A Theory of Regulatory Fine Print*

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Abstract

We analyze a dynamic reputational model of regulation in which regulators are elected every period. Regulators signal that they are not captured by the regulated firm by designing a regulatory contract that appears to be less favorable to the regulated firm than their ideal contract. However, regulators compensate the firm by including clauses in the contract's fine print that transfer rents to the regulated firm by inefficiently distorting technical dimensions of the contract that voters do not observe or understand. Since the distortionary signaling is done by the regulators whose goals are more aligned with those of voters, this "bad reputation" effect reduces the expected benefit of replacing "bad" regulators and thus limits regulator accountability.

Keywords: Regulation, fine print, "bad reputation", signaling, collusion and capture.

JEL classification numbers: L51, H57, K23.

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1 Introduction

In consumer markets, strategic disclosure of information to consumers is common practice. Good product characteristics are emphasized while the bad ones are not disclosed or hidden in the fine print. Often, some product dimensions are more salient for consumers, which creates incentives for sellers to improve and advertise the most salient dimensions even at the cost of reducing the quality of the less salient attributes, which are disclosed in the fine print if at all.

In this paper we argue that these informational issues, which have been analyzed extensively in consumer markets, also play a prominent role in the design of public policies and, in particular, in regulatory and procurement settings. For example, when the administration procures a telecommunications' license, the public debate mainly focuses on the price of such license (or the reserve price if the license is procured through a competitive auction mechanism) while the regulatory details of the license (interconnection fees and conditions, the length of the concessions, etc.) receive less attention. The fact that voters (or the legislature or elected officials who select the regulator) are mostly unaware of these technical details allows regulators to transfer rents to regulated firms by altering the fine print of procurement contracts or regulatory documents in ways that favor the regulated firms and are undetected by voters. The regulatory response in Europe to the high electricity prices that resulted from Russia's invasion of Ukraine in February of 2022 is a case in point. Since the high electricity prices were caused by the scarcity and high price of natural gas, electricity companies obtained large windfall profits from the generation of electricity from sources other than gas, since they benefited from the high prices without incurring the high cost of acquiring natural gas. The Spanish government introduced a specific tax on these windfall profits but excluded from the tax the profits stemming from long term contracts with consumers because these contracts did not allow electricity producers to benefit from the increase in spot electricity prices. However, the "fine print" was that this exemption was not restricted to old contracts, allowing electricity producers to transform most of their short-term contracts with their costumers into long-term contracts (at high prices) and avoid the tax.

In this paper we explore how the fact that some dimensions of the regulation are less salient (the regulatory fine print) shapes regulators' incentives and their accountability. We study a dynamic setting in which regulators are elected by a representative voter (the voter) every period, who can be understood literally as a representative voter or as the legislature or politicians in charge of selecting the regulator. The regulator's task is to design a contract for a regulated firm or industry. This contract can be a procurement contract or a regulatory rule. The contract has dimensions that are inherently more salient. In particular, we assume that the contract includes a monetary transfer to or from the regulated firm, which is highly salient for the voter. The regulation also prescribes a standard of quality (technical requirements, limits to pollution production processes, etc.) that affects firm profits and total welfare. This standard may be altered by technical and obfuscated clauses hidden in the contract's fine print, which are not observed or fully understood by the voter, at least in the short run.

In the absence of reputational concerns, regulators have no incentives to distort the standard. However, reputational incentives are in place because regulators may be reelected and differ in the alignment of their goals with those of the voter. We assume that regulators enjoy rents from being in office and care about total welfare. However, while "good" regulators' preferences are fully aligned with the voter's, "bad" regulators place excessive weight on the interest of the regulated firm. This difference may be due to regulatory capture or simply to ideological differences regarding the weight that the social welfare function should place on firm profits.

Regulators' first term in office gives them the opportunity to signal their type in order to increase their probability of reelection. Good regulators signal their type by lowering the observable transfer to the firm, since reducing the firm's profits is more costly for the bad type. However, to meet the firm's participation constraint good regulators have to lower the quality standard by means of the contract's fine print. Since in equilibrium good regulators are able to signal their type, bad regulators choose their ideal contract, which transfers rents to the firm but sets the standard to its first-best level, and are replaced with positive probability. Therefore, we show that the combination of reputational concerns and the ability to hide terms of the contract in the fine print, leads good regulators to distort the regulation in a way that harms voters. In our setting, there is "bad reputation" (Ely and Valimaki (2003)).

In our dynamic setting, the amount by which the good type has to lower the transfer to separate (and thus the distortion caused by the fine print used to compensate the firm for the reduced transfer) depends on voters' expected payoff from replacing the incumbent. If voters believe the payoff from replacing the incumbent to be low, they reelect the incumbent with a high probability even if they believe the incumbent to be bad. Therefore, the gain for the bad type of imitating the good type is low and the good type can achieve separation without having to lower the transfer greatly. Conversely, a high expected utility from replacement will lead voters to replace the bad type with high probability. As a result, the bad type would have strong incentives to imitate the good type, forcing the latter to distort the standard more. Therefore, voters' expectations, which are correct in equilibrium, moderate the bad reputation effects and the regulator's accountability.

Our model showcases potential unwanted consequences of regulatory reform aimed at increasing regulators' accountability. A regulatory reform that increases regulator accountability gives the bad regulator stronger incentives to mimic the good regulator and thus forces the latter to distort the standard more to separate from the bad type. Because of the resulting reduction in the expected utility for voters from replacing the incumbent, voters are more reluctant to replace a bad incumbent, an effect that partly or even fully offsets the desired increase in regulator accountability.

This paper contributes to different strands of literature. First, it is related to the literature that analyzes adverse selection and moral hazard problems in political economy models of repeated elections (Banks and Sundaram (1998), Banks and Duggan (2008), Duggan and Martinelli (2017), Kartik and Van Weelden (2019b)). In particular, in terms of modeling choices our dynamic setting of regulator accountability is closely related to the one proposed by Kartik and Van Weelden (2019b), who analyze the possibility that reputational incentives may lead to good reputation (and thus a disadvantage for incumbents) or bad reputation (and thus an advantage for incumbents). However, their results are driven by different mechanisms and they do not analyze the contrast between salient and hidden dimensions of regulation.

Our paper also contributes to the literature on collusion in three-tiered (principal (representative voter) – supervisor (regulator) – agent (firm)) contracting relations initiated by Tirole (1986) and Laffont and Tirole (1991) and to the related literature that analyzes the delegation of contracting to a productive agent (in multi-agent settings) or a third party (Melumad et al. (1995), Laffont and Martimort (1998), Macho-Stadler and Pérez-Castrillo (1998), Faure-Grimaud et al. (2003), Mookherjee and Tsumagari (2004), Celik (2009), Buffa et al. (2021)). In all of these papers the principal optimally designs the contract of the delegate.[1] Our paper is especially related to Hiriart and Martimort (2012), Khalil et al. (2013), and Kundu and Nilssen (2020), who assume that the principal's ability to write contracts with the delegate is limited. Hiriart and Martimort (2012) and Kundu and Nilssen (2020) analyze whether it may be optimal for the principal to restrict the contracts that the delegate can offer the agent. Khalil et al. (2013) assume that the principal is not able to design an optimal contract for the delegate and instead decides on the fixed budget allocated to the delegate, which the delegate can use to compensate the agent for carrying out a productive task. Our model also contributes to the literature on the allocations made by corruptible bureaucrats (Banerjee (1997), Prendergast (2003)).

None of the references cited in the previous paragraph analyze the ef-

[1] In Gryglewicz and Mayer (2020), the delegate is the residual claimant and the one who designs both the agent's contract and the principal's.

fect of the regulator's (delegate) reputational concerns on the regulatory contract design. Some delegation models explicitly account for the possibility that the principal is uncertain about the delegate's type (Besley and McLaren (1993), Kofman and Lawarrée (1996), Laffont and N'Guessan (1999), Drugov (2010)). However, only the models by Leaver (2009), Dasgupta and Noe (2019), and Ruiz-Verdú and Singh (2021) consider the possibility that the delegate's actions may signal her type to the principal. Leaver (2009) assumes that delegates differ in their competence (smart vs. dumb), that they can be tough or generous with the agent, and that the agent can complain about the delegate's actions. They show that the agent will follow a strategy of complaining when the delegate is tough and that the dumb delegate may be generous when she gets a signal that recommends being tough to avoid the risk of being shown to be wrong by the agent's complaint. Dasgupta and Noe (2019) and Ruiz-Verdú and Singh (2021) study the particular context of a board of directors acting as a delegate of shareholders in setting CEO compensation. In that context, Ruiz-Verdú and Singh (2021) show that boards' concerns about keeping a reputation for independence reputational concerns may lead independent boards to lower disclosed CEO pay, distort compensation contracts, and compensate the CEO with hidden pay.

This paper contributes to the literature on collusion and delegation described above by analyzing the role that the regulator's (delegate's) reputational concerns play in determining the contracts the delegate offers to the agent and by showing that reputational concerns may have opposite effects on open and stealth forms of collusion. Although these themes are present in Leaver (2009), Dasgupta and Noe (2019) and, especially, Ruiz-Verdú and Singh (2021), this paper brings these insights to a dynamic setting and sheds light on how reputational distortions and the corresponding loss of welfare limit the accountability of regulators/delegates.

2 The Model

We consider a discrete-time infinite horizon model. In each period t, a regulator (or policymaker) is chosen by a representative voter (or principal) to design a contract to regulate a firm or industry.

In each period there is a new representative voter. Regulators can be in office for up to two periods. In period 1 and in any period $t > 1$ in which the incumbent regulator has completed her second term in office, the voter selects a new regulator. In any other period, the voter decides whether to retain or replace the incumbent regulator.[2]

2.1 Contracts and payoffs

A regulatory contract has two components (l, q), with $l \in L \equiv [\underline{l}, \bar{l}]$ and $q \in Q \equiv [\underline{q}, \bar{q}]$. Component l is a lump-sum transfer and is observed by voters. Component q, which we call the quality standard, is not observed by voters. To be sure, the contract may contain observable clauses describing the standard. However, the standard can be altered by means of the fine print of the regulatory contract, which is not observed by voters. To fix ideas, in a procurement context one can interpret l as the payment to the supplier and q as a set of technical contractual terms that determine the quality level of the service. In a regulatory context, l can be interpreted a subsidy to regulated firms to introduce pollution abatement technologies, and q as a set of technical contractual terms describing target pollution levels or the technological protocols that pollution abatement technologies must meet.

We do not model how the firm responds to the contract and simply assume that if the regulator sets contract (l, q) in period t, the utilities of

[2]We note that the assumption that there is a new voter in each period is made for simplicity. Our results go through if the voter is long lived as long as we require the voter's strategies to be such that the probability of retaining an incumbent depends only on the history of choices of that incumbent.

the period-t's firm and voter are given, respectively, by

$$a(l,q) = l - c(q), \tag{1}$$

$$v(l,q) = -l + w(q), \tag{2}$$

where $c' > 0$, $w' > 0$, $c'' > 0$, and $w'' < 0$.

Our assumptions guarantee that here is a unique q^* that maximizes total surplus $TS(q) = w(q) - c(q)$.

The firm's reservation payoff is $\underline{a}$. Therefore, the contract chosen by the regulator must satisfy the the firm's participation constraint

$$a(l,q) = l - c(q) \geq \underline{a}. \tag{3}$$

To simplify the derivations, we assume that for any $l \in L$ there is a $\hat{q}(l) \in (\underline{q}, \bar{q})$ such that the participation constraint holds with equality. This assumption holds if and only if

$$a(\bar{l}, \bar{q}) < \underline{a} < a(\underline{l}, \underline{q}). \tag{4}$$

2.2 The public component of the contract and the fine print

The transfer component of the contract, l, is publicly observed. However, the q component (the regulatory fine print) is privately observed by the regulator and the firm. Moreover, we assume that the payoff of the period-$t-1$ voter is realized at the end of period t. Therefore, the only information about the $t-1$ contract that the voter in period t has is the publicly observed transfer offered by the regulator in period $t-1$ (l_{t-1}).

2.3 The regulator's preferences

The regulator's per-period utility given contract (l, q) is

$$u(l, q, \theta) = v(l, q) + \theta f(a(l, q)) + \gamma + \delta_\theta, \tag{5}$$

where $\theta \in \{g, b\}$, with $b > g \geq 0$ is the regulator's type, $f' > 0$ and $f'' < 0$, γ represents the rents of being in the office, and δ_θ is a parameter that captures type-specific benefits and costs of holding office, which we specify below. We note that the voter's utility v can in principle incorporate the firm's profits, so the second term in the utility function can be understood as the weight placed by the regulator on the firm's profits in excess of the one considered optimal by the voter.

The regulator's type is private information. In period $t = 1$ and whenever a new regulator is chosen, the probability that the new regulator is of type g is $\pi \in (0, 1)$. For simplicity, we assume that $g = 0$.

Let (l_θ^*, q_θ^*) be the ideal contract for a regulator of type θ, that is, the contract that solves

$$\max_{(l,q)} \quad v(l, q) + \theta f(a(l, q)) + \gamma + \delta_\theta \tag{6}$$

$$s.t. \quad a(l, q) \geq \underline{a}. \tag{7}$$

Since the good regulator places no weight on the firm's profits ($g = 0$), her ideal contract leaves no rents to the firm. Therefore, if the first-best quality standard q^* were so low that the firm's participation constraint could be satisfied by requiring the firm to implement q^* and setting the transfer at the minimum feasible level $\underline{l}$ (that is, if $q^* \leq \hat{q}(\underline{l})$), the good regulator's ideal contract would be $(\underline{l}, q^*)$. In such a case there would be no room for the good regulator to lower the transfer below her ideal point to signal her type. Therefore, we assume that if the regulator sets the minimum transfer $\underline{l}$ the first-best quality standard does not meet the firm's participation constraint (that is, $q^* > \hat{q}(\underline{l})$), so the ideal transfer for the good regulator is above $\underline{l}$. At the same time, to ensure that there is some transfer in $(\underline{l}, \bar{l})$ that satisfies the firm's participation constraint if the standard is set to q^*, we assume that $q^* < \hat{q}(\bar{l})$. These two assumptions are equivalent to

$$\frac{w'(\hat{q}(\bar{l}))}{c'(\hat{q}(\bar{l}))} < 1 < \frac{w'(\hat{q}(\underline{l}))}{c'(\hat{q}(\underline{l}))} \tag{8}$$

Assumption (8) ensures that the good regulator can set the first-best transfer and leave no rents to the firm. To ensure that the ideal contracts of the two types differ, it must be the case that the bad regulator would transfer rents to the firm if the standard is set to its first-best level (which requires $bf'(\underline{a}) > 1$). To simplify the analysis, we make the stronger assumption that that the bad type wants to grant rents to the firm for any $l \in L$. This assumption holds if and only if

$$bf'(\underline{a})c'(\hat{q}(\underline{l})) > w'(\hat{q}(\underline{l})) \tag{9}$$

Hereafter, we will assume that (4), (8), and (9) hold without making explicit mention of these assumptions. We note that these assumptions are made for simplicity and can be relaxed without qualitatively affecting the results.

The following lemma describes the ideal points of both regulator types. (All proofs are in the appendix.)

Lemma 1.

1. $q_g^* = q_b^* = q^*$,
2. $a(l_g^*, q^*) = \underline{a} < a(l_b^*, q^*)$,
3. $l_g^* < l_b^*$, *and*
4. $v_g^* \equiv v(l_g^*, q_g^*) > v_b^* \equiv v(l_b^*, q_b^*)$.

Therefore, type g is the good type for the voter. Point 1 in the lemma shows that in the absence of reputational concerns, neither type would distort the unobservable component of the contract away from the first-best regulation q^*.

To simplify the analysis, we follow Kartik and Van Weelden (2019b) and assume that

$$\delta_\theta = -v(l_\theta^*, q_\theta^*) - \theta f(a(l_\theta^*, q_\theta^*)). \tag{10}$$

With this normalization, the utility from holding office for a regulator choosing her preferred contract is γ for both types.

2.4 The voter's choice

At the beginning of any period t, the voter chooses the regulator. If the regulator in period $t-1$ was in her second term in office in that period, then the voter chooses a new regulator at t (recall that regulators have a two term limit). If the regulator in period $t-1$ was elected in $t-1$, then the period-t voter decides whether to reelect or replace the incumbent regulator. If a new regulator is elected, the new regulator is of type g with probability π.

Before deciding whether to replace an incumbent regulator, the voter in period t observes the entire history of observable play up to period $t-1$ but not the fine print of any previous contract. Since the payoff of the voter in period $t-1$ is not realized until the end of period t, the period-t voter cannot observe that payoff either before deciding whether to retain the incumbent regulator. We let μ_t denote the period-t voter's posterior belief that the incumbent regulator is of type g conditional on the observable history up to period $t-1$. The voter also forms a belief $\bar{v}_t$ about the expected payoff he would receive if the incumbent regulator were replaced.

For simplicity and generality, we do not model the voter's decision explicitly. Instead, we assume that the probability with which the voter in period t reelects an incumbent regulator is given by a function ρ_t of the posterior belief μ_t that the incumbent regulator is of type g and the payoff $\bar{v}_t$ that the voter expects to obtain under a new regulator. We assume that

ρ_t is continuous and that $\rho_t(\mu_t, \bar{v}_t) \in (0, 1)$ for any $\mu \in [0, 1]$ and feasible $\bar{v}_t$. The assumption that ρ_t is interior is not needed for our results but greatly simplifies the derivations. We also assume that the voter is (at least mostly) rational, so ρ_t is decreasing in the utility $\bar{v}_t$ the voter expects to obtain by replacing the regulator and increasing in the belief μ_t that the incumbent is of type g. The latter assumption captures the fact that the incumbent will choose her ideal contract in her last term in office (a fact that we derive as part of the equilibrium below) and the ideal contract of the type g regulator gives the voter a higher payoff.

In many contexts, the voter has a tendency to reelect the incumbent. For example, if the regulator is chosen by a legislature or an elected official, replacing the regulator may require costly due diligence and administrative procedures or hearings. If the regulator is elected directly by voters, limited attention by voters and the visibility and campaigning advantages provided by office may lead voters to vote for the incumbent unless it is clear that the expected gain from replacing her is sufficiently high. Therefore, we expect $\rho_t(\mu_t, \bar{v}_t)$ to be close to one and vary little with $\bar{v}_t$ if the expected utility of replacing the incumbent ($\bar{v}_t$) is lower than the expected utility of reelecting her given the voter's belief μ_t, that is, if $\bar{v}_t < \mu_t v_g^* + (1 - \mu_t)v_b^*$. To capture this idea while maintaining the assumption that ρ_t is interior, we assume that if $\bar{v}_t$, μ_t, and μ_t' are such that $\mu_t > \mu_t'$ and $\bar{v}_t < \mu_t v_g^* + (1 - \mu_t)v_b^*$, then $\frac{\partial \rho_t}{\partial \bar{v}_t}(\mu_t, \bar{v}_t) \geq \frac{\partial \rho_t}{\partial \bar{v}_t}(\mu_t', \bar{v}_t)$, because the voter's probability of reelecting the incumbent given belief μ_t is already very close to one.

3 Solving the Model

3.1 The regulator's intertemporal preferences

The utility of a regulator who is in her first term in office in period t is determined by the per-period utility in period t and her discounted expected utility in period $t+1$. Normalizing the regulator's utility to zero if she does not hold office, the regulator's intertemporal utility is

$$u(l_t, q_t, \theta) + \beta\rho_{t+1}(\mu_{t+1}, \overline{v}_{t+1})u(l_{t+1}, q_{t+1}, \theta),$$

where $\beta \in (0, 1]$ is the regulator's discount factor.

In the second term, regulators have no reputational concerns. Therefore, both types choose their ideal contracts in the second term. As showed above, it follows that the utility from holding office in the second term is γ for both types. Therefore, the regulators' intertemporal preferences simplify to

$$u(l_t, q_t, \theta) + \beta\rho_{t+1}(\mu_{t+1}, \overline{v}_{t+1})\gamma.$$

3.2 The fine print choice

The regulator's expected utility in period $t + 1$ does not depend on the regulatory fine print q_t set at t because only l_t is observable by the voter at $t + 1$. This fact allows us to characterize the optimal choice of regulatory fine print as a function $q(l, \theta)$ of the chosen level of the transfer l and the regulator's type, which is the solution to the following problem,

$$\max_q \quad v(l, q) + \theta f(a(l, q)) + \gamma + \delta_\theta \tag{11}$$

$$s.t. \quad a(l, q) \geq \underline{a}. \tag{12}$$

We note that the function q is the same for every t, since for a given transfer l the problem faced by every regulator is the same.

The following lemma characterizes the function q.

Lemma 2. *The function q is continuous in l and,*

1. $q(l, g) = \hat{q}(l) = c^{-1}(l - \underline{a})$, $a(l, q(l, g)) = \underline{a}$, *and* $v(l, q(l, g))$ *is increasing in* l,
2. $q(l, b) < q(l, g)$ *for any* $l \in L$,

3. $a(l, q(l, b)) > \underline{a}$ *for any* $l \in L$,

4. $q_l(l, \theta) > 0$ *for any* $l \in L$,

5. *If* $l' > l$, *then* $a(l', q(l', \theta)) \geq a(l, q(l, \theta))$, *with strict inequality if* $a(l', q(l', \theta)) > \underline{a}$.

Part 1 of the lemma establishes that the good type adjusts the standard q to leave the firm no rents. Part 2 shows that for a given transfer l the bad type would set a lower standard than the good type. Part 3, which follows directly from part 1 and 2, shows that the bad type always grants rents to the firm. Parts 4 shows that a reduction in the transfer leads both types to lower the standard. Finally, part 5 shows that increasing the transfer always makes the firm better off.

3.3 The regulator's reduced form preferences and the single-crossing property

Using the function q we can express the regulator's intertemporal preferences in her first period in office as a function or the observable transfer l chosen in that period, the probability of being reelected ρ, and the type θ as follows,

$$U(l, \rho, \theta) = u(l, q(l, \theta), \theta) + \beta\rho\gamma. \tag{13}$$

The regulator's reduced-form utility U is continuous in l and ρ, monotonically increasing in ρ, and satisfies the following properties.

Lemma 3.

1. *U satisfies the strict single-crossing property.*[3] *That is, if* $l < l'$, *then* $U(l, \rho, b) \geq U(l', \rho', b)$ *implies* $U(l, \rho, g) > U(l', \rho', g)$.

2. $U(l, \rho, \theta)$ *is strictly concave in* l, *and* $l < l^*_\theta$ *implies that* $U_l > 0$.

[3]We define the single-crossing property as in Cho and Sobel (1990).

The single-crossing condition implies that the cost of reducing the observable transfer to the firm is higher for the bad type than for the good type. Therefore the good regulator can attempt to signal her independence by reducing the observable transfer.

The second part of the Lemma implies that reducing the transfer away from the ideal point reduces the regulator's utility even if the reduction in the transfer can be offset by adjusting the standard.

3.4 Equilibrium concept

In any equilibrium in which the regulator's strategy is required to be sequentially rational any regulator will choose her ideal contract in her second period in office. Sequential rationality also requires that the q chosen by the type θ regulator in her first period in office be equal to $q(l, \theta)$. Therefore, to study the model's equilibrium we can consider that the action space for any regulator in her first period in office is simply the space of observable transfers L and her preferences over transfers and the probability of reelection are given by U.

Even if the action space is reduced to an interval, the regulator's strategies can in principle be highly complex, since the period t regulator could condition her transfer choice on the entire observable history of play up to $t-1$. To avoid analyzing implausible dynamic strategies we follow Banks and Sundaram (1998), Duggan (2017), and Kartik and Van Weelden (2019b) and restrict the analysis to stationary strategies. We say that a regulator's strategy is stationary if it conditions the transfer solely on her type. We can thus denote a regulator's (pure) strategy simply as a pair (l_g, l_b). Similarly, we say that a voter's strategy is stationary if $\rho_t = \rho$ for every t in which the incumbent regulator could be reelected.

To avoid the multiplicity of equilibria common to signaling games we further require the voters' belief μ to satisfy criterion D1. Criterion D1 requires voters to believe that the regulator is of type θ' upon observing a deviation l if the subset of values of ρ that would make the deviation weakly profitable for type θ is either empty or a subset of the nonempty set of values of ρ that would make the deviation strictly profitable for type θ'.[4]

Definition 1 (Stationary Equilibrium)**.** *A stationary strategy* (l_g, l_b)*, a reelection function* ρ*, a belief system* $\mu : L \to [0, 1]$*, and an expected utility of replacement* $\bar{v}$ *for the voter are a stationary equilibrium if:*

1. *For any* $\theta \in \{g, b\}$*,* $U^e_\theta \equiv U(l_\theta, \rho(\mu(l_\theta), \bar{v}), \theta) \geq U(l, \rho(\mu(l), \bar{v}), \theta)$ *for any* $l \in L$*.*

2. $\mu(l)$ *is derived by Bayes' rule for* $l \in \{l_g, l_b\}$*.*

3. $\bar{v} = \pi v(l_g, q(l_g, g)) + (1 - \pi)v(l_b, q(l_b, b))$*.*

4. *Criterion D1. For* $l \notin \{l_g, l_b\}$*, if*

   (a) $U(l, \rho(1, \bar{v}), \theta) > U^e_\theta$*, and*

   (b) $U(l, \rho(0, \bar{v}), \theta') < U^e_{\theta'}$*, and either*

   (c) $U(l, \rho(1, \bar{v}), \theta') < U^e_{\theta'}$ *or*

   (d) $U(l, \rho(\mu, \bar{v}), \theta') \geq U^e_{\theta'} \Rightarrow U(l, \rho(\mu, \bar{v}), \theta) > U^e_\theta$ *for any* $\mu \in [0, 1]$*,*

   then $\mu(l) = 1$ *if* $\theta' = g$ *and* $\mu(l) = 0$ *if* $\theta' = b$*.*

Taking the expected payoff for the voter if the incumbent is replaced $\bar{v}$ as given, each period t in which a new regulator is appointed can be described as a static signaling game with the regulator as the sender and the voter in $t + 1$ as the receiver. First, the regulator, whose preferences over transfers and the probability of reelection are given by U, learns her type $\theta \in \{g, b\}$ and then chooses the message l. Second, the representative voter observes l and decides the probability of reelection of the regulator. Our equilibrium definition implies that a stationary equilibrium is an equilibrium of the static signaling game with given $\bar{v}$ with the additional requirement that $\bar{v}$ is equal to the voter's expected utility from replacing the incumbent given the regulator's equilibrium strategy of the signaling game.

[4] We define the equilibrium for pure strategies for the sake of clarity but the definition extends to mixed strategies straightforwardly.

The regulator's reduced form utility U is monotonic in ρ and satisfies the single-crossing property defined in Lemma 3. It is a well known result that in signaling models with these features, criterion D1 generally selects as the unique equilibrium the least cost separating equilibrium (Cho and Sobel, 1990). At this equilibrium, there is full separation and the good type distorts the signal choice the minimum amount required to avoid imitation by the bad type. Therefore, the stationary equilibrium will be the least cost separating equilibrium of the static signaling game with given $\bar{v}$, for $\bar{v}$ given by the regulator's equilibrium strategy.

To simplify the discussion and reduce the number of cases to consider, we assume that the bad regulator would not find it optimal to lower the transfer all the way down to its lower bound in order to be perceived as a good type by the voter, that is,

$$U(\underline{l}, 1, b) < U(l_b^*, 0, b). \tag{14}$$

This assumption ensures existence of the equilibrium and that the unique equilibrium is the least cost separating equilibrium.

To derive the model's equilibrium, we discuss first the equilibria of the stage game taking the expected voter's utility under replacement $\bar{v}$ as an exogenous parameter. We then discuss how endogenizing $\bar{v}$ constrains equilibrium outcomes and derive the equilibrium of the dynamic model.

3.5 Signaling and distortionary fine print

The single crossing property implies that reducing the transfer is more costly for the bad type. If the bad type has incentives to imitate the transfer choice of the good type, the good regulator will therefore reduce the transfer to dissuade the bad type from imitating.

As mentioned above, in equilibrium the good type will reduce the transfer the minimum amount necessary to avoid imitation from the bad type. If the ideal transfers of the good and bad types are sufficiently different, the utility of the bad type falls very rapidly as the transfer is reduced, or the voter is not very responsive to the regulator's policies (so $\rho(0, \bar{v})$ is not very different from $\rho(1, \bar{v})$), the bad type will have no incentives to imitate the good type. In this case, in equilibrium each type simply selects her ideal transfer, the good type remains in office, and the bad type is reelected with probability $\rho(0, \bar{v})$. Since both types select the first best standard if they choose their preferred contract, in this equilibrium neither type uses the fine print to distort the standard.

However, if the bad type would imitate the good regulator if the latter chose her ideal transfer, then the good type will lower her transfer to separate from the bad type. Since the good type's ideal contract prescribes the optimal q and a transfer that keeps the firm at its reservation payoff, reducing the transfer requires reducing q to the extent necessary to compensate the firm for the reduction in the transfer to ensure that the firm's participation constraint holds. Therefore, the good type's signaling entails both a reduction in the publicly observable transfer and an offsetting reduction in the standard.

Since the reduction in quality is inefficient, the net effect of the good type's signaling is to reduce the voter's per-period utility. Thus, in equilibrium, the cost of signaling is borne fully by the voter, while the firm receives the same utility it would have received in the absence of any reputational concerns. Therefore, the equilibrium in our model is one with *bad reputation* (Ely and Valimaki (2003), Kartik and Van Weelden (2019b)).

Of course, at a separating equilibrium, the bad type chooses her ideal contract and thus does not distort the quality away from its first-best level q^*. Therefore, the distortionary fine print is a byproduct of the signaling by the good type and not a strategy by the bad type to conceal from voters a favorable treatment of the firm.

The amount by which the good type has to lower the transfer to separate (and thus the distortion caused by the fine print used to compensate the firm for the reduced transfer) will depend on voters' expected payoff from replacing the incumbent. If voters believe the payoff from replacing the incumbent to be low, they will reelect the incumbent with a high probability even if they believe the incumbent to be bad. Therefore, the gain for the bad type of imitating the good type will be low and the good type will be able to achieve separation without having to lower the transfer greatly. Conversely, a high expected utility from replacement will lead voters to replace the bad type with high probability. As a result, the bad type would have strong incentives to imitate the good type, forcing the latter to distort the standard more. Therefore, voters' expectations, which are correct in equilibrium, moderate the distortion introduced in the fine print by the good type as well as the equilibrium accountability, understood as the (inverse of the) probability of reelection of an incumbent believed to be bad.

Before describing the equilibrium formally, we introduce some notation. We first define $\bar{v}(l_g)$ as the voters' expected utility from replacing the incumbent if the bad type would set her ideal contract and the good type the contract $(l_g, q(l_g, g))$,

$$\bar{v}(l_g) = \pi v(l_g, q(l_g, g)) + (1 - \pi)v_b^*, \tag{15}$$

and we let $\bar{v}^*$ be the voters' expected utility from replacing the incumbent if both types would set their ideal contracts,

$$\bar{v}^* \equiv \bar{v}(l_g^*) = \pi v_g^* + (1 - \pi)v_b^*. \tag{16}$$

We also define ρ^* as the probability of reelection that would make the bad type indifferent between choosing her ideal contract and being reelected with probability ρ^* and choosing the good type ideal's contract and being reelected with probability $\rho(1, \bar{v}^*)$.

$$U(l_g^*, \rho(1, \bar{v}^*), b) = U(l_b^*, \rho^*, b). \tag{17}$$

Proposition 1. *There is a unique stationary equilibrium with the following properties:*

1. *Each type θ plays a pure strategy l_θ^e and $l_g^e \neq l_b^e$ (separating equilibrium).*

2. $l_b^e = l_b^*$ *and* $q_b^e = q(l_b^e, b) = q^*$, *so the bad type chooses its ideal contract. Since* $q_b^e = q^*$, *the bad type does not include distortionary fine print in the contract.*

3. *The voter's expected utility of replacing an incumbent is* $\bar{v}^e = \bar{v}(l_g^e)$.

4. *If* $\rho(0, \bar{v}^*) \geq \rho^*$, *then* $l_g^e = l_g^*$, $q_g^e = q^*$, *and* $\bar{v}^e = \bar{v}^*$.

5. *If* $\rho(0, \bar{v}^*) < \rho^*$, *then:*

   (a) l_g^e *is such that* $l_g^e < l_g^*$ *and*

$$U(l_g^e, \rho(1, \bar{v}(l_g^e)), b) = U(l_b^*, \rho(0, \bar{v}(l_g^e)), b), \tag{18}$$

   (b) $q_g^e = q(l_g^e, g) < q^*$, *so the good type includes distortionary fine print in the contract,*

   (c) $a(l_g^e, q_g^e) = a(l_g^*, q^*)$ *and* $v(l_g^e, q_g^e) < v_g^*$ *(bad reputation).*

If the bad regulator may benefit from imitating the good regulator (part 5 of the proposition), the good regulator reduces the observable transfer to separate from the bad regulator (part a). However, since such a reduction alone would lead to a contract that does not meet the firm's participation constraint, the good regulator is forced to introduce a distortionary reduction of the quality standard in the fine print (part b). Therefore, it is the good regulator the one that uses the fine print to benefit the firm in equilibrium.

We highlight that even though voters do not observe the fine print, they could in principle infer the reduction in the quality standard introduced by the good regulator because the equilibrium is separating. This suggests that in a scenario in which the fine print could be observed by voters at a cost, there could be equilibria in which the fine print is not read by voters since the observable transfer already conveys sufficient information to identify the regulator's type.

The fact that the equilibrium reelection probabilities depend on the equilibrium expected utility for the voter of replacing an incumbent ($\bar{v}^e$) limits the magnitude of the reduction in the transfer needed to separate from the bad regulator. Inspection of equation (18) shows that reducing l_g not only reduces the left-hand side of the equation directly (since lowering the transfer away from l_b^* hurts the bad regulator) but also reduces $\bar{v}(l_g)$. While the reduction in $\bar{v}(l_g)$ increases the probabilities of reelection for both the good and bad regulators (since ρ is decreasing in $\bar{v}$), the increase is larger for the bad regulator (since $l_g^e < l_g^*$ implies that $\bar{v}^e < \bar{v}^* < v_g^*$, so $\rho_v(1, \bar{v}^e) \geq \rho_v(0, \bar{v}^e)$). Because of this differential effect on the reelection probabilities, a reduction in l_g also indirectly reduces the bad regulator's incentives to imitate the good regulator. The effect is especially clear if, as discussed in Section 2.4, one assumes that the probability of reelection is arbitrarily close to one if the expected utility for the voter from reelecting the incumbent is greater than the expected utility from replacing her (that is, $\rho(\mu, \bar{v}) \approx 1$ if $\bar{v} < \mu v_g^* + (1-\mu) v_b^*$). Under this assumption, the good regulator is reelected almost with certainty in equilibrium ($\rho(1, \bar{v}(l_g^e)) \approx 1$ since $\bar{v}(l_g^e) < v_g^*$), so a reduction in $\bar{v}(l_g^e)$ essentially increases only the probability of reelection of the bad regulator ($\rho(0, \bar{v}(l_g^e))$) and thus reduces the bad regulator's incentive to imitate the good regulator. Further, this assumption ensures that the voter obtains a higher utility from a first-term good regulator than from a bad regulator (that is, $v(l_g^e, q_g^e) > v_b^*$). This is so because otherwise the expected utility of replacing the incumbent would be lower than that of keeping an incumbent known to be bad ($\bar{v}(l_g^e) < v_b^*$), which would imply that a bad incumbent would be reelected almost with certainty ($\rho(0, \bar{v}(l_g^e)) \approx 1$), so (18) would not hold. More generally, the fact that the probability of reelection depends on the expected utility from replacing the incumbent imposes lower bounds both to the distortion introduced by the good regulator and to regulator accountability (that is, to the difference $\rho(1, \bar{v}(l_g^e)) - \rho(0, \bar{v}(l_g^e))$).

It is important to relate our results to those of prior models on populism and pandering by elected officials seeking reelection. Acemoglu et al.

(2013) show that elected politicians may choose "populist" policies to the left of their and the median voter's ideal point to signal that they cannot be bribed by the right-wing elite. Our model differs from theirs in two main dimensions. First, we show that even if observable policy choices favor voters at the expense of the regulated firm, in equilibrium the good regulator distorts the standard so that effectively the regulated firm is not worse off and the cost of the distortion is fully borne by voters. Second, Acemoglu et al. (2013) propose a two-period model that does not capture the interplay between the distortion generated by the good type's signaling and equilibrium accountability. Canes-Wrone et al. (2001), Maskin and Tirole (2004), and Kartik and Van Weelden (2019a) focus on cases in which the elected politicians have an advantage relative to voters in identifying the optimal policy but may deviate from such policy to increase their reelection probability ("pandering").

3.6 Equilibrium effects of changes in accountability

A usual objective of regulatory reform is to increase regulators' accountability, so bad regulators are less likely to remain in office. To analyze the effects of such reforms, we assume that the probability ρ with which the voter retains the incumbent is a function not only of μ and $\bar{v}$, but also of a parameter α such that $\rho_\alpha(1, \bar{v}, \alpha) > 0$ and $\rho_\alpha(0, \bar{v}, \alpha) < 0$. Therefore, an increase in α represents an increase in regulator accountability *for given* $\bar{v}$.

Equation (18) shows that an increase in accountability will have some negative side effects, because greater accountability increases the bad regulator's incentives to imitate the good regulator and forces the good type to distort the standard more. Moreover, the ensuing reduction in the equilibrium expected utility from replacing the incumbent will increase the probability of reelection of the bad type, at least partly offsetting the desired increase in accountability. The following proposition formalizes these results. We note that if $\rho(0, \bar{v}^*, \alpha) > \rho^*$, so $l_g^e = l_g^*$, local changes in α do not affect equilibrium outcomes, so we focus on the case $\rho(0, \bar{v}^*, \alpha) < \rho^*$.

Proposition 2. *Assume that $\rho(0, \bar{v}^*, \alpha) < \rho^*$. Then an increase in α reduces the good regulator's equilibrium transfer l_g^e and the equilibrium expected utility from replacing an incumbent regulator $\bar{v}^e$. The net effect of the increase in α on the equilibrium probability of reelection of the good regulator is (weakly) positive but the net effect on the equilibrium probability of reelection of the bad regulator depends on functional forms and parameters.*

Proposition 2 shows that without further assumptions about the preferences of voters, the firm, and the regulator, one cannot sign the effect of an increase in α on the equilibrium probability of reelection of the bad regulator. The following corollary shows that an increase in accountability can actually increase the equilibrium probability of reelection of the bad regulator by providing a simple specification of the function ρ leading to this result.

Corollary 1. *Let $\alpha \in (\underline{\alpha}, \bar{\alpha})$, with $\underline{\alpha} > 0$, and $\bar{v} \in [\bar{v}_L, \bar{v}_H]$ (where $\bar{v}_L$ and $\bar{v}_H$ are the lower and upper bound, respectively, of the feasible levels of the expected utility from replacing the incumbent) and let*

$$\rho(\mu, \bar{v}, \alpha) = g(\bar{v}) - k\alpha + \alpha\mu, \tag{19}$$

with $g'(\bar{v}) < \underline{g} < 0$ for any $\bar{v} \in [\bar{v}_L, \bar{v}_H]$, $k \in (0, 1)$, $g(\bar{v}_H) - k\bar{\alpha} > 0$, and $g(\bar{v}_L) - k\bar{\alpha} + \bar{\alpha} < 1$ (so $\rho(\mu, \bar{v}, \alpha) \in (0, 1)$ for any $\mu \in [0, 1]$, $\rho_\alpha(1, \bar{v}, \alpha) > 0$, and $\rho_\alpha(0, \bar{v}, \alpha) < 0$ for any $\alpha \in (\underline{\alpha}, \bar{\alpha})$ and $\bar{v} \in [\bar{v}_L, \bar{v}_H]$). Let $\bar{v}^e(\alpha)$ denote the equilibrium expected utility from replacing the incumbent as a function of α and assume that $\rho(0, \bar{v}^*, \alpha) < \rho^*$. Then for k sufficiently low, $\alpha' > \alpha$ implies that $\rho(0, \bar{v}^e(\alpha'), \alpha') > \rho(0, \bar{v}^e(\alpha), \alpha)$.

3.7 The effects of improved candidate vetting

Improvements in candidates' eligibility requirements to become regulators or in the vetting process for new regulators may increase the probability that a replacement candidate is good (that is, increase π). The direct effect of such improvements is welfare improving for voters because voters' ex ante expected utility is greater if a good candidate is appointed.[5] Moreover, by increasing the expected utility from replacing an incumbent, the increase in π also increases regulator accountability. However, this greater accountability has a negative side effect because it increases bad regulators' incentive to imitate the good type and thus leads to greater distortion by the good regulator. The resulting reduction in the equilibrium expected utility from replacing the incumbent, in turn, reduces accountability, partly offsetting the positive direct effect on accountability caused by the increase in π. As the following proposition shows, the negative indirect effect on equilibrium accountability is smaller than the direct effect, so increasing the probability of appointing a good regulator unambiguously reduces the probability of reelecting incumbents of both types.

Proposition 3. *Assume that $v(l_g^e, q(l_g^e, g)) \geq v_b^*$ and $\rho(0, \bar{v}^*) < \rho^*$. Then an increase in the probability π of appointing a good regulator reduces the equilibrium transfer by the good regulator (l_g^e) and the equilibrium probabilities of reelecting both good ($\rho(1, \bar{v}^e)$) and bad ($\rho(0, \bar{v}^e)$) regulators.*

4 Discussion and extensions

4.1 Long-lived voters

We have assumed that voters live only one period. However, as long as we require strategies to be stationary, the model's results would obtain if we instead assumed that voters live longer than regulators.

[5] Voters' expected utility is higher if a good regulator is appointed than if a bad one is appointed because because the probability of reelection is higher for a good regulator and the voter's utility if a good regulator is reelected is higher than if a bad regulator is reelected or a new regulator is appointed. Further, a sufficient, but not necessary, condition to ensure that the voter's equilibrium utility in the regulator's first term in office is higher for the good regulator is that $\rho(1, \bar{v}) \approx 1$ if $\bar{v} < \bar{v}^*$.

4.2 Relatively good regulators and good reputation

In the model in previous sections, good regulators care only about voters' welfare. We are extending the model to allow for "relatively good" regulator types, who care about firms' profits more than voters but less than bad regulators. This is not just a robustness check. If the relatively good regulators' ideal point leaves some rents to the firm, signaling can be welfare improving for voters (good reputation) because reducing the transfer to separate from the bad type need not be accompanied by an offsetting distortionary reduction in the quality standard to meet the firm's participation constraint. Further, by increasing voters' utility such signaling increases the incentives to replace incumbent regulators thereby improving regulator accountability.

4.3 Transparency and the inefficiency of the fine print

We have taken the unobservability of the standard of quality as given. In reality, there are different dimensions of the regulation that may be more salient or observable than others. At the same time, those dimensions also differ in the extent of the inefficiency caused by deviating from their first-best levels. In a richer setting with several regulatory dimensions, we conjecture that an exogenous increase in regulatory transparency may reduce the choice set of unobservable regulatory dimensions, forcing regulators to compensate regulated firms for the reduction in their observable rents by means of more distortionary fine print. This increase in the cost of signaling would also reduce regulators' equilibrium accountability.

5 Conclusions

In this paper, we show that distortionary "fine print" in regulation can arise as the result of signaling by good regulators. In our model, the regulation consists a transfer to or from the regulated firm and a quality standard that the firm has to meet, which is costly to the firm. Good regulators care about voters' welfare but also about being reelected, while bad regulators care about the regulated firm's profits as well. To separate from bad regulators, good regulators reduce monetary transfers to regulated firms relative to the first-best level. However, to meet the firm's participation constraint, good regulators have to compensate the firm with an offsetting reduction in the quality standard, which is introduced in the regulation's fine print in ways that voters cannot observe or understand. Since the reduction in the quality standard is distortionary, signaling reduces voters' utility, so in the model there is bad reputation. Further, even though signaling allows voters to identify the regulator's type, the good type's distortionary regulation reduces voters' incentives to replace bad incumbents, thus reducing regulator accountability.

The model shows that the interplay between the welfare-reducing signaling and regulator accountability sets lower a bound the extent of the equilibrium distortion of the quality standard. In equilibrium, the distortion of the quality standard cannot be too extreme, since a very large distortion would reduce voters' incentives to replace the bad regulator. This reduced accountability would, in turn, also reduce the bad regulator's motivation to mimic the good regulator, removing the good regulator's need to distort the quality standard to signal her type.

The model also identifies negative side effects of regulatory reforms aimed at either increasing regulator accountability or improving the selection process of regulators. Increasing accountability increases bad regulators' incentives to mimic good regulators and thus forces the latter to distort the quality standard more to signal their type. The reduced quality standard lowers voters' expected utility from replacing a bad regulator and thus reduces the equilibrium probability of replacing bad regulators. We show that the reduction in the equilibrium probability of replacing the bad regulator caused by the more distortionary regulation of the good type can be so large to fully offset the direct effect of the regulatory increase in accountability, so that bad regulators can end up being reelected with higher probability after the reform.

We also show that an improvement in the selection process of regulators increases voters' incentives to replace bad regulators and thus increases bad regulators' incentives to imitate the good type, forcing good regulators to distort the quality standard more to signal their type.

Our model highlights a relevant dimension of regulation that has received little attention so far, namely the fact that regulation can include items that are not readily observable by voters or the politicians appointing the regulators, and suggests that understanding the interplay between the observability of different regulatory items, regulators' career concerns, and regulator accountability can be a fruitful path for future research.

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Appendix: Proofs

Proof of Lemma 1. One can show that assumptions (4) and (8) imply that $q^*_\theta \in (\underline{q}, \bar{q})$ and $l^*_g \in (\underline{l}, \bar{l})$. Assumption (9) further implies that $l^*_b > \underline{l}$. For brevity, we assume in the rest of the proof that $l^*_b < \bar{l}$, so the ideal points of both types are in the interior of $L \times Q$ (but the lemma also holds without this assumption). Therefore, the first-order conditions of the type θ regulator's problem are

$$-1 + \theta f'(a(l,q)) + \lambda = 0 \tag{20}$$

$$w'(q) - \theta f'(a(l,q))c'(q) - \lambda c'(q) = 0, \tag{21}$$

where $\lambda \geq 0$ is the Lagrange multiplier of the firm's participation constraint. It follows from these first-order conditions that for both types

$$w'(q^*_\theta) - c'(q^*_\theta) = 0, \tag{22}$$

so $q^*_g = q^*_b = q^*$, proving part 1 of the lemma.

It follows from $g = 0$ that the good type objective is decreasing in l, so the firm's participation constraint must be binding. Therefore, $a(l^*_g, q^*) = \underline{a}$. At the same time, (8), (9), and $w'(q^*) - c'(q^*) = 0$ imply that

$$w'(q^*) - bf'(\underline{a})c'(q^*) - \lambda c'(q^*) < w'(q^*) - c'(q^*) - \lambda c'(q^*) \leq 0. \tag{23}$$

Therefore, $f'' < 0$ implies that $a(l^*_b, q^*) > \underline{a}$, so $l^*_b > l^*_g$, which completes the proof of parts 2 and 3. Part 4 follows immediately. $\square$

Proof of Lemma 2. To prove part 1 of the lemma we only need to check that $v(l, q(l,g))$ is increasing in l for $l < l^*_g$, since the rest of part 1 follows immediately from $g = 0$.

Since $q(l,g) = \hat{q}(l)$, $q_l(l,g) = \hat{q}'(l) = \frac{1}{c'(\hat{q}(l))} > 0$ and $v_l(l, \hat{q}(l)) + v_q(l, \hat{q}(l))\hat{q}'(l) = -1 + \frac{w'(\hat{q}(l))}{c'(\hat{q}(l))} > 0$, since $w'(q) > c'(q)$ for $q < q^*$ and $\hat{q}(l) < q^* = \hat{q}(l^e_g)$ for $l < l^*_g$.

The first-order condition of the bad type's problem is

$$w'(q(l,b)) - bf'(l - c(q(l,b)))c'(q(l,b)) - \eta c'(q(l,b)) = 0, \tag{24}$$

where $\eta \geq 0$ is the Lagrange multiplier of the firm's participation constraint.

Assumption (9) implies that $bf'(\underline{a})c'(q) > w'(q)$ for any $q \geq \hat{q}(\underline{l})$, so $\hat{q}' > 0$ thus implies that for any $l \geq \underline{l}$

$$w'(\hat{q}(l)) - bf'(\underline{a})c'(\hat{q}(l)) - \eta c'(\hat{q}(l)) < -\eta c'(\hat{q}(l)) \leq 0. \tag{25}$$

Therefore, $q(l,b) < \hat{q}(l) = q(l,g)$, proving parts 2 and 3 of the lemma. Part 4 follows from $q_l(l,g) = \hat{q}'(l) = \frac{1}{c'(\hat{q}(l))} > 0$ and implicit differentiation of the first order condition of the bad type.

To prove part 5, let $l' > l$, $q = q(l,\theta)$, $a = a(l,q)$, $q' = q(l',\theta)$, $a' = a(l',q')$, and assume that $a' \leq a$. The assumptions $a' = l' - c(q') \leq a = l - c(q)$ and $l' > l$ imply that $q' > q$.

If q' is an interior solution (i.e., $a' > \underline{a}$), then $a' \leq a$ implies that q is also interior, but then $q' > q$, $w'' < 0$, $c'' > 0$, $a' \leq a$ and $f'' < 0$ imply that

$$0 = w'(q) - \theta f'(a)c'(q) > w'(q') - \theta f'(a)c'(q') \geq w'(q') - \theta f'(a')c'(q'), \tag{26}$$

which contradicts the assumption that q' is optimal because the last expression in (26) must be nonnegative at an optimum. Therefore, if q' is interior, then $a' > a$.

If the firm's participation constraint binds at q' (i.e., $a' = \underline{a}$), then if q is interior (26) contradicts the optimality of q'. Therefore, if $a' = \underline{a}$, $a' \leq a$ can hold only if $a = \underline{a}$ as well, so $a' = a = \underline{a}$.

Therefore, either $a = a' = \underline{a}$ or else $a' > a$. $\square$

Proof of Lemma 3. For fixed l, l', ρ, ρ' with $l < l'$ and an arbitrary type $\theta > 0$ define

$$\Delta(\theta) = U(l,\rho,\theta) - U(l',\rho',\theta). \tag{27}$$

Since U is the value function of the problem of maximizing the regulator's utility for a given l, it follows from a standard envelope theorem that

$$\Delta'(\theta) = f(a(l, q(l, \theta))) - f(a(l', q(l', \theta))). \tag{28}$$

Therefore, $\Delta' \leq (<) 0$ if $a(l, q(l, \theta)) \leq (<) a(l', q(l', \theta))$. Now, it follows from part 5 of Lemma 2 that for any $\theta \in [0, b]$, $a(l, q(l, \theta)) \leq a(l', q(l', \theta))$, so $\Delta' \leq 0$. Further, it follows from parts 3 and 5 of Lemma 2 that $a(l, q(l, \theta)) < a(l', q(l', \theta))$ for θ sufficiently close to b. Therefore $\Delta' \leq 0$ for any $\theta \in (0, b)$ and $\Delta' < 0$ for some interval (θ', b). It follows that $\Delta(g) > \Delta(b)$ (increasing differences), which implies the single-crossing condition, proving part 1 of the Lemma.

To prove part 2 of the Lemma, let $l' > l$, $q = q(l, \theta)$, $a = a(l, q)$, $q' = q(l', \theta)$, $a' = a(l', q')$, $\tilde{l} = \kappa l + (1 - \kappa) l'$, and $\tilde{q} = \kappa q + (1 - \kappa) q'$, for $\kappa \in (0, 1)$. Then

$$\begin{gathered}
U(\tilde{l}, \rho, \theta) = u(\tilde{l}, q(\tilde{l}, \theta), \theta) + \beta\rho\gamma \geq u(\tilde{l}, \tilde{q}, \theta) + \beta\rho\gamma = \\
w(\tilde{q}) - \tilde{l} + \theta f(\tilde{l} - c(\tilde{q})) + \delta_\theta + \beta\rho\gamma > \\
\kappa(w(q) - l) + (1 - \kappa)(w(q') - l') + \\
\kappa\theta f(l - c(q)) + (1 - \kappa)\theta f(l' - c(q')) + \delta_\theta + \beta\rho\gamma = \\
\kappa(u(l, q, \theta) + \beta\rho\gamma) + (1 - \kappa)(u(l', q', \theta) + \beta\rho\gamma) = \\
\kappa U(l, \rho, \theta) + (1 - \kappa) U(l', \rho, \theta),
\end{gathered} \tag{29}$$

where the first inequality follows from the optimality of $q(\tilde{l}, \theta)$ and the fact that $\tilde{q}$ satisfies the firm's participation constraint for $l = \tilde{l}$ (which follows from $l - c(q) \geq \underline{a}$, $l' - c(q') \geq \underline{a}$, and $c'' > 0$) and the second inequality from $w'' < 0$, $f' > 0$, $f'' < 0$, and $c'' > 0$.

For any $l < l' < l^*_\theta$, l' is equal to $\kappa l + (1 - \kappa) l^*_\theta$ for some $\kappa \in (0, 1)$. Therefore, the strict concavity of U implies that

$$U(l', \rho, \theta) > \kappa U(l, \rho, \theta) + (1 - \kappa) U(l^*_\theta, \rho, \theta), \tag{30}$$

so $U(l', \rho, \theta) > U(l, \rho, \theta)$ because $U(l_\theta^*, \rho, \theta) \geq U(l, \rho, \theta)$ for any l. $\square$

Proof of Proposition 1. It follows from the equilibrium definition that (l_g^e, l_b^e), $\mu : L \to [0,1]$, and $\bar{v}^e$ are a stationary equilibrium if and only if $((l_g^e, l_b^e), \mu)$ is a Perfect Bayesian equilibrium satisfying criterion D1 of the static signaling game with expected utility of replacement $\bar{v}^e = \bar{v}(l_g^e)$.

The regulator's preferences are continuous (assumption [A0] in Cho and Sobel (1990)), increasing in ρ (assumption [A1]) and satisfy the single-crossing condition described in Lemma 3 (assumption [A4]). By assumption, ρ is continuous and increasing in μ, which amounts to assuming [A2] and [A3] in Cho and Sobel (1990). Finally, our assumption (14) is equivalent to assumption [A6] in Cho and Sobel (1990). Therefore, it follows from propositions 4.4 and 4.5 in Cho and Sobel (1990) that the unique equilibrium of the signaling game with given $\bar{v}$ is the least-cost separating equilibrium.

Therefore, if $\rho(0, \bar{v}^*) \geq \rho^*$, then the unique stationary equilibrium is such that $l_g^e = l_g^*$ and $\bar{v} = \bar{v}^*$ (part 4 of the proposition).

If $\rho(0, \bar{v}^*) < \rho^*$, then l_g^e must satisfy equation (18). Propositions 4.4 and 4.5 in Cho and Sobel (1990) ensure that there is a unique separating equilibrium for a given $\bar{v}$. However, we need to check whether there exists a l_g^e that is an equilibrium for $\bar{v} = \bar{v}(l_g^e)$ and whether such l_g^e is unique.

Let $F(l_g) = U(l_g, \rho(1, \bar{v}(l_g)), b) - U(l_b^*, \rho(0, \bar{v}(l_g)), b)$. If $\rho(0, \bar{v}^*) < \rho^*$, then $F(l_g^*) > 0$. By assumption (14), $F(\underline{l}) < 0$. Therefore, there exists $l_g \in (\underline{l}, l_g^*)$ such that $F(l_g) = 0$. Moreover,

$$\begin{aligned} F'(l_g) &= U_l + U_\rho \rho_v(1, \bar{v}(l_g))\bar{v}'(l_g) - U_\rho \rho_v(0, \bar{v}(l_g))\bar{v}'(l_g) = \\ &= U_l + \beta\gamma\bar{v}'(l_g)\left(\rho_v(1, \bar{v}(l_g)) - \rho_v(0, \bar{v}(l_g))\right) > 0, \end{aligned} \tag{31}$$

where the inequality follows from $U_l > 0$ (from Lemma 3), $\bar{v}' > 0$ (which follows from part 1 of Lemma 2) , and $\rho_v(1, \bar{v}(l_g)) \geq \rho_v(0, \bar{v}(l_g))$. Therefore, there is a unique $l_g^e \in (\underline{l}, l_g^*)$ such that $F(l_g^e) = 0$.

Parts 5(b) and 5(c) follow from $l_g < l_g^*$ and the facts that for $l < l_g^*$ $q(l, g)$ and $v(l, q(l, g))$ are increasing in l. $\square$

Proof of Proposition 2. Let $v_g(l) = v(l, q(l, g))$, so (by Lemma 2) $v_g' > 0$ for $l < l_g^*$. Let $l_g(\alpha)$ denote the equilibrium l_g^e as a function of α and $\bar{v}(\alpha) = \pi v_g(l_g(\alpha)) + (1-\pi)v_b^*$, and recall that $l_g^e < l_g^*$.

Implicitly differentiating (18) with respect to α, one obtains

$$\begin{aligned} U_l l_g'(\alpha) + U_\rho \rho_v(1, \bar{v}(\alpha), \alpha)\pi v_g'(l_g(\alpha))l_g'(\alpha) + U_\rho \rho_\alpha(1, \bar{v}(\alpha), \alpha) = \\ U_\rho \rho_v(0, \bar{v}(\alpha), \alpha)\pi v_g'(l_g(\alpha))l_g'(\alpha) + U_\rho \rho_\alpha(0, \bar{v}(\alpha), \alpha). \end{aligned} \tag{32}$$

Rearranging and replacing U_ρ by $\beta\gamma$,

$$l_g'(\alpha) = \frac{\beta\gamma\left(\rho_\alpha(0, \bar{v}(\alpha), \alpha) - \rho_\alpha(1, \bar{v}(\alpha), \alpha)\right)}{U_l + \beta\gamma\pi v_g'(l_g(\alpha))\left(\rho_v(1, \bar{v}(\alpha), \alpha) - \rho_v(0, \bar{v}(\alpha), \alpha)\right)} < 0, \tag{33}$$

where the inequality follows from $\rho_\alpha(0, \bar{v}(\alpha), \alpha) - \rho_\alpha(1, \bar{v}(\alpha), \alpha) < 0$, $U_l(l, \rho, b) > 0$ for $l < l_b^*$, $v_g' > 0$ for $l_g < l_g^*$, and $\rho_v(1, \bar{v}(\alpha), \alpha) - \rho_v(0, \bar{v}(\alpha), \alpha) \geq 0$.

Let $\rho^\mu(\alpha) = \rho(\mu, \bar{v}(\alpha), \alpha)$, so

$$\rho^{\mu\prime} = \rho_v(\mu, \bar{v}(\alpha), \alpha)\pi v_g'(l_g(\alpha))l_g'(\alpha) + \rho_\alpha(\mu, \bar{v}(\alpha), \alpha). \tag{34}$$

It follows from $\rho_v < 0$, $v_g' > 0$ for $l < l_g^*$, and $l_g' < 0$ that $\rho^{\mu\prime} > \rho_\alpha$. Therefore, $\rho^{1\prime} > 0$. For $\mu = 0$, by (33),

$$\begin{aligned} \rho^{0\prime} \propto\, & \rho_v(0, \bar{v}(\alpha), \alpha)\pi v_g'(l_g(\alpha))\beta\gamma\left(\rho_\alpha(0, \bar{v}(\alpha), \alpha) - \rho_\alpha(1, \bar{v}(\alpha), \alpha)\right) + \\ & + \rho_\alpha(0, \bar{v}(\alpha), \alpha)\left(U_l + \beta\gamma\pi v_g'(l_g(\alpha))\left(\rho_v(1, \bar{v}(\alpha), \alpha) - \rho_v(0, \bar{v}(\alpha), \alpha)\right)\right) = \\ & \rho_\alpha(0, \bar{v}(\alpha), \alpha)U_l + \\ & \beta\gamma\pi v_g'\left(\rho_\alpha(0, \bar{v}(\alpha), \alpha)\rho_v(1, \bar{v}(\alpha), \alpha) - \rho_\alpha(1, \bar{v}(\alpha), \alpha)\rho_v(0, \bar{v}(\alpha), \alpha)\right), \end{aligned} \tag{35}$$

where the first term in the last expression is negative and the second term is positive. □

Proof of Corollary 1. By assumption,

$$\rho_v = g'(\bar{v}) < 0, \tag{36}$$

$$\rho_\alpha(\mu, \bar{v}, \alpha) = (\mu - k). \tag{37}$$

It follows from (35) that

$$\rho^{0\prime} \propto -kU_l + \beta\gamma\pi v_g' g'(\bar{v})\left(-k-(1-k)\right) = -kU_l - \beta\gamma\pi v_g' g'(\bar{v}). \tag{38}$$

Therefore, since $g'(\bar{v}) < \underline{g} < 0$ for any $\bar{v} \in [\bar{v}_L, \bar{v}_H]$, $\rho^{0\prime} > 0$ for k sufficiently small as long as $U_l(l_g(\alpha), \rho(1, \bar{v}(\alpha), \alpha), b)$ is bounded above. $\square$

Proof of Proposition 3. As in the proof of Proposition 2, let $v_g(l) = v(l, q(l, g))$, so $v_g' > 0$ for $l < l_g^*$. Let $l_g(\pi)$ denote the equilibrium transfer for given π. Let $\bar{v}(\pi) = \pi v_g(l_g(\pi)) + (1-\pi)v_b^*$, so $\bar{v}'(\pi) = v_g(l_g(\pi)) - v_b^* + \pi v_g'(l_g(\pi))l_g'(\pi)$ or, letting $\Delta v \equiv v_g(l_g(\pi)) - v_b^*$, $\bar{v}'(\pi) = \Delta v + \pi v_g'(l_g^e)l_g'(\pi)$.

Implicitly differentiating (18) with respect to π, one obtains

$$\begin{aligned} U_l l_g'(\pi) + U_\rho \rho_v(1, \bar{v}(\pi))\left(\Delta v + \pi v_g'(l_g^e)l_g'(\pi)\right) = \\ U_\rho \rho_v(0, \bar{v}(\pi))\left(\Delta v + \pi v_g'(l_g^e)l_g'(\pi)\right). \end{aligned} \tag{39}$$

Rearranging and replacing U_ρ by $\beta\gamma$,

$$l_g'(\pi) = \frac{\beta\gamma\Delta v(\rho_v(0, \bar{v}(\pi)) - \rho_v(1, \bar{v}(\pi)))}{U_l - \beta\gamma\pi v_g'(l_g^e)(\rho_v(0, \bar{v}(\pi)) - \rho_v(1, \bar{v}(\pi)))} \leq 0, \tag{40}$$

where the inequality follows from $U_l(l, \rho, b) > 0$ for $l < l_b^*$, $\Delta v \geq 0$, and $\rho_v(0, \bar{v}(\pi)) - \rho_v(1, \bar{v}(\pi)) \leq 0$ and is strict if the last two inequalities are strict.

Let $\hat{\rho}(\pi) = \rho(\mu, \bar{v}(\pi))$. Then

$$\hat{\rho}' = \rho_v(\mu, \bar{v}(\pi))\bar{v}'(\pi). \tag{41}$$

Now,

$$\begin{aligned} \bar{v}'(\pi) = \Delta v + \pi v_g'(l_g^e)l_g'(\pi) = \\ \propto \Delta v\left(U_l - \beta\gamma\pi v_g'(l_g^e)(\rho_v(0, \bar{v}(\pi)) - \rho_v(1, \bar{v}(\pi)))\right) + \\ \pi v_g'(l_g^e)\left(\beta\gamma\Delta v(\rho_v(0, \bar{v}(\pi)) - \rho_v(1, \bar{v}(\pi)))\right) = \\ = \Delta v U_l \geq 0, \end{aligned} \tag{42}$$

with strict inequality if $\Delta v > 0$. Therefore, $\hat{\rho}' \leq 0$ (with strict inequality if $\Delta v > 0$) because $\rho_v < 0$. $\square$