve Bank of Philadelphia Working Paper, 2009.

Protiviti Consulting. Ten keys to managing reputation risk. *The Bulletin (http://www.protiviti.com/enUS/Documents/Newsletters/Bulletin/The-Bulletin-Vol-5-Issue-2-10-Keys-Managing-Reputation-Risk-Protiviti.pdf)*, 2016.

Peter W. Roberts and Grahame R. Dowling. Corporate reputation and sustained superior financial performance. *Strategic Management Journal*, 23(12):1077–1093, 2002.

Carl Shapiro and Joseph E Stiglitz. Equilibrium unemployment as a worker discipline device. *The American Economic Review*, pages 433–444, 1984.

Rajendra K. Srivastava, Thomas H. McInish, Robert A. Wood, and Anthony J. Capraro. Part IV: How do reputations affect corporate performance?: The value of corporate reputation: Evidence from the equity markets. *Corporate Reputation Review*, 1 and 2(1):62–68, 1997.

Steven Tadelis. What's in a name? reputation as a tradeable asset. *The American Economic Review*, 89(3):548–563, 1999.

James P Walsh and James K Seward. On the efficiency of internal and external corporate control mechanisms. *Academy of Management Review*, 15(3):421–458, 1990.

Appendix

Proof of Lemma 1. Proof of Claim (i). If the period T good's price is p_T, the manager is contracted to receive an incentive payment $B_T(p_T)$ in period T. Note that p_T and thus both the firm's revenue and the manager's incentive payment are unaffected by his technology choice. However, if the manager diverts, he receives an additional c. Therefore, the manager maximizes his payoff in period T by diverting.

Proof of Claim (ii). Once the firm is revealed, consumers know that the manager will divert in period T. This fixes the price of the period T good at δ. Therefore, the manager's period T compensation is fixed whether or not he is discovered to have diverted in period $T-1$. Hence, period $T-1$ diversion is optimal for the manager. This argument extends backwards to the period in which the firm is first revealed and establishes that the manager will divert in every period that the firm operates after it is revealed.

Proof of Claim (iii). Claim (ii) establishes that the price of the period-t good will equal δ if the firm produces in period t after it is revealed. By Assumption 2, period t production is not profitable if the t-period good's price is δ. Therefore, if the oversight system is known to be insecure in period t, the firm will shut down. □

Proof of Proposition 1. We first establish parts (a), (b), and (c) of the Proposition. To establish these parts, we first solve a "full commitment problem." Then we will establish that this solution is also a solution to the "actual problem" modeled in the paper.

In the full commitment problem, the owner can contract on the operating decision on the unrevealed path, i.e., specify at date 0, the choice between shutting down an operating in period t when the firm is unrevealed. The full commitment problem also assumes that the owner can contract a "payment schedule" at date 0. A payment schedule is a non-negative vector $\mathbf{b} = (b(1), b(2), \ldots b(T))$ of compensation payments, where $b(t) \geq 0$ is the payment received by the manager if the firm is unrevealed at the start of period t. This problem differs from the actual problem only for the following two reasons: (a) in the actual problem, payments cannot be conditioned directly on revelation but rather must depend only on the price history up to the period when the payment is made, and (b) the operating decision is made ex post not ex ante.

We will show that the compensation/operating policy for the full commitment problem is exactly the same as our candidate solution to the actual problem. Finally, we will show that the full commitment payment schedule can be implemented by price-history contingent contracts and that the operating policy under the full commitment policy is ex post incentive compatible. Since the actual problem features more constraints that the full-commitment problem, its solution cannot produce a higher payoff to the owner than the optimal solution under full commitment. Thus, the payment schedule and operating policy specified by the solution to the full commitment problem is an optimal solution to the actual problem, and the contracted payments to the manager in the actual problem must satisfy the necessary and sufficient restrictions on payments in the full commitment problem.

First, consider the full commitment compensation schedule assuming that the owner's operating policy is to never shut down when unrevealed. For any given compensation schedule, $\mathbf{b}$, let $v_M[\mathbf{b}](t)$ represent the manager's value function when the oversight system is insecure and the firm is unrevealed up to period t. If the manager does not divert in period t, then it must be the case that the manager's value from diversion, $b(t) + c + \delta\, v_M[\mathbf{b}](t+1)$, is no greater than the value from not diverting, $b(t) + v_M[\mathbf{b}](t+1)$. Thus, not diverting is incentive compatible if and only if

$$(1-\delta) v_M[\mathbf{b}](t+1) \geq c. \tag{A-1}$$

Next note that $v_M[\mathbf{b}](t)$ is non-increasing in t because, in period t, the manager can always secure a value of $b(t) + v_M[\mathbf{b}](t+1)$ by not diverting. Because the manager chooses the optimal policy in period t

$$v_M[\mathbf{b}](t) \geq b(t) + v_M[\mathbf{b}](t+1) \geq v_M[\mathbf{b}](t+1). \tag{A-2}$$

Thus, if equation (A-1) is satisfied at t, it is satisfied for $s < t$. Next note that, in period T, the manager's continuation value is 0 and thus diversion is always optimal. Hence, regardless of the

payment schedule, there will exist a period, $t^+ \in \{0,1,\ldots,T-1\}$, such that the manager does not divert before t^+ and diverts at $t^+ + 1$. If $t^+ = 0$ then the manager diverts in all periods and under the optimal compensation policy is paid zero in all periods.

A necessary condition for a payment schedule to be optimal is that over all payment schedules inducing the same reputation cutoff period, it maximizes the payoff to the owner. The anticipated value to the owner at date 0 equals gross firm profit (firm profit excluding the cost of management compensation) less managerial compensation. Under our assumptions that the firm has committed to a policy of not shutting down on the unrevealed path, expected gross profit is fixed. Thus, an optimal schedule must minimize expected payments to the manager over all schedules that implement the same reputation cutoff period.

If the oversight system is secure, $\mathrm{EP}^{\mathcal{S}}$, the expected payments to the manager equals the simple sum of payments promised on the unrevealed path, i.e,

$$\mathrm{EP}^{\mathcal{S}}[\mathbf{b}] = \sum_{t=1}^{T} b(t).$$

If the oversight system is insecure, then up to period $t^+ + 1$, the expected payment also equals the sum of payments. Subsequent to period $t^+ + 1$ the manager may not receive payments because of revelation which occurs with probability $1-\delta$ in each such period. Thus, the expected payments to the manager given the control structure is insecure, $\mathrm{EP}^{\mathcal{J}}$, are given by

$$\mathrm{EP}^{\mathcal{J}}[\mathbf{b}] = \sum_{t=1}^{t^+} b(t) + b(t^+ + 1) + \sum_{t=t^+ + 2}^{T} \delta^{t-(t^+ + 1)}\, b(t).$$

Expected payments to the manager, $\mathrm{EP}[\mathbf{b}]$, equal the expectation over the secure and insecure states, i.e.,

$$\mathrm{EP}[\mathbf{b}] = \rho_1\, \mathrm{EP}^{\mathcal{S}} + (1-\rho_1)\, \mathrm{EP}^{\mathcal{J}}. \tag{A-3}$$

The manager's value at $t^+ + 1$, equals the value obtained from diverting in every period after t^+. Under this strategy, if the oversight system is insecure, the manager captures c and all compensation payments so long as the firm remains unrevealed, i.e.,

$$v_M[\mathbf{b}](t^+ + 1) = c + b(t^+ + 1) + \sum_{t=t^+ + 2}^{T} \delta^{t-(t^+ + 1)}\, (c + b(t)). \tag{A-4}$$

An optimal schedule $\mathbf{b}$ must satisfy the condition that it minimizes payments to the manager subject to the incentive constraint, (A-1), i.e., an optimal schedule that induces a reputation cutoff period of t^+ must solve the following problem:

$$\begin{aligned} &\mathrm{Min}_{\mathbf{b}\geq 0}\, \mathrm{EP}[\mathbf{b}], \\ &\text{s.t. } (1-\delta) v_M[\mathbf{b}](t^+ + 1) \geq c. \end{aligned} \tag{A-5}$$

The Lagrange, $\mathscr{L}$ for this problem is

$$\mathscr{L}[\mathbf{b}] = \mathrm{EP}[\mathbf{b}] - \lambda \left((1-\delta) v_M[\mathbf{b}](t^+ + 1) - c \right). \tag{A-6}$$

Let $\partial_t \mathscr{L}$ represent the partial derivative of the Lagrange with respect to $b(t)$. Then, using equation (A-4),

$$\partial_t \mathscr{L} = \begin{cases} 1 & \text{if } t < t^+ + 1, \\ \rho_1 - \left((1-\delta)\lambda - (1-\rho_1)\right) & \text{if } t = t^+ + 1, \\ \rho_1 - \delta^{t-t^+-1}\left((1-\delta)\lambda - (1-\rho_1)\right) & \text{if } t > t^+ + 1. \end{cases} \tag{A-7}$$

First note that since, $\partial_t \mathscr{L} > 0$ for $t < t^+ + 1$, by the Kuhn-Tucker conditions, $b(t) = 0$, for all $t < t^+ + 1$. Next, note the following two items: (i) Because positive compensation must be paid in at least one period to ensure non-diversion, it must be the case that $\partial_t \mathscr{L} \leq 0$ for some period $t \geq t^+ + 1$. (ii) Because infinite compensation is not optimal, it must be the case that, for all t, $\partial_t \mathscr{L} \geq 0$. Condition (i) implies that $(1-\delta)\lambda - (1-\rho_1) > 0$ which, in turn, implies that $\partial_{t^+ + 1} \mathscr{L} < \partial_t \mathscr{L}$, for $t > t^+ + 1$. This implies, combined with (ii) that (a) $\partial_{t^+ + 1} \mathscr{L} = 0$ and (b) $\partial_t \mathscr{L} > 0$, for $t > t^+ + 1$. By the Kuhn-Tucker conditions, (b) implies that $b(t) = 0$ for all $t > t^+ + 1$. Thus, we have shown that if **b** is an optimal payment schedule over all payment schedules, and, under **b**, the last non-diversion period is t^+, then the performance schedule will call for one positive payment at date $t^+ + 1$. This payment will exactly satisfy the incentive compatibility condition and thus, the contract will specify $b(t) = 0$ for $t \neq t^+ + 1$ and specify a payment $b(t^+ + 1)$ that satisfies

$$(1-\delta)\left(c + b(t^+ + 1) + \sum_{t=t^+ + 2}^{T} \delta^{t-(t^+ + 1)} c\right) = c. \tag{A-8}$$

Simple algebra shows that this contract design coincides with the payments specified in part (b) of Proposition 1 when $t^+ = t_*^+$.

Next, note that, ex ante, shutting down production is never optimal. This result is an easy consequence of (i) Assumption 1, which implies that per-period profit on the unrevealed path is positive, and (ii) the incentive compatibility condition for non-diversion, (A-1): Reducing the number of unrevealed periods in which the firm operates, lowers the manager's continuation value after the reputation cutoff period and thus increases the compensation payment required to ensure that the manager does divert up to the reputation cutoff period. Because shutting down on the unrevealed path strictly lowers gross profits and weakly increases expected managerial compensation, shutting down on the unrevealed path is strictly suboptimal ex ante for the owner. Thus we have established the following result:

Result 1. The payments received by the manager and the operating policy under an optimal solution to the full commitment problem are identical to the payments and policies specified in Proposition 1.

To complete the proof of parts (a), (b), and (c), we need only show that (i) the full-commitment schedule of payments can be implemented with price-history-dependent contracts and (ii) under a full-commitment optimal contract, the ex post optimal operating policy coincides with the ex ante

optimal policy. Establishing (i) is straightforward: A contract that promises to pay $b(t)$ at date t if and only if the good's price at least equals p_1 will provide a payment to the manager of $b(t)$ if and only if the firm is unrevealed at date t.

Next consider (ii). First note that the fact that the manager can always divert c in any period implies that $v_M[\mathbf{b}](t^+ + 1) \geq c$. Thus, equation (A-1) implies the following result:

Result 2. A compensation payment of $\frac{c\delta}{1-\delta}$ always satisfies (A-1) for any reputation cutoff period, t^+. Thus, schedules that solve the full commitment problem will never specify higher payments to the manager than $\frac{c\delta}{1-\delta}$ at any date.

Now consider the ex post operating decision in periods $t < t^+ + 1$. In these periods, no payments are received by the manager; the probability of the manager diverting is 0 and thus beliefs about the oversight system are not revised. Thus, Assumption 1 ensures that it is never optimal ex post to shut down.

Next consider $t \geq t^+ + 1$. In this case, the operating decision will affect the belief revision process, i.e, if the firm operates at date $t^+ + 1$ then, either the firm will be revealed with probability $1 - P_1$ and will shut down, or the firm will remain unrevealed with probability P_1. If the firm remains unrevealed and operates in period $t^+ + 2$, the price of the period $t^+ + 2$ good, $p_{t^+ + 2} = \Gamma[P_1]$. So, assuming the firm operates when unrevealed at $t^+ + 1$, its gross expected profit in period $t^+ + 2$ conditioned on operating in period $t^+ + 2$ when unrevealed is given by

$$P_1(\Gamma[P] - e) + (1 - P_1)\,0 > P_1(\Gamma[P] - e) + (1 - P_1)(\delta - e) = P_1 - e, \tag{A-9}$$

where the last equality follows from Assumption (2) and expression (3). However, the right-hand side of equation (A-9) equals the expected gross profit in period $t^+ + 2$ conditioned on the firm shutting down for period $t^+ + 1$ and resuming operations in period $t^+ + 2$. Thus, the expected gross profit in period $t^+ + 2$ conditioned on operating in period $t^+ + 1$ and operating when unrevealed at $t^+ + 2$ is always higher than the expected gross profit in period $t^+ + 2$ conditioned on shutting down in period $t^+ + 1$. This implies, by an easy backward induction argument, that operating in any period $t \geq t^+ + 1$ leads to a higher gross continuation value. Because no payments are made to the manager after period $t^+ + 1$, the owner's continuation value is thus always higher if the firm operates rather than shuts down when unrevealed.

Now consider the current period payoff: In all periods $t \geq t^+ + 1$ except period $t^+ + 1$ no compensation is paid and thus, by Assumption 1, the current payoff to the owner from operating exceeds the current payoff from shutting down. Thus, operating is ex post optimal for the owner. In period $t^+ + 1$, since $p_{t^+ + 1} = P_1$ and the owner must pay the manager $b(t^+ + 1)$ regardless of whether the firm operates, the owner's current payoff from operating is larger than her payoff from shutting down. Hence, operating is ex post optimal in period $t^+ + 1$. It follows that, the full commitment optimal payment schedule and operating policy is identical to the payment schedule

specified in Proposition 1, and the full commitment policy satisfies the ex post incentive compatibility on operating and can be implement with price-history-dependent contracts. Hence, it is feasible for the more constrained actual problem and thus is optimal for that problem.

Because we have verified that the operating policy for the full-commitment policy is in fact dynamically incentive compatible, there is only one last step to verifying parts (a), (b), and (c) of the Proposition: showing that the full commitment contract satisfies all the restrictions imposed by the model on the contract design, i.e., a. it is conditioned only on past prices, b. its payments are non-negative, c. its payments are nondecreasing in past prices, and d. and it satisfies the limited liability condition. It is obvious that the contract satisfies restrictions b and c, and c. To see that it satisfies restriction d, note that trivially it satisfies restriction d when the specified payment under the contract is 0. Note that part (b) implies that positive payments under the full commitment contract are bounded from above by $c\,\delta/(1-\delta)$, and note that Assumptions 1 and 2 imply that $c < 1-\delta$. Therefore,

$$p_t - b * b^*[t^+] \geq P_1 - c\,(\delta/(1-\delta) \geq P_1 - \delta = (1-\delta)\,\rho_1 > 0,$$

So restriction d is satisfied as well.

Consider part (d) of the proposition. Define a "t^+-shift" as follows: incrementing the reputation cutoff period t^+ by one period to $t^+ + 1$. The change in the manager's compensation is the change in expected compensation under $b^*[t^+ + 1]$ and $b^*[t^+]$. Using part (b), we see that this difference is given by

$$c\,\delta^{T-(t^+ +1)}. \tag{A-10}$$

If the firm is unrevealed, let $p(t)$ represent the price consumers are willing to pay for the good in period t. Note that $p(t)$ also represents the probability that the firm will remained unrevealed until period $t+1$. Since, under the t^+-policy, the manager diverts in all periods after t^+ and does not divert in any period before t^+, the good's price is given by

$$p[t^+](t) = \begin{cases} 1 & t \leq t^+ \\ \Gamma^{(t-(t^+ +1))}(P_1) & t > t^+ \end{cases}, \tag{A-11}$$

and $\Gamma^{(n)}$ is the n-fold composition of the Bayes' operator defined in equation (2), which is explicitly represented by solving a difference equation yielding

$$\Gamma^{(n)}(P_1) = \frac{(P_1 - \delta) + (1-P_1)\,\delta^{n+1}}{(P_1 - \delta) + (1-P_1)\,\delta^n}. \tag{A-12}$$

The owner's expected gross profit in period t under the t^+-policy, which we represent by $\bar{\pi}[t^+](t)$, equals

$$\bar{\pi}[t^+](t) = (p[t^+](t) - e) \prod_{s=0}^{t-1} p[t^+](s), \quad t = \{1, 2, \ldots T\}, \tag{A-13}$$

and the owner's gross value is simply a sum of these gross profits across all periods. Since the

good's price under both the t^+ and $t^+ + 1$ policies equals 1 when $t \leq t^+$, $\bar{\pi}[t^+ + 1](t) = \bar{\pi}[t^+](t)$ for all $t \leq t^+$. Since the Bayes' operator goes into effect with a one period delay under the $t^+ + 1$-policy, $\bar{\pi}[t^+ + 1](t+1) = \bar{\pi}[t^+](t)$ for $t \in (t^+, T)$. Thus, the difference in gross value induced by a t^+-shift is a telescoping sum given by

$$\bar{\pi}[t^+](t^+) - \bar{\pi}[t^+](T) = (1-e) - \bar{\pi}[t^+](T). \tag{A-14}$$

Using equations (A-11), (A-12), and (A-13), we see that

$$\bar{\pi}[t^+](T) = \frac{(P_1 - \delta)(1-e) - (1-P_1)(e-\delta)\delta^{T-(t^+ +1)}}{1-\delta}. \tag{A-15}$$

Thus, the effect on the gross value of the owner of a t^+-shift is given by

$$(1-e) - \frac{(P_1 - \delta)(1-e) - (1-P_1)(e-\delta)\delta^{T-(t^+ +1)}}{1-\delta} = \frac{(1-P_1)(1-e) + (1-P_1)(e-\delta)\delta^{T-(t^+ +1)}}{1-\delta}. \tag{A-16}$$

Combining the effects of a t^+ shift on compensation and gross firm value shows that the net effect on the owner is given by

$$\frac{(1-P_1)\,(1-e) + ((1-P_1)\,(e-\delta) - c)\,\delta^{T-(t^+ +1)}}{1-\delta}. \tag{A-17}$$

Thus, if $(1-P_1)\,(e-\delta) - c \geq 0$, all t^+-shifts increase the owner's value and the owner will set $t^+ = T-1$. Otherwise, $(1-P_1)\,(e-\delta) - c < 0$. In which case, the effect of a t^+ shift on the owner's value is strictly decreasing. Thus, the set of t^+-shifts that increase the owner's value is a (possibly empty) downward directed order interval. The owner will pick the unique t^+, which we denote by t^+_*, which satisfies the following conditions: if some t^+-shift lowers owner value, t^+_* is the smallest $t^+ \in \{0, 1, \ldots T-1\}$ such that the effect of a t^+ shift is to lower the owner's value, or, if all t^+ shifts increase owner value, then $t^+_* = T-1$. This is exactly the assertion made in part (d). Thus the proof is complete. □

Proof of Proposition 2. The proof for each claim follows directly from the discussion preceding the proposition. □

Preamble to proof of Proposition 3. Many features of the baseline model are unaffected by the change in the information structure. The optimal incentive payment, $b^* = c\,\frac{\delta}{1-\delta}$, remains unchanged as the manager's incentives are only affected by his contract and, thus, are not directly affected by consumer or owner beliefs. Moreover, except in a degenerate case discussed below, conditioning the incentive payment on the period 2 good's price exceeding δ is still sufficient to ensure that the incentive payment is made if and only if output quality in period 1 is high.

To interpret the model as a signaling game, we can view the owner as an informed first-mover who sends one of three messages, $m \in \mathscr{M} = \{\text{C}, \text{NC}, \text{SH}\}$, where message C denotes that the owner chooses an optimal contract, NC represents the decision not to pay incentive compensation, and SH represents the decision to shut down the firm in period 1. The owner's type, θ, depends on

the oversight system, i.e., $\theta \in \{\mathcal{S}, \mathcal{I}\}$. A strategy for the owner, $\sigma(\cdot|\theta)$, is a probability measure over $\mathscr{M}$ conditioned on the owner's type. Let v_O represent the owner's payoff function at the start of the game, the beginning of period 1. Consumers are uninformed responders. Their beliefs are represented by the function $\rho : \mathscr{M} \to [0,1]$, where $\rho(m)$ represents their assessment of the probability the oversight system is type $\mathcal{S}$ conditioned on message m. Consumers' response is a price for the period 1 good. Let $p^* : \mathscr{M} \to [\delta, 1]$ represent the period 1 good's price when quality is not assured by compensation. A Perfect Bayesian Equilibrium (PBE) is a triple, (σ^*, ρ^*, p^*), satisfying the following conditions:

i. If $\sigma^*(m|\theta) > 0$, then m is a best response for type θ, i.e.,
$$v_O(m, p^*(m), \theta) = \max_{m \in \mathscr{M}} v_O(m, p^*(m), \theta).$$
ii. Prices are based on beliefs, i.e. $p^*(m) = \rho^*(m) + (1 - \rho^*(m))\,\delta$.
iii. Whenever, under σ^*, a message m is selected with positive probability, ρ^* is consistent with Bayes' rule.

To complete the description of the signaling game, we have to define the owner's payoff function. The need to redefine the owner's payoff function arises because of complications that arise when consumers have a very low assessment of a good's quality. If they believe that a given compensation policy signals that the oversight system is insecure with probability 1, then high quality output will not lead them to revise their assessment. Consequently, the period 2 good's price will equal δ regardless of the quality of the period 1 good. It follows that incentive compensation will not motivate the manager. As long as consumers' assess a non-zero probability to the oversight system being secure, a high quality period 1 good will result in a strictly higher period 2 good price than a low quality period 1 good. However, the period 2 price might still be less than the cost of production, so the firm will shut down in period 2. Accounting for these cases, we obtain the following payoff function for the owner:

$$v_O(m, p, \theta) = \begin{cases} (p - I - c) + \delta \max\left[\Gamma(p) - I - c, 0\right] & \text{if } m = \text{NC } \&\ \theta = \mathcal{I}, \\ (p - I - c) + \max\left[\Gamma(p) - I - c, 0\right] & \text{if } m = \text{NC } \&\ \theta = \mathcal{S}, \\ (1 - I - c) + \max\left[\Gamma(p) - I - c, 0\right] - b^* & \text{if } m = \text{C } \&\ p > \delta, \\ 0 & \text{if } m = \text{C } \&\ p = \delta, \\ 0 & \text{if } m = \text{SH}, \end{cases} \tag{A-18}$$

where $\Gamma(p) = 1 + \delta - \frac{\delta}{p}$ and $b^* = c\,\frac{\delta}{1-\delta}$. □

To complete the proof of Proposition 3, we need to first establish the following results:

Lemma A-1. *In any D1-PBE in which incentive compensation is offered with positive probability, choosing to not provide incentive compensation, NC is on the equilibrium path.*

Proof. Suppose instead that $m = \text{NC}$ is off the equilibrium path in a D1-PBE in which $m = \text{C}$ is on the equilibrium path. Note that expression (A-18) shows that

$$v_O(m, p, \mathcal{S}) = v_O(m, p, \mathcal{I}), \quad m = \text{C or } m = \text{SH}. \tag{A-19}$$

Because $m = NC$ is off the equilibrium path, this implies that the equilibrium payoff v_O^* of $\theta = \mathcal{I}$ equals equilibrium payoff of $\theta = \mathcal{S}$, i.e.,

$$v_O^*(\mathcal{S}) = v_O^*(\mathcal{I}). \tag{A-20}$$

Next note that expression (A-18) shows that

$$\begin{aligned} v_O(\text{NC}, p, \mathcal{S}) &\geq v_O(\text{NC}, p, \mathcal{I}) \\ \text{and if } \Gamma(p) > I + c &\Rightarrow v_O(\text{NC}, p, \mathcal{S}) > v_O(\text{NC}, p, \mathcal{I}). \end{aligned} \tag{A-21}$$

Expressions (A-20) and (A-21) imply that

$$\begin{aligned} v_O(\text{NC}, p, \mathcal{S}) - v_O^*(\mathcal{S}) &\geq v_O(\text{NC}, p, \mathcal{I}) - v_O^*(\mathcal{I}) \\ \text{and if } \Gamma(p) > I + c &\Rightarrow v_O(\text{NC}, p, \mathcal{S}) - v_O^*(\mathcal{S}) > v_O(\text{NC}, p, \mathcal{I}) - v_O^*(\mathcal{I}). \end{aligned}$$

If $\Gamma(p) \leq I + c$ then, because $p < \Gamma(p)$ when $p > \delta$ the payoff to both types from selecting NC is negative and thus less than the payoff from shutting down. So the set of market responses to NC that will induce either type to deviate is a subset of the set of responses, p, for which $\Gamma(p) > I + c$. Over this subset, $v_O(\text{NC}, p, \mathcal{S}) - v_O^*(\mathcal{S}) > v_O(\text{NC}, p, \mathcal{I}) - v_O^*(\mathcal{I})$ and $p \hookrightarrow v_O(\text{NC}, p, \theta)$ is continuous. If consumers responded to the off equilibrium message NC with $p = 1$, then $v_O(\text{NC}, p, \mathcal{S}) - v_O^*(\mathcal{S}) > 0$. So the set of responses that will induce $\mathcal{S}$ to deviate from the equilibrium is also not empty. Thus, the set of market responses p for which $\mathcal{S}$ strictly gains from deviation to NC includes the set of consumer responses under which type $\mathcal{I}$ weakly gains from deviating from the equilibrium. D1 then requires that market assign the belief that $\rho^*(\text{NC}) = 1$ and thus $p^*(\text{NC})$ equals 1. However, under this belief, the unique best response of type $\mathcal{S}$ is to choose $m = \text{NC}$, contradicting the assumption that NC is off the equilibrium path □

Lemma A-2. *In every D1-PBE,* $\Gamma(p^*(NC)) > I + c$.

Proof. Suppose not. First note that, if $\Gamma(p^*(\text{NC})) \leq I + c$, then shutting down produces a strictly higher payoff than selecting $m = \text{NC}$ for both types. Lemma A-1 shows that $m = \text{NC}$ is played in equilibrium. Thus, because equilibrium strategies are best responses, it must be the case that $\Gamma(p^*(\text{NC})) > I + c$. □

Lemma A-3. *In every D1-PBE, the equilibrium payoffs received by types* $\mathcal{I}$ *and* $\mathcal{S}$ *are positive.*

Proof. Expressions (A-19), Lemma A-2, and (A-21), imply that in any equilibrium, whenever NC is a best response for type $\mathcal{I}$ it is the unique best reply for type $\mathcal{S}$. Thus, the probability that type $\mathcal{S}$ chooses NC is weakly higher than the probability that type $\mathcal{I}$ plays NC. Lemma A-1 shows that NC is a best reply for some type. Thus, the probability that type $\mathcal{S}$ chooses NC is weakly higher than

the probability that type $\mathcal{I}$ chooses NC and this probability is positive. Bayes' rule then implies that $p^*(\text{NC}) \geq P_1$. Expression (A-18) and Assumption 1 show that $p^*(\text{NC}) \geq P_1$ implies that the payoff from selecting NC is positive for both types. Thus because both types play best replies, the equilibrium payoff for both types must be positive. □

Lemma A-4. *In every D1 equilibrium in which the equilibrium payoff to both types is positive, $m = C$ is selected with zero probability.*

Proof. Suppose not. Note that it must be the case that type $\mathcal{I}$ is selecting NC with positive probability. Otherwise choosing NC, by Bayes' rule, would reveal that the oversight system is secure and, thus, imply that $p^*(\text{NC}) = 1$. In which case, type $\mathcal{S}$ would strictly prefer $m = \text{NC}$ to $m = \text{C}$. But if type $\mathcal{S}$ strictly prefers NC over C, then C would only be selected by type $\mathcal{I}$. In which case selecting C would reveal the structure to be insecure and, thus, generate a payoff of 0, contradicting the payoff being positive for both types.

The hypothesis that C is played with positive probability combined with our result that type $\mathcal{I}$ is selecting NC with positive probability imply that (a) NC is a best response for $\mathcal{I}$ and that (b) C is a best response for some type. Expressions (A-19), Lemma A-2, and (A-21) imply that

$$v_O(\text{NC}, p^*(\text{NC}), \mathcal{S}) - v_O(\text{C}, p^*(\text{C}), \mathcal{S}) > v_O(\text{NC}, p^*(\text{NC}), \mathcal{I}) - v_O(\text{C}, p^*(\text{C}), \mathcal{I}). \tag{A-22}$$

(a) and (b) and (A-22), imply that NC is the unique best response for $\mathcal{S}$. (b) then implies that C is a best response for type $\mathcal{I}$. Bayes' rule thus implies that $p^*(\text{C}) = \delta$ and thus $v_O(\text{C}, p^*(\text{C}), \mathcal{I}) = 0$, which is not possible given that C is a best response for type $\mathcal{I}$ and type $\mathcal{I}$'s equilibrium payoff is positive. □

Proof of Proposition 3. The proof follows from Lemmas A-1 through A-4. □

Proof of Lemma 2. The proof follows directly from the discussion preceding the Lemma. □

Proof of Proposition 4. Suppose that in period 2, consumers believe that the firm is secure with probability $P_1(\delta)$ if the firm produces a high (low) quality good in period 1. Also suppose that the owner operates the firm in period 2 only if it is unrevealed.

By Assumptions 1 and 2, the period 2 operating policy is incentive compatible for the owner. Condition (16) ensures that the owner's payoff from eschewing diversion in period 1 is higher. Thus, it is incentive compatible for the owner to eschew diversion in period 1 and divert in period 2. Hence, all the agents' actions are incentive compatible and belief updates follow Bayes' rule. This establishes that a reputation equilibrium exists when condition (16) is satisfied.

Suppose consumers believe that the owner will divert with positive probability in period 1. Then, the period 2 floor price $\Gamma[P_1] > P_1$ if the firm produces a high quality period 1 good. But from the discussion immediately preceding the proposition it is clear that, in this case, the owner's

payoff from eschewing diversion in period 1 will exceed his payoff from diverting if condition (16) is satisfied. Thus, there can only exist reputation equilibria when condition (16) holds. □

Proof of Proposition 5. The proof follows directly from comparing the conditions for reputation equilibria in Propositions 2 and 4. □

Lemma A-5. *If $c+2I<1$, under owner management there exist only reputation equilibria or mixed equilibria.*

Proof of Lemma A-5. Under owner management, there can exist "all diversion" equilibria in which the manager diverts in period 1 with a probability 1 when the oversight system is insecure. Hence, in an all diversion equilibrium $p_1 = P_1$ and $p_2 = \Gamma(p_1)$. For manager to be indifferent between diverting and not diverting in period 1, from condition (19), $c = (1-\delta)(p_2 - I)$. Simultaneously solving $p_1 = P_1; p_2 = \Gamma(p_1); c = (1-\delta)(p_2 - I)$, we obtain the highest value of ρ_1 that supports the existence of all cheat equilibria:

$$\frac{\delta\Big(c+(I-\delta)(1-\delta)\Big)}{(1-\delta)\Big((1-\delta)(1+\delta-I)-c\Big)} \tag{A-23}$$

Hence, all cheat equilibria are not supported when (A-23) is smaller than the lower bound on ρ_1, Assumption 1. The conditon $c+2I<1$ ensures that this is indeed the case. □

Proof of Lemma 3. The proof follows directly from Lemma A-5 and the discussion preceding Lemma 3. □