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Policy Making with Reputation Concerns*

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Abstract

We study the policy choice of an incumbent politician who is concerned with the public's perception of his capability. The politician decides whether to maintain the status quo or to conduct a risky reform. The success of the reform critically depends on the ability of the politician in office, which is privately known to the politician. The public observes both his policy choice and the outcome of the reform, and forms a posterior on the true ability of the politician. We show that politicians may engage in socially detrimental reform in order to be perceived as more capable. Conservative institutions that thwart reform may potentially improve social welfare.

JEL Nos: C72, D72, D82

Keywords: Reform, Reputation, Ability, Conservatism

1 Introduction

> She (Emma) was not much deceived as to her own skill either as an artist or a musician, but she was not unwilling to have others deceived, or sorry to know her reputation for accomplishment often higher than it deserved.
>
> *Emma*, vol. 1, ch. 6, by Jane Austen

In making decisions and taking actions, we are often concerned about inferences that people draw about us from our choices and/or their consequences. Positive assessment

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from others not only generates psychological satisfaction and improves one's social status, but also could lead to various tangible gains such as opportunities in career development. To a large extent, our success, professional or otherwise, is determined by such inferences. The concerns on reputation form one important dimension of the informal incentives that motivate economic agents to make relevant decisions in various contexts.

Formal contracts based on explicit performance-based incentives are rare in public sectors and nonprofit organizations. Economic agents' reputation concerns play a dominant role in these environments. Plenty of examples are available to illustrate the ubiquity. A politician in office can be worried about his chance of being reelected or how the public evaluates his legacy. A bureaucrat in SEC may desire a promotion or a generous job offer from private financial sectors after his term of service.

As Irving Rein, Philip Kotler, and Martin Stoller [25] state, politics is an "image intensive sector", where "image building and transformation truly dominate". In our paper, we follow the literature on career concerns and we refer to reputation as the perception of one's competence or capability. The measurement of political reputation and image definitely includes factors from various dimensions, apart from technical competence. However, professional and political capabilities often impacts one's reputation substantially (see Petras Oržekauskas and Ingrida Šmaižienė [21], among others). As an aftermath of the economic turmoil, commentators doomed Gordon Brown to have lost his "reputation for economic competence" "through a combination of appallingly bad luck and even worse misjudgment,"[1] which would immediately jeopardize his premiership. Due to the higher power and prevalence of such informal incentives, actions chosen by decision makers to enhance their reputation are widespread. For instance, Frederick Sheehan [27] comment that Alan Greenspan deliberately build his own reputation at the cost of that of the Fed in designing monetary policy, and he went to a great length to protect his reputation.

Reputation concerns may loom large in private sectors as well. The epic failure of Pets.com and it aftermath evidenced the significance of reputation concerns in business world. The company fell apart due to unwise investment instead of the IT bubble collapse. Its former CEO, Julie Wainwright, although left the company with a fortune, has suffered heavily from the loss of her reputation. As she admitted in a TV interview: "I had people laugh in my face when I introduced myself for years after the company closed. It happened as recently as a year ago. A couple of people asked me what it felt like to be one of the best-known failures in the U.S. Most just walked away from me." By way of contrast, a long list of CEO recognition prizes are awarded every year, which could tremendously contribute to the career development of highlighted business leaders. Both anecdotal and empirical

[1]Source: Fraser Neslon, Brown's "Reputation for Economic Competence Has Gone. The Tories Should Seize the Chance." http://www.spectator.co.uk, January 23rd, 2008.

evidence are available to testify the nontrivial role of recognition awards on executives' behaviours. The incentives of financial analysts provide another salient example. They have to strategically report the information they have received as the ex post realization of market activities tremendously affect the perception of investors on their capabilities, which critically influences their future career.

An enormous economics literature has been devoted to analyzing economic agents' behaviour in a wide array of environments where they are subject to reputation or career concerns. In this paper, we identify one particular way in which such concerns affect individuals' behaviour – they may take on risky or innovative initiatives whose success depends on their capability to improve the public's perception on their talent, even though they know their own capability is low, and they have a lesser chance of making success. As Tereza Capelos [4] state, "political actors often engage in controversial activities that challenge their reputation". He pointed out that politicians would risk losing their support "after showing instances, or wrong judgment". Our analysis can then set out to provide a rationale for these behaviours. Throughout our paper, we refer to the decision maker in our model as a "politician", though our analysis may encompass a variety of environments: a CEO who has to decide whether to implement an expansion plan or not, a doctoral candidate who has to decide to pursue a cutting-edge research project or not, a prosecutor who has to decide whether to file charges against a crime suspect or not, etc.

In our model, a politician's reputation concerns manifest through his desire to raise the public's perception of his capability, namely, his ability to gather information and make the right decision in situations of uncertainty. The office-holding politician decides whether to drop the status quo policy in favour of a reform proposal. The ex post performance of the reform depends on two factors: the inherent merit of the available reform proposal (its potential value) and implementation by the politician. The potential value of a reform proposal follows certain continuous distribution, which can be costlessly discovered by the politician in office before he decides to undertake the reform. We assume that the potential value of the available reform proposal is a piece of "hard" information and therefore is verifiable, while publicizing this information is in the discretion of the politician. There exist two types of politicians with differing abilities. The ability of a politician in office can be either high or low and is privately known only to the politician himself.

If the status quo is retained, the performance of the politician does not vary across differing types, and it would not be subject to perturbation. Arguably, a continuing policy reduces uncertainty and allows the politician in office to gather reliable information from the past. By contrast, uncertain situations arise once the status quo is abandoned, and the politician has to manage the resulted uncertainty. He receives a private signal regarding the true state of the world, and has to choose his action in response to his conjectured underlying state of the world. The reform could succeed only if the politician chooses the ex post optimal response to the state of the world, while it fails otherwise. For instance, although HP's acquisition of Compaq has proven its merit over the years, it has been widely held that the fiasco of the company was caused by the flawed approach of Carly Florina (HP's former CEO) to managing the merger.

The ability of the politician plays a critical role in the outcome of a reform. A high-type politician receives a more precise signal about the true state of the world, which enables him to choose responsive action and conduct socially beneficial reform given sufficiently promising reform proposal; while the low type receives only a noisy signal, which causes him to make more mistakes. We assume that the reform implemented by a low-type politician is ex ante socially inefficient regardless of the merit of the reform proposal. His ability is inadequate for managing the uncertainty after the status quo is overthrown.

We posit that the politician in office is concerned about the public's perception of his capability. He therefore makes his policy choice (reform or not reform) to maximize his reputation payoff. The public observes the policy choice of the politician as well as the resulted performance. The public then updates their belief on the type of the politician based on the two pieces of information. Two possibilities may lie beneath when status quo is maintained. Firstly, a high-type politician may not reform if a rosy proposal is available; Secondly, a low-type may abstain from reform even if considerably valuable proposal appears as he is afraid of failure. If a reform has been implemented, a politician is more likely to be regarded as being capable if the reform succeeds, while he suffers from a more pessimistic assessment if a miserable outcome results. Hence, reform function as a costly signal that conveys the politician's private information; while the posterior is formed based on not only the politician's action of reform (or no reform) but also his (random) performance.

We show that there exist a continuum of Perfect Bayesian equilibria in this game. Each equilibrium is characterized by a distinct cutoff, such that the high-type politician reforms if and only if the available reform proposal carries a potential value that exceeds the cutoff. We find that there exists no fully-separating equilibrium. We show that a high-type politician is always "eager" to reveal more information by undertaking reform: he reforms with probability one once the value of available proposal exceeds the cutoff of prevailing equilibrium. The low type always mimics his high-type counterpart with a positive probability. Although the reform undertaken by a low type fails with a higher probability, his reputation concerns "force" him to do so, because he would otherwise suffer from more unfavourable assessment.

Our analysis allows us to make a number of interesting observations.

- **Pressure to prove oneself.** The probability of the low type undertaking reform strictly decreases with the public's assessment of the likelihood that the politician is capable. When the public holds a more pessimistic prior, the low-type politician would expect a greater gain if his reform turns out to succeed. Because of this effect, we predict that reform will be observed less often when the public holds a more favourable prior on the type of the politician, or a higher portion of high-type politicians exist in the population. Furthermore, though our model is static, this result points towards the following conjecture about the dynamic behaviour of a politician: a politician who has failed in the past is more likely to take radical action in the future. Past failure lowers his rating among the public, which therefore makes more lucrative an accidental success in the future.

- **Tough act to follow.** The higher is the capability differential between the high type and the low type, the less likely the low type undertakes reform. On the one hand, it could lead high type to reform more, which forces the low type to follow suit. On the other hand, it makes successful mimicry more difficult. We show that the latter effect always prevails and the low type in equilibrium must reform less often to avoid failure.

- **Thwarted good reforms.** Our model has multiple-equilibria, with different thresholds for reform. Suppose a legislative body can set the threshold, i.e., a limit of the freedom of the politician, and require the politician not to conduct reform unless the value of available reform proposal exceeds the threshold. Thus, what is the optimal threshold that maximizes expected social welfare? Competing effects again result. A higher threshold reduces the gambling of the low type on the one hand, while it reduces the efficient reform undertaken by the high type on the other. We derive a fairly general conclusion about the socially optimal threshold, and we find that moderate "conservatism" can be optimal in this context, despite that it must thwart ex ante beneficial reform.

In the rest of this section, we discuss the link between our paper and the relevant literature. In Section 2, we set up the model. We carry out our analysis in Section 3, which establishes equilibria of the model and present comparative statics of relevant environmental factors. We discuss the welfare implications of our equilibrium results and the issue of institution design in Section 4. Section 5 provides a concluding remark.

Relation to Literature

In our paper, the action of reform serves as a signalling device for the office-holding politician. A reform is more costly to a low-type politician as he would be more likely to fail and therefore suffer an unfavourable assessment. In the current setting, the politician takes action to maximize his reputation payoff. Hence, our paper also belongs to the extensive literature on career concerns.

The notion of career or reputation concerns is not novel. Ever since the pathbreaking work of Bengt Holmstrom [13] and Mathias Dewtripont, Ian Jewitt, and Jean Tirole [6] [7], the incentive effect of career (reputation) concerns has been the subject of a vast amount of scholarly effort in a wide array of contexts. For instance, Alberto Alesina and Guido Tabellini [1] discuss the appropriate task allocation to bureaucrats when they take action in fulfilling their duty to maximize their reputation payoff.

Our model has two distinct features: first, the policy maker's capability is only relevant when he takes the reform, and the action of reform is observable; second, the politician knows his own type, so his action of reform serves as a signalling device.

Within the career concerns literature, our paper is similar in spirit to those of Andrea Prat [23] and Jeffrey Zwiebel [29]. Prat studies a principal-agent model in which an agent cares about his perceived capability by the principal, and the principal cares both about the consequence of the agent's action and learning about the capability of the agent. He shows that the principal benefits from knowing the consequence of the agent's action, but not the agent's action itself. We abstract from the welfare consideration of revelation of the policy maker's ability, but we introduce a scenario where there are both observable (strategic) actions and unobservable (tactical) ones. This setup allows us to address the institutional issue of setting a threshold for reform. Zwiebel [29] also explores how reputation concerns moderate one's incentive to undertake innovative but risky action. He shows that, in a setup where innovation rarely occurs and the act of innovation is not observable, managers with intermediate capability may not want to innovate even if it is beneficial to the firm. The main difference between our model and his is that the act of reform is observable in our model. Hence, the setting of [29], as well as those in the managerial herding literature, does not involve costly signalling action on the part of the decision maker. We also arrive at the opposite conclusion that there can be *too much* reform when the politician cares about his reputation.[2]

In other related work, Adam Brandenburger and Ben Polak [3], Stephen Morris [20], David S. Scharfstein and Jeremy C. Stein [26], and Marco Ottaviani and Peter Norman Sørensen [22] show that decision makers who are concerned about public or market perceptions may ignore their own useful information and take the decision ex ante favoured by the public or market.

A handful of studies include flavours from both the literature of signalling and that of career concerns. Canice Prendergast and Lars Stole [24] argue that career concerns induce young investors to overreact to new information they receive, so as to signal that they are fast learners. Wei Li [18] makes a similar point in the case of experts providing advice

[2]Robert A. J. Dur [9] and Peter Howitt and Ronald Wintrobe [14] also explore scenarios where there is too little change of policy.

to decision makers. Sumon Majumdar and Sharun W. Mukand [19] study governments' dynamic incentives of policy experimentation and persistence when the government's payoff depends on not only the performance of the economy but also its chance of being re-elected, which is determined by voters' perception of its ability. They show that the government can be either too radical or too conservative at early stages of its term. In another closely related paper, Kim-Sau Chung and Péter Esö [5] build a model in which a worker chooses a task to both signal to potential employers his capability and learn about his capability himself, as he only has imperfect knowledge about it. Notably, they assume that the more difficult task is a worse (less informative) device for evaluating the capability of the worker. They show that workers with very high and low capability choose the more difficult task while those with intermediate capability choose the easier task. Their result is similar in spirit to that of Nick Feltovich, Rick Harbaugh, and Ted To [10], who show that a worker with very high capability may in fact not engage in costly signalling (in other words, they "countersignal") but a worker with intermediate capability does. Finally, in a model with a flavour of institution design, Gilat Levy [16] shows that in a committee of voters with career concerns, radical actions are more likely to be accepted when the committee voting process is transparent, and the public is able to infer a voter's ability by observed vote.

Our paper is also conceptually related to those of Benjamin E. Hermalin [12] and Silvia Dominguez-Martinez, Otto H. Swank, and Bauke Visser [8]. Hermalin [12] constructs a model where board members engage in costly effort to monitor a CEO. Higher effort allows them to learn better about the type of the CEO, and they retain the CEO only if the posterior is sufficiently optimistic. However, he does not model the strategic action of the CEO. Dominguez-Martinez, Swank, and Visser [8]) extend Hermalin's [12] model but allows the CEO to design and implement "projects". Board members design an efficient contract, infer the CEO's ability by monitoring his performance, and make the retention decision. Their study also mainly focuses on the behaviour of board. Our paper therefore also complements this literature.

Our result that restrictions on change of policies could be welfare-improving complements other justifications of institutional conservatism, for example, those offered by Li, Hao [17] and Young K. Kwon [15]. Our analysis suggests institutional barrier (bureaucracy) that limits the discretion the decision maker can exercise. Our paper echoes Jean Tirole [28] in this aspect.

2 Setup

A risk-neutral politician makes a policy choice between two alternatives: maintaining the status quo or implementing a reform. If the politician retains the status quo, the outcome of this polity, y, is deterministic, which we normalize to 0. By contrast, if the politician chooses to undertake the reform, uncertainty will arise that affect the outcome and the politician must take an action to address it. The outcome is given by

$$y = \theta - (a - \omega)^{2}. \tag{1}$$

where θ measures the value of reform, ω is the true state of the world, and a is the action taken by the politician in response to his assessment of ω. The politician observes the value of reform, θ, before choosing whether to implement it. We assume that the signal θ is a piece of "hard" and verifiable information. It is common knowledge that θ is continuously distributed on $[-\widehat{\theta}, \widehat{\theta}]$ with distribution function F and density function f, where $\widehat{\theta} \in (1, 2)$. The state of the world, ω, may take two values, -1 or 1, each with probability 1/2. Neither the politician nor the public observe the true state. The action a is chosen from $\{-1, 1\}$. Thus, when a reform is implemented, the best outcome is achieved when the politician takes an action that turns out to match the state of the world.

The distinction between policies (status quo or reform) and actions is important in our model. Policies are macro-level or "strategic" decisions such as whether to introduce a new product or whether to start a war. By contrast, actions are micro-level or "tactical" decisions such as which technology to use in the new product or how many troops to deploy in the war. Though there may be general agreement about how desirable a reform is (θ), there may well be disagreement over the optimal way to implement the reform (a). The true nature of the problem (ω) determines which action is ex post suitable for implementing the reform.

The politician's talent, t, which affects the success of the reform, can be high ($t = H$) or low ($t = L$). The talent of the politician is his private information. A high-talent politician receives an informative signal $\sigma \in \{-1, 1\}$, which matches the true state with probability

$$q = \Pr(\sigma = \omega) > \frac{3}{4}.$$

By contrast, a low-talent politician's signal is completely uninformative.[3] Let α be the probability of $t = H$, which is commonly known. We assume that the proportion of "good" politicians in the population is small:[4]

$$\alpha < \frac{1}{2}.$$

[3]Though we do not model how the politician obtains his signal, one may interpret the politician's talent in our model as the ability to gather information from various sources. The US presidential historian, Erwin C. Hargrove, paints two completely different pictures of Franklin D. Roosevelt and Herbert Hoover with respect to information gathering. Roosevelt brought together experts who held a great variety of views and balanced them off against each other while Hoover did not enjoy critical advice from anyone. See [11], pp 70-73 and pp 114-116.

[4]This regularity assumption guarantees that the low type has an incentive to undertake reform and mimic the high type when the high type takes perfectly informed action when he implements reform (see the proof of Lemma 1).

Upon receiving σ (either informative or uninformative), the politician takes an action.

The public observes the politician's policy choice (status quo or reform) and the final outcome.[5] Their updated belief, or the reputation of the politician, can be written as

$$\mu_i(y) \equiv \Pr(t = H|\, y, i)$$

by Baye's rule, where $i = 0$ indicates status quo and $i = 1$ indicates reform. We use μ_0 to denote the politician's reputation when no reform is implemented as the outcome is always zero. We also use $\mu_{1H}(\theta)$ and $\mu_{1L}(\theta)$ to denote the expected reputation payoff of the high type and the low type from choosing to reform when the value of the reform proposal is θ. Similar to Chung and Esö [5] and Ottaviani and Sørensen [22], we assume that the politician's payoff purely depends on his reputation. The politician therefore chooses the action that maximizes his reputation.

We adopt the concept of Perfect Bayesian Equilibrium to analyze the game.

3 The Analysis

First, we consider the outcome of reform. When the status quo is abandoned, and an action a is taken, the expected output of the reform is given by

$$E(y) = \theta - E_{\omega\in\{-1,1\}}(a - \omega)^2 \geq 0. \tag{2}$$

Since a low-type politician's signal is completely noisy, the outcome is the same regardless of his action. A high-type politician, however, would use his signal to maximize his probability of success.

In the first-best situation, a politician would adopt the reform if and only if the expected outcome $E(y)$ is nonnegative. A low-type politician should never reform regardless of θ as the expected loss from wrong actions always exceeds the benefit of reform, that is,

$$E(y) = \frac{1}{2}\theta + \frac{1}{2}(\theta - 4) \leq \widehat{\theta} - 2 < 0,$$

as the upper bound of the value of reform, $\widehat{\theta}$, is in $(1, 2)$. By contrast, the expected outcome for a high-type politician is given by

$$E(y) = \theta - 4(1 - q).$$

Thus, the high type should undertake reform if and only if the value of reform is sufficiently high:

$$\theta \geq 4(1 - q).$$

[5] In our setup, whether or not the public observe the action is inconsequential. Once the politician chooses reform, the belief of the public is determined only by whether the outcome is a "failure" or "success."

When the value of reform is below $4(1-q)$, reform is socially undesirable regardless of the type of the politician.

We now formally analyze the politician's policy choice. We assume that the politician is subject to a minimum level of "*accountability*" constraint such that no reform with a value $\theta < 4(1-q)$ can be accepted by the public. Clearly, when a reform with $\theta < 4(1-q)$ is undertaken, the reform is ex ante socially detrimental even if it is implemented by a high-talent politician. In our setup, the assumption of $\widehat{\theta} < 2$ guarantees that the true value of θ can be correctly inferred by the public after the output y is realized. Given the accountability obligation, we assume that a politician in office is not allowed by public to undertake obviously socially undesirable activities. We then focus on our attention on equilibria where the politician reforms only when $\theta \geq 4(1-q)$.

Let $\rho_t(\theta)$ be the probability with which a type-t politician chooses reform when its value is θ. We focus on *monotonic equilibria*, where the politician's probability of undertaking reform is nondecreasing in θ, the potential value of reform. Define $\overline{\theta}_t \equiv \inf\{\theta | \rho_t(\theta) > 0\}$. Thus, a type-$t$ politician undertakes reform with a positive probability only if the value θ exceeds a cutoff $\overline{\theta}_t$.

To summarize, we consider equilibria that satisfy:

A type-t politician maintains the status quo when the value of reform is lower than $\bar{\theta}_t$ and adopts reform with probability $\rho_t(\theta)$ in state $\theta \geq \bar{\theta}_t$, where $\bar{\theta}_t \geq 4(1-q)$.

Given the politician's behaviour above, when the politician maintains the status quo, his reputation among the public will be

$$\mu_0 = \frac{\alpha F(\overline{\theta}_H) + \alpha \int_{\overline{\theta}_H}^{\widehat{\theta}} [1-\rho_H(\theta)] f(\theta) d\theta}{\left[\begin{array}{l} \alpha F(\overline{\theta}_H) + \alpha \int_{\overline{\theta}_H}^{\widehat{\theta}} [1-\rho_H(\theta)] f(\theta) d\theta \\ +(1-\alpha) F(\overline{\theta}_L) + (1-\alpha) \int_{\overline{\theta}_L}^{\widehat{\theta}} [1-\rho_L(\theta)] f(\theta) d\widehat{\theta} \end{array}\right]}. \quad (3)$$

Clearly, when no reform occurs, the politician's reputation does not depend on his talent, as the outcome is always zero.

When the politician implements a reform of value θ, his reputation will become

$$\mu_1(\theta) = \frac{\alpha q \rho_H(\theta) f(\theta)}{\alpha q \rho_H(\theta) f(\theta) + (1-\alpha)\frac{1}{2}\rho_L(\theta) f(\theta)}$$

when the reform succeeds and

$$\mu_1(\theta-4) = \frac{\alpha q \rho_H(\theta) f(\theta)}{\alpha q \rho_H(\theta) f(\theta) + (1-\alpha)\frac{1}{2}\rho_L(\theta) f(\theta)}$$

when the reform fails.

If a high-talent politician implements a reform with value θ, he receives an expected payoff

$$\mu_{1H}(\theta) = q\mu_1(\theta) + (1-q)\mu_1(\theta-4),$$

while a low-talent politician

$$\mu_{1L}(\theta) = \frac{1}{2}\mu_1(\theta) + \frac{1}{2}\mu_1(\theta - 4).$$

In any equilibrium, the low type does not reform when the realized value of reform satisfies $\theta < \overline{\theta}_H$. If he did in equilibrium, since the high type does not reform for $\theta < \overline{\theta}_H$, the public must assign probability one to him being the low type regardless of success or failure, thereby leaving him worse off than if he does not reform. Hence, we must have $\overline{\theta}_L \geq \overline{\theta}_H$ in any equilibrium. In the following lemma, we show that their strategies follow the same cutoff $\overline{\theta} = \overline{\theta}_L = \overline{\theta}_H$.

Lemma 1 *In any equilibrium that involves a positive probability of reform, (1) the cutoffs for reform must be the same for the low type and the high type, i.e.,* $\overline{\theta}_L = \overline{\theta}_H = \overline{\theta}$*; and (2) the high-type politician plays a pure strategy* $\rho_H(\theta) = 1$ *for any* $\theta \in [\overline{\theta}, \widehat{\theta}]$.

Proof. See Appendix. ■

The above lemma states that there is no full separation of the two types regardless of the value of the reform proposal. The same cutoff level $\overline{\theta} = \overline{\theta}_L = \overline{\theta}_H$ applies to both types of the politician. Above this threshold, the high type always undertakes reform and the low type mixes between reform and no reform.

We now determine the low-type politician's probability of reform for a proposal with value θ, which we denote by $\rho(\theta)$ to economize on notation. By (3), if the politician maintains the status quo, his payoff is

$$\begin{aligned} \mu_0 &= \frac{\alpha F(\overline{\theta})}{\alpha F(\overline{\theta}) + (1-\alpha)F(\overline{\theta}) + (1-\alpha)\int_{\overline{\theta}}^{\widehat{\theta}}[1-\rho(\theta)]f(\theta)d\widehat{\theta}} \\ &= \frac{\alpha}{\alpha + (1-\alpha)\frac{F(\overline{\theta}) + \int_{\overline{\theta}}^{\widehat{\theta}}[1-\rho(\theta)]f(\theta)d\theta}{F(\overline{\theta})}}. \end{aligned} \tag{4}$$

Note that it does not depend on θ.

On the other hand, if the low-type politician undertakes the reform, his payoff is given by

$$\begin{aligned} \mu_{1L}(\theta) &= \frac{1}{2}\cdot\frac{q\alpha f(\theta)}{q\alpha f(\theta) + \frac{1}{2}(1-\alpha)\rho(\theta)f(\theta)} + \frac{1}{2}\cdot\frac{(1-q)\alpha f(\theta)}{(1-q)\alpha f(\theta) + \frac{1}{2}(1-\alpha)\rho(\theta)f(\theta)} \\ &= \frac{1}{2}\cdot\frac{\alpha}{\alpha + \frac{\frac{1}{2}(1-\alpha)\rho(\theta)}{q}} + \frac{1}{2}\cdot\frac{\alpha}{\alpha + \frac{\frac{1}{2}(1-\alpha)\rho(\theta)}{1-q}}. \end{aligned} \tag{5}$$

If the low-type plays a completely mixed strategy, $\rho(\theta) \in (0,1)$, we need to equate (4) and (5), which implies that $\rho(\theta)$ must be a constant ρ regardless of the value θ. Consequently, in equilibrium,

$$\frac{\alpha}{\alpha+(1-\alpha)\frac{F(\overline{\theta})+(1-\rho)[1-F(\overline{\theta})]}{F(\overline{\theta})}}=\frac{1}{2}\cdot\frac{\alpha}{\alpha+(1-\alpha)\frac{\frac{1}{2}\rho}{q}}+\frac{1}{2}\cdot\frac{\alpha}{\alpha+(1-\alpha)\frac{\frac{1}{2}\rho}{1-q}}, \tag{6}$$

which we may rewrite as

$$\frac{1}{1+\lambda(\alpha)A}=\frac{1}{2}\cdot\frac{1}{1+\lambda(\alpha)B}+\frac{1}{2}\cdot\frac{1}{1+\lambda(\alpha)C}, \tag{7}$$

where

$$\lambda(\alpha)=\frac{1-\alpha}{\alpha},\ A=1+(1-\rho)\kappa(\bar{\theta}),\ \kappa(\bar{\theta})=\frac{1-F(\bar{\theta})}{F(\bar{\theta})},\ B=\frac{\frac{1}{2}\rho}{q},\ C=\frac{\frac{1}{2}\rho}{1-q}.$$

The expression $\lambda(\alpha)$ is the likelihood ratio of the low type versus the high type, $\kappa(\bar{\theta})$ is the likelihood ratio of reform having good prospects versus bad prospects, and A, B, and C are respective the likely hood ratios of the low type not reforming, having a successful reform, and having a failed reform versus the high type obtaining each outcome.

Theorem 1 *There exist a continuum of Perfect Bayesian Equilibria with cutoffs* $\overline{\theta}\in[4(1-q),\widehat{\theta})$*. For any* $\overline{\theta}$*, there exists a unique equilibrium probability* $\rho^*\in(0,1)$*, which solves (7), such that the low-type politician undertakes reform with the probability* ρ^* *whenever he receives a signal* $\theta\geq\overline{\theta}$*.*

Proof. See Appendix. ■

In the case when the high-type politician receives a perfect signal, i.e. $\Pr(\sigma=\omega|\,\omega)=1$. Equation (7) can be rewritten as

$$\frac{1}{1+\lambda(\alpha)A}=\frac{1}{2\alpha+(1-\alpha)\rho}, \tag{8}$$

which yields the solution

$$\rho^*=\frac{1-\alpha[1+F(\overline{\theta})]}{1-\alpha}. \tag{9}$$

The high type reforms with probability one when the prospect of reform is good, and does not reform when it is not. The low type, by contrast, mimics the high type with a positive probability in the former case, and does not reform in the latter. Even though the probability of success is only 1/2, it is optimal for the low type to reform because the choice of reform is a signal of high talent.

Comparative Statics

We now examine how the policy maker's equilibrium behaviour varies with environment parameters. We examine how a change in α, the prior of the public, or the proportion of high-type politicians, affects the probability with which a low-type politician conducts reform.

The answer to this question is not straightforward. When α increases, as implied by the equilibrium condition (7), a low-type's reputation goes up regardless of his policy choice. Formal analysis leads to the following conclusion.

Theorem 2 *Fixing a cutoff for reform, $\bar{\theta}$, the probability of reform by the low type, ρ^*, is strictly decreasing in α, the probability of high type.*

Proof. See Appendix. ■

The theorem states that the less favourable the public's prior assessment, the more likely the low type conducts reform. The analysis that is laid out above reveals its logic. A favourable prior assessment makes it more desirable for the low-type politician to maintain the status than to takes reform: on the one hand, the public would more likely attribute his failure to reform to the lack of opportunities (when a lower θ is realized) rather than the lack of talent; on the other hand, his loss from a failed reform would increase, which consequently weakens his incentive to reform. By contrast, a less favourable prior would strengthen his incentive to take risk, because it implies a lesser loss from a failed reform but a larger gain from a successful one. We then interpret this as the "pressure to prove oneself" phenomenon.

The result of Theorem 2 allows us to investigate another property of the equilibrium. In this game, reform would take place with probability

$$\bar{\rho} = [1 - F(\bar{\theta})][\alpha + (1-\alpha)\rho^*]. \tag{10}$$

Using Theorem 2, we may investigate whether more reform or less reform takes place when the public has a more favourable assessment of the politician's talent (or there is a higher proportion of capable politicians. Note that

$$\frac{\partial \bar{\rho}}{\partial \alpha} = [1 - F(\bar{\theta})][1 - \rho^* + (1-\alpha)\frac{\partial \rho^*}{\partial \alpha}]. \tag{11}$$

Two competing forces come into play when α is higher. On the one hand, since the low type reforms with a lower probability than the high type, the overall probability of reform increases when there is a higher proportion of high type. On the other hand, Theorem 2 implies that the low type reforms less when α is higher, causing the overall probability of reform to decrease. Our next theorem states that the second effect dominates.

The equilibrium condition can be rewritten as

$$G(\rho,\alpha) \equiv [1+(1-\rho)\kappa(\bar{\theta})] - \frac{\rho[\lambda(\alpha)\rho+1]}{4q(1-q)+\lambda(\alpha)\rho} = 0. \tag{12}$$

We have

$$\frac{\partial G(\rho,\alpha)}{\partial\rho} = [\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda(\alpha)\rho]^2}],$$

where $\kappa(\bar{\theta}) = \frac{1-F(\bar{\theta})}{F(\bar{\theta})}$, and

$$\frac{\partial G(\rho,\alpha)}{\partial\alpha} = -\frac{1}{\alpha^2}\cdot\frac{\rho^2[1-4q(1-q)]}{[4q(1-q)+\lambda(\alpha)\rho]^2}.$$

Our analysis leads to the following prediction.

Theorem 3 *The overall likelihood of reform $\bar{\rho}(\bar{\theta};\alpha)$ strictly decreases with α.*

Proof. See Appendix. ■

The analysis shows that the overall likelihood of reform would be unambiguously reduced when α increases. Theorem 3 yields an empirically testable hypothesis, namely, when there is a smaller proportion of capable politicians in the population or when the public holds a more pessimistic prior, more reform is expected. This conclusion is drawn without knowing the true type of the politician in office (which is the politician's private information and cannot be verified).

Next, we investigate how the low type's frequency of reform varies with q, the ability measure of the high-type politician.

Theorem 4 *Fix any equilibrium with cutoff $\bar{\theta}$, the probability of reform by the low type, ρ^*, is strictly decreasing in q.*

Proof. See Appendix. ■

Theorem 4 states that a low-type politician would mimic his high-type counterpart less often when the latter becomes more capable. The logic of this result is as follows. As the high type becomes more capable, the public is more likely to attribute an unsuccessful reform to a low-type politician, which unambiguously reduces the expected payoff of the low type from reform. This logic can be verified by evaluating $\mu_{1L}(\theta)$ with q for a fixed ρ, which yields

$$\begin{aligned}\frac{\partial\mu_{1L}(\theta)}{\partial q} &= \frac{\partial[\frac{1}{2}\cdot\frac{1}{1+\lambda(\alpha)B}+\frac{1}{2}\cdot\frac{1}{1+\lambda(\alpha)C}]}{\partial q} \\ &= \frac{1}{2}\lambda(\alpha)\rho[\frac{1}{q+\frac{1}{2}\lambda(\alpha)\rho} - \frac{1}{(1-q)+\frac{1}{2}\lambda(\alpha)\rho}].\end{aligned} \tag{13}$$

The first term stands for the increase in reputation when the reform succeeds and the second the decrease in reputation when it fails. The combined effect is negative because $q > 1 - q$. A greater ability differential makes it more difficult for a low type to mimic his high-type counterpart, and therefore leads to a lower ρ^*. We then interpret this result as the "tough action to follow" phenomenon.

As implied by the analysis laid out above, the distribution of the value of reform does not qualitatively alter the main prediction of our analysis. We now examine how it quantitatively affects the equilibrium probability of low type undertaking reform.

Theorem 5 *Let ρ and ρ' denote respectively the equilibrium probabilities of the low type undertaking reform associated with distributions $F(\cdot)$ and $G(\cdot)$. For a fixed $\overline{\theta}$, then, $\rho > \rho'$ if $F(\cdot)$ first order stochastically dominates $G(\cdot)$.*

Proof. See Appendix. ■

The intuition of the theorem is as follows: when the prospect of reform is more likely to be good, the public would then believe a no-reform outcome is more likely to be caused by the politician's lack of talent, instead of the lack of opportunities (a lower θ is realized). It therefore lowers the public's rating of the politician when they observe no reform, and induces the low type to reform more often.

Comparison across Equilibria

Analogous to standard signalling game, our analysis yields multiple equilibria, which are characterized by differing cutoffs. One may interpret a higher cutoff $\overline{\theta}$ in the prevailing equilibrium as a proxy for escalating conservatism or more resistance to reform. Then we first investigate how the equilibrium strategy of a low-type politician ρ^* would differ across differing equilibria, i.e., how it responds to different levels of "conservatism".

Theorem 6 *The equilibrium probability of reform by the low type, ρ^*, strictly decreases with the cutoff $\overline{\theta}$.*

Proof. See Appendix. ■

The intuition is in line with that of Theorem 5. A higher cutoff $\overline{\theta}$ increases the size of $F(\overline{\theta})$, which in turn increases the low type's reputation when he does not take reform. This makes reform less attractive to the low type when the prospect of reform is above the threshold $\overline{\theta}$.

Theorem 6 allows us to further explore a politician's preference for "conservatism". We are interested in the following question: Do politicians prefer equilibria with more reform or less reform?

The high-type politician can benefit from more reform, as it allows the public to infer his type more often from successful reform. However, because ρ^* decreases with $\overline{\theta}$, an equilibrium with a lower cutoff $\overline{\theta}$ encourages his low-type counterpart to conduct reform, which then makes his reform less informative and tends to offset the gain he may have by undertaking reform.

Recall that the equilibrium is defined by the equation

$$\underbrace{\frac{\alpha}{1+\frac{(1-\alpha)(1-\rho^*)[1-F(\overline{\theta})]}{F(\overline{\theta})}}}_{\mu_0} = \frac{1}{2}[\underbrace{\frac{\alpha}{\alpha+(1-\alpha)\frac{\frac{1}{2}\rho^*}{q}}}_{\mu_1'} + \underbrace{\frac{\alpha}{\alpha+(1-\alpha)\frac{\frac{1}{2}\rho^*}{1-q}}}_{\mu_1''}].$$

The politician in office receives a payoff μ_0 when he maintains the status quo. He receives a payoff μ_1' when he successfully implements a reform and μ_1'' when he fails. Define

$$q_t = \begin{cases} q & \text{for } t = H; \\ \frac{1}{2} & \text{for } t = L. \end{cases}$$

In any equilibrium with a given $\overline{\theta}$, the type-t politician receives a payoff

$$u_t = \begin{cases} q_t\mu_1' + (1-q_t)\mu_1'', & \text{for } \theta \geq \overline{\theta}; \\ \mu_0 & \text{for } \theta < \overline{\theta} \end{cases}. \tag{14}$$

Hence, in this equilibrium, the expected payoff of a type-t politician is given by

$$E(u_t) = \mu_0 F(\bar{\theta}) + [q_t\mu_1' + (1-q_t)\mu_1''][1-F(\bar{\theta})]. \tag{15}$$

Taking its derivative with respect to $\overline{\theta}$ yields

$$\begin{aligned}\frac{dE(u_t)}{d\overline{\theta}} &= \mu_0 f(\overline{\theta}) - [q_t\mu_1' + (1-q)\mu_1'']f(\overline{\theta}) \\ &\quad + [d\mu_0/d\overline{\theta}]F(\bar{\theta}) + \{d[q_t\mu_1' + (1-q_t)\mu_1'']/d\overline{\theta}\}[1-F(\bar{\theta})].\end{aligned}$$

Theorem 7 *The low-type politician always prefers an equilibrium with a higher cutoff $\overline{\theta}$; while the high-type politician always benefits from an equilibrium with a lower $\overline{\theta}$.*

Proof. See Appendix. ■

Theorem 7 states that the low type always prefers more conservative equilibria, while the high type prefers equilibria with more reform. The low type's aversion to reform embodies the logic that explains Theorem 5. On one hand, when $\overline{\theta}$ increases, a no-reform outcome reveals less information to the public, which allows the low type to receive a higher payoff from maintaining status quo. On the other hand, when the low type reforms less often, the public would believe a reform is increasingly likely to be implemented by the high type, which further reduces the damage to the low type when an unsuccessful reform realizes. Both effects contribute to the result. By way of contrast, the high type always prefers to reform as much as possible! In an equilibrium with a lower cutoff $\overline{\theta}$, his true type is more likely to be revealed.

Equilibrium Refinement

To further tighten our analysis and sharpen our prediction, we now employ a common refinement technique to select plausible equilibria. Particularly, we follow Jeffrey S. Banks and Joel Sobel [2] and apply the "Divinity Criterion" to strike out implausible equilibria.

Analogous to other conventional refinement techniques for signalling games, the Divinity Criterion seeks to impose additional restrictions on out-of-equilibrium beliefs. When an unexpected signal is received, the receiver has to form a conjecture about the type of sender who deviates from the equilibrium path. The criterion is built upon the notion that a sender is willing to deviate by sending unexpected signal only if she hopes for a payoff higher than that in the equilibrium. Consider two differing types of senders. If one type is more likely to benefit from a given deviation, then the receiver should believe the former type deviates at least no less often than the latter. The receiver must assign in her posterior more weight to the type that is more likely to gain from the given deviation.

We now formally translate the notion of the Divinity Criterion into our context. Fix an equilibrium with a cutoff $\overline{\theta} > 4(1-q)$. Suppose that an unexpected reform takes place. The public infers from its outcome that the proposal has a value $\theta \in [4(1-q), \overline{\theta})$. The public forms a set of beliefs $\phi_\theta \equiv \{\widetilde{\rho}_H(\theta), \widetilde{\rho}_L(\theta)\}$, where $\widetilde{\rho}_t(\theta)$ specifies the probability of a type-t politician to undertake this reform. Given this conjecture, a type-t politician, when deviating, has a payoff

$$\begin{aligned}\mu_t(\theta;\phi_\theta) \quad &= \quad q_t \times \frac{\alpha\widetilde{\rho}_H(\theta)q}{\alpha\widetilde{\rho}_H(\theta)q + \frac{1}{2}(1-\alpha)\widetilde{\rho}_L(\theta)} \\ &\quad +(1-q_t) \times \frac{\alpha\widetilde{\rho}_H(\theta)(1-q)}{\alpha\widetilde{\rho}_H(\theta)(1-q) + \frac{1}{2}(1-\alpha)\widetilde{\rho}_L(\theta)}, \end{aligned} \tag{16}$$

with

$$q_t = \begin{cases} q & \text{for } t = H; \\ \frac{1}{2} & \text{for } t = L. \end{cases}$$

Let μ_t^* denote the payoff of a type-t politician in the equilibrium. Further define $\Phi_\theta^t \equiv \{\phi_\theta | \, \mu_t(\theta;\phi_\theta) > \mu_t^*\}$. We then have the following.

Definition 1 *Divinity Criterion: the out-of-equilibrium belief ϕ_θ satisfies:*

$$\widetilde{\rho}_t(\theta) \geq \widetilde{\rho}_{t'}(\theta) \text{ if } \Phi_\theta^{t'} \subset \Phi_\theta^t, \text{ with } t \in \{H, L\} \text{ and } t \neq t'.$$

The application of this criterion to our equilibria leads to the following.

Theorem 8 *Only the most aggressive equilibrium, i.e., the equilibrium with a cutoff $\overline{\theta} = 4(1-q)$, satisfies the Divinity Criterion.*

Proof. See Appendix. ■

The logic behind this result is straightforward. It is driven by the fact that the high-type politician always has a stronger incentive to undertake reform, and prefers to reform as much as possible, as evidenced by Theorem 7. The refinement criterion requires the belief system to reflect this natural notion. None of the equilibria with cutoff $\overline{\theta} > 4(1-q)$ can be supported by such a out-of-equilibrium belief system.

This result paves a foundation for our subsequent analysis on welfare-maximizing institution design.

4 Institution Design

In this section, we explore the optimal institution design that maximizes social welfare. For any equilibrium with a given equilibrium cutoff $\overline{\theta}$, the social welfare in equilibrium can be written as a function

$$W = \alpha \int_{\overline{\theta}}^{\widehat{\theta}} [\theta - 4(1-q)] f(\theta) d\theta + (1-\alpha)\rho^* \int_{\overline{\theta}}^{\widehat{\theta}} (\theta - 2) f(\theta) d\theta. \tag{17}$$

The first term, which is strictly positive, represents the expected net gain from reform undertaken by the high-type politician; while the second term, which is strictly negative, depicts the next loss that results from the inefficient reform undertaken by the low type.

In our analysis so far, we have assumed that the politician in office is maximally empowered and is subject to virtually no institutional constraint except the Accountability Constraint, which prevents the politician from undertaking any reform with a value less than $4(1-q)$). Hereby we consider an alternative context. We assume that there exists a legislative body whose goal is to maximize social welfare, which may include parliaments, senate, or board of directors, etc. The legislative body enforces a limit of authority by restricting the action space of the politician. The rule set by the legislative body can be also understood as organizational bureaucracies discussed by Tirole [28], which restricts the discretion of the decision maker. Institutional restrictions on a decision maker's discretionary actions are prevalent in various organizations. For instance, an office-holding politician usually can only exercise limited discretion. Military commanders have to honor "rule of engagement" when resorting to forces. A bureaucrat in EPA is often handcuffed in terms of regulatory power. An attorney general's ability of legal enforcement is bound to a large extent. Alternatively, a mutual fund manager is subject to various restrictions on investment activities.

In particular, the institution we focus on in this setting resembles a "rule of engagement": the legislative body sets a threshold $\overline{\theta}'$ and a politician is allowed to undertake a reform only if the potential value of his available reform proposal exceeds the cutoff $\overline{\theta}'$. As aforementioned, the assumption of $\widehat{\theta} < 2$ guarantees that the true value of θ can be correctly inferred once the output y of a reform is realized. There are two lines in which we can illustrate the implementation of the rule. First, one may assume that the politician would be held accountable and be subject to severe non-pecuniary punishment, e.g., termination of career, if the rule is breached and a reform with $\theta < \overline{\theta}'$ were attempted. Second, analogous to Tirole [28], one may assume that the politician can form a partially informative report on the realization of θ when he advocates a reform.[6]

The equilibrium refinement we adopt implies that the least conservative equilibrium is always played. An authorization rule that specifies the minimum acceptable threshold $\overline{\theta}'$, therefore, must lead to an equilibrium with a cutoff $\overline{\theta} = \overline{\theta}'$ in the subsequent game. We then explore the optimal authorization rule that maximizes social welfare W. We then analyze the following questions: How does social welfare differ in different equilibria? What is the optimal cutoff that maximizes social welfare?

To start our analysis, suppose a threshold $\overline{\theta}' \in [4(1-q), \widehat{\theta}]$ is enforced. If a reform proposal with a value $\theta \in [\overline{\theta}', \widehat{\theta}]$ is realized, then reform is undertaken with a probability $\alpha + (1-\alpha)\rho^*$, and it generates an ex ante expected output

$$E(y|\,\theta) = \alpha[\theta - 4(1-q)] + (1-\alpha)\rho^*(\theta - 2).$$

The expected output of a proposal with a value $\theta = \overline{\theta}'$

$$E(y|\,\overline{\theta}') = \alpha[\overline{\theta}' - 4(1-q)] + (1-\alpha)\ \rho^*|_{\overline{\theta}=\overline{\theta}'}\,(\overline{\theta}' - 2).$$

It is straightforward to show that $E(y|\,\overline{\theta}')$ strictly increases with $\overline{\theta}'$ because $\overline{\theta}' < \widehat{\theta} < 2$, and $\rho^*|_{\overline{\theta}=\overline{\theta}'}$ strictly decreases with $\overline{\theta}'$. Define define $\underline{\rho} \equiv \lim_{\overline{\theta}\uparrow\widehat{\theta}} \rho^*$. We have the following.

Lemma 2 *Whenever* $\frac{(1-\alpha)\underline{\rho}}{\alpha} < \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$, *there exists a unique* $\widetilde{\theta} \in (4(1-q), \widehat{\theta})$, *which uniquely solves*

$$E(y|\,\widetilde{\theta}) = \alpha[\widetilde{\theta} - 4(1-q)] + (1-\alpha)\ \rho^*|_{\overline{\theta}=\widetilde{\theta}}\,(\widetilde{\theta} - 2) = 0.$$

Proof. See Appendix. ■

Because $E(y|\,\overline{\theta}')$ strictly increases with $\overline{\theta}'$, $\widetilde{\theta}$, if exists, must exhibit the following important property:

$$E(y|\,\overline{\theta}') \gtreqless 0 \text{ if and only if } \overline{\theta}' \gtreqless \widetilde{\theta}. \tag{18}$$

Suppose that $\widetilde{\theta}$ indeed exists and that the legislative body enforces a cutoff $\widetilde{\theta}$, that is, only reform with $\theta \geq \widetilde{\theta}$ is allowed to be implemented. By the property of $\widetilde{\theta}$ demonstrated by (18),

[6] In addition, it should be remarked that the legislative body does not use contigent monetary transfer to elicit desirable action. The performance of a decision maker can be non-contractible in a wide array of settings. Consider the examples of career politicians, supreme court justices, and district attorney, to name a few. (shall we put it here, or move to some other places, or simple throw it into a footnote?)

"bad" reform with negative ex ante expected output is ruled out. Furthermore, any less conservative authorization rule (with $\overline{\theta}' < \widetilde{\theta}$) must admit "bad" reform (because $E(y|\overline{\theta}') < 0$), while any more conservative rule must eliminate "good" reform, which otherwise yields positive expected output. Hence, is $\widetilde{\theta}$ the optimal cutoff $\overline{\theta}^*$ that maximizes social welfare? If not, then is the the optimal institution more conservative or less conservative?

To explore this issue, we now compare the social welfare that could result from equilibria with differing cutoffs $\overline{\theta}$. Taking first order derivative of (17) with respect to $\overline{\theta}$ yields

$$\frac{dW}{d\overline{\theta}} = f(\overline{\theta})\left\{\begin{array}{c} -\alpha[\theta - 4(1-q)] - (1-\alpha)\rho^*(\overline{\theta}-2) \\ +(1-\alpha)\frac{d\rho^*/d\overline{\theta}}{f(\overline{\theta})}\int_{\overline{\theta}}^{\widehat{\theta}}(\theta-2)f(\theta)d\theta \end{array}\right\}. \quad (19)$$

The sign of $dW/d\overline{\theta}$ is indeterminate. However, decomposing $dW(\overline{\theta})/d\overline{\theta}$ allows us to identify the underlying trade-offs when $\overline{\theta}$ varies. A higher threshold $\overline{\theta}$ affects W through three venues. First, it reduces the beneficial reform undertaken by the high type, and therefore decreases the gain from reform by the high-type politician. This loss is given by the term $-\alpha[\theta - 4(1-q)]$, which is obviously negative. Second, a higher cutoff $\overline{\theta}$ (directly) reduces the ex ante inefficient reform undertaken by the low type. This (direct) effect is embodied through the term $-(1-\alpha)\rho^*(\overline{\theta}-2)$, which is unambiguously positive, because $\overline{\theta} < \widehat{\theta} < 2$. Third, it allows the low-type politician to refrain from reforming for any given $\theta \geq \overline{\theta}$, which further reduces the loss from the inefficient reform undertaken. This positive (indirect) effect is depicted by the term $(1-\alpha)\frac{d\rho^*}{d\overline{\theta}}\int_{\overline{\theta}}^{\widehat{\theta}}(\theta-2)f(\theta)d\theta$.

The decomposition of $dW(\overline{\theta})/d\overline{\theta}$ unambiguously points out that $\widetilde{\theta}$ is never the optimum, despite that it leads to only reform with positive expected output. When $\widetilde{\theta}$ is enforced, we see that $dW(\overline{\theta})/d\overline{\theta}$ must remain positive, because the first two terms are equal to zero by the definition of $\widetilde{\theta}$, but the last term, $(1-\alpha)\left.\frac{d\rho^*}{d\overline{\theta}}\right|_{\overline{\theta}=\widetilde{\theta}'}\int_{\widetilde{\theta}}^{\widehat{\theta}}(\theta-2)f(\theta)d\theta$, is positive. Hence, the optimal cutoff $\overline{\theta}^*$ tends to exceed $\widetilde{\theta}$: although such a conservative cutoff would deter productive reform, it would also deter detrimental reform undertaken by the low type by decreasing ρ^*. We then learn that the optimum must require proper "conservatism" towards potential reform.

We then continue to explore the existence and properties of the optimal $\overline{\theta}^*$. Because $f(\overline{\theta}) > 0$ for all $\overline{\theta} \in [-\widehat{\theta}, \widehat{\theta}]$, the sign of (32) is the same as that of $\frac{dW(\overline{\theta})}{d\overline{\theta}} \big/ f(\overline{\theta})$. For our purpose, it suffices to explore $dW(\overline{\theta})/d\overline{\theta} \big/ f(\overline{\theta})$. We then establish the following.

Lemma 3 *The expression $dW(\overline{\theta})/d\overline{\theta} \big/ f(\overline{\theta})$ strictly decreases with $\overline{\theta}$.*

Proof. See Appendix. ■

Lemma 3 allows us to further explore the optimal cutoff $\overline{\theta}^*$.

Theorem 9 *The public prefers no reform, i.e., $\overline{\theta}^* = \widehat{\theta}$, if and only if $\frac{(1-\alpha)\rho}{\alpha} \geq \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$; While a unique socially optimal cutoff $\overline{\theta}^* \in (\widetilde{\theta}, \widehat{\theta})$ exists if and only if $\frac{(1-\alpha)\rho}{\alpha} < \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$.*

Proof. See Appendix. ∎

We examine the condition under which a $\overline{\theta}^* \in (\widetilde{\theta}, \widehat{\theta})$ exists. Because $\underline{\rho}$ decreases with α (by Theorem 2), LHS must strictly decreases with α. Hence, this condition is more likely to be met with a larger α, i.e., a higher proportion of high-talent politicians. When the talent required for successful reform is very scarce, the public may prefer not to allow for any reform, as the gain from efficient reform undertaken by the high type cannot offset the loss from increased inefficient reform.

Similarly, the condition is more likely met with a larger q. That is, reform is socially beneficial only when the high type is sufficiently capable.

These arguments further lead to more general conclusions on the impact of α and q on the properties of $\overline{\theta}^* \in (\widetilde{\theta}, \widehat{\theta})$.

Theorem 10 *The socially optimal cutoff $\overline{\theta}^*$ decreases with α and q.*

Proof. See Appendix. ∎

Example: Uniform Distribution and Perfect Signal

In this subsection, to gain more insights on the optimal institution $\overline{\theta}^*$, we consider an example in which the value of reform follows a uniform distribution

$$F(\theta) = \frac{\widehat{\theta} + \theta}{2\widehat{\theta}}$$

and the high-talent politician receives a perfect signal.

Theorem 5 demonstrates that the equilibrium behaviour depends on the properties of the distribution of θ. We now discuss its impact on $\overline{\theta}^*$ in the case of the uniform distribution. We consider an increase in the upper bound, $\widehat{\theta}$. It implies that the distribution is more dispersed and high-valued reform proposals are more likely. This has two effects. On the one hand, it tends to cause the cutoff $\overline{\theta}^*$ to fall in order to realize the gain from the increased reform opportunities. On the other hand, for any given cutoff, the low type reforms more (see Theorem 5), which increases social loss and tends to lift $\overline{\theta}^*$. The overall effect remains obscure.

To illustrate this trade-off, let us consider the welfare implication of an increasing $\widehat{\theta}$ in an arbitrary equilibrium with a fixed $\overline{\theta}$. Figure 1 testifies to such nonmonotonicity and ambiguity, where θ is assumed to follow a uniform distribution.

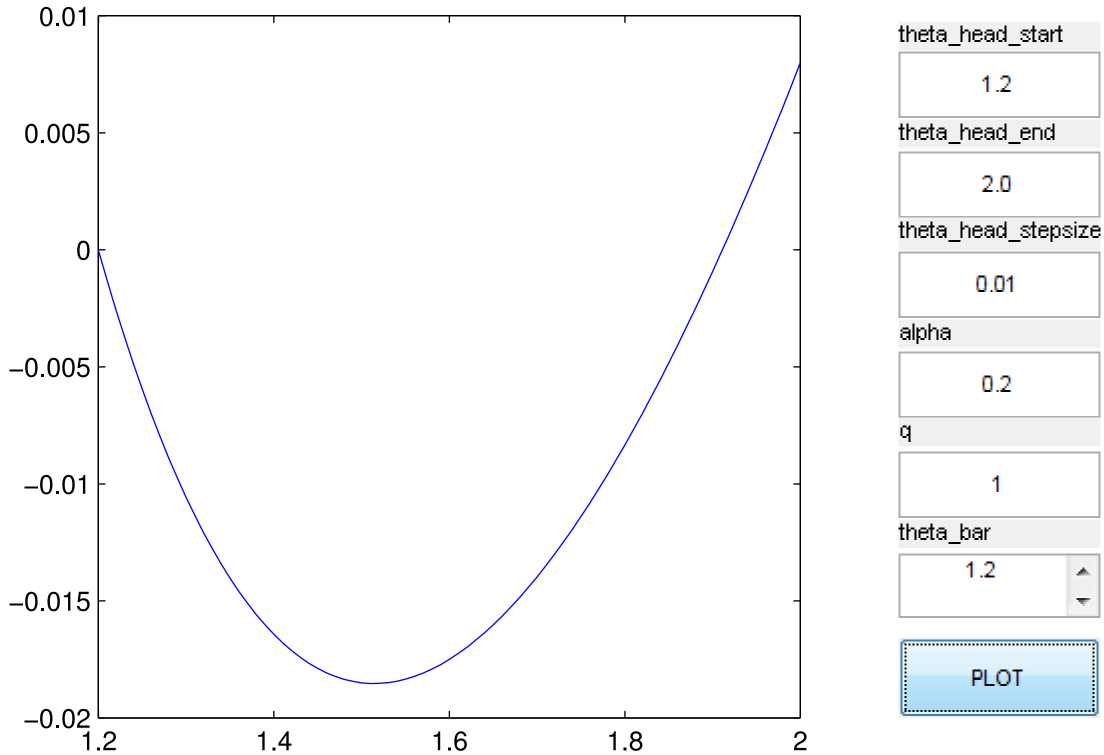

Figure 1: The Nonmonotonic Effect of $\widehat{\theta}$ on Social Welfare

Now we examine how a higher upper support $\widehat{\theta}$ could affect $dW(\overline{\theta})/d\overline{\theta}$ for any given $\overline{\theta}$. When the high-type politician is perfectly informed, any positive θ would imply an efficient reform. In any equilibrium with a given cutoff $\overline{\theta}$, the equilibrium strategy ρ^* is given by

$$\begin{aligned}\rho^* &= \frac{1-\alpha[1+F(\overline{\theta})]}{1-\alpha} \\ &= \frac{2\widehat{\theta}-3\widehat{\theta}\alpha-\alpha\overline{\theta}}{2\widehat{\theta}(1-\alpha)}.\end{aligned} \tag{20}$$

The first-order derivative of the welfare function is as follows

$$\begin{aligned}\frac{dW(\overline{\theta})}{d\overline{\theta}} &= \frac{1}{2\widehat{\theta}}[-\alpha\int_{\overline{\theta}}^{\widehat{\theta}}\theta\cdot\frac{1}{2\widehat{\theta}}d\theta-4\alpha\frac{\overline{\theta}+\widehat{\theta}}{2\widehat{\theta}}-(\overline{\theta}-2)+\alpha\frac{\overline{\theta}+\widehat{\theta}}{2\widehat{\theta}}\cdot\overline{\theta}] \\ &= \frac{1}{8\widehat{\theta}^2}[\underbrace{\frac{3\alpha}{4\hat{\theta}}\bar{\theta}^2-\left(1+\frac{2\alpha}{\hat{\theta}}-\frac{\alpha}{2}\right)\bar{\theta}+\left(2-2\alpha-\frac{\alpha\hat{\theta}}{4}\right)}_{w}]\end{aligned}$$

Because $\frac{1}{2\widehat{\theta}} > 0$, we only need to look at the sign of the term w in the bracket learn the property of $\frac{dW(\overline{\theta})}{d\overline{\theta}}$. It is straightforward to verify in this scenario $\underline{\rho} = \frac{1-2\alpha}{1-\alpha}$. The condition for $\overline{\theta}^* < \widehat{\theta}$, i.e., $\frac{(1-\alpha)\underline{\rho}}{\alpha} < \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$, then boils down to $\alpha > \frac{2-\widehat{\theta}}{4-\widehat{\theta}}$. Assume that this condition is satisfied and a $\overline{\theta}^* < \widehat{\theta}$ exists. Then the optimal cutoff $\overline{\theta}^*$ is determined by the equation

$$W = \frac{3\alpha}{4\hat{\theta}}\bar{\theta}^2 - \left(1 + \frac{2\alpha}{\hat{\theta}} - \frac{\alpha}{2}\right)\bar{\theta} + \left(2 - 2\alpha - \frac{\alpha\hat{\theta}}{4}\right) = 0 \qquad (21)$$

We then obtain the following.

Proposition 1 *The socially optimal cutoff point for reform, $\bar{\theta}^*$ strictly increases with $\hat{\theta}$. The probability of reform, $1 - F(\bar{\theta}^*)$, is strictly increasing in $\hat{\theta}$; so is the overall likelihood of reform $[\alpha + (1-\alpha)\rho]\left[1 - F(\bar{\theta}^*)\right]$.*

Proof. See Appendix. ■

Our comparative static analysis yields unambiguous results. We find that when the uniform distribution of θ is more dispersed, more reform can always be expected, and it unambiguously lifts the optimal cutoff $\overline{\theta}^*$. A less conservative social optimum is then expected.

5 Concluding Remarks

In this paper, we study a politician's incentive to implement reform when his true ability is privately known but he is concerned about the public's perception of his ability. The politician then chooses his action to maximize his reputation payoff. We find that a high-type politician always attempts to reform as much as possible, which "forces" his low-type counterpart to mimic with positive probability. Socially inefficient reform therefore results. We further explore the socially optimal level of empowerment, and we find that both radicalism and conservatism may find their support depending on the specific parameterization.

Our paper sets forth a simple theoretical framework to investigate politician's incentive to undertake innovative but risky action when he has reputation concerns. Our paper leaves open plenty possibilities of extensions and variations. For instance, one may extend the model to allow a larger strategy space, or to allow the payoff of the politician to depend on realized outcome of his policy choice. Although we believe extensions in these directions would not yield predictions that fundamentally depart from those out of the current setting, these more comprehensive settings may still spawn richer comparative statics that further add to our understanding on this issue.

6 Appendix: Proofs

Proof of Lemma 1

Proof. First, observe that $q > 1/2$ implies that $\mu_1(\theta) > \mu_1(\theta - 4)$ as long as $\rho_H(\theta) > 0$ and $\rho_L(\theta) > 0$. But, this implies that $\mu_{1H}(\theta) > \mu_{1L}(\theta)$. Thus, whenever both types choose reform with a positive probability, the high type must choose it with probability one.

Second, we claim that whenever the high type chooses reform with a positive probability, the low type must do so as well. We have shown that whenever both types choose reform with positive probability, the high type's probability of reform is one and therefore at least as high as the low type's. Therefore, the overall probability for the low type to choose the status quo, P_{0L}, is weakly higher than that for the high type, P_{0H}. Thus, if the low type chooses the status quo, his reputation is $\mu_0 = \frac{\alpha P_{0H}}{\alpha P_{0H} + (1-\alpha) P_{0L}} \leq \alpha$.

However, if he deviates and undertakes reform, he is believed to be a high type with probability one if $q < 1$. If $q = 1$, his payoff depends on the public's off-equilibrium belief when reform fails. However, he succeeds with probability $\frac{1}{2}$, and the resulting expected payoff still exceeds α. Therefore, it cannot be that the low type always chooses the status quo when the high type chooses reform. This completes our proof. ■

Proof of Theorem 1

Proof. Consider the equilibrium condition (7). Note that its LHS is μ_0 and its RHS is μ_{1L}. When $\rho = 0$, $\mu_0 \leq \alpha$, while $\mu_{1L} = 1$ as $B = C = 0$. Therefore, $\mu_0 < \mu_{1L}$. By contrast, when $\rho = 1$, $\mu_0 = \alpha$ as $A = 1$, and $\mu_{1L} < \alpha$, which can be seen from the fact that when $\rho = 1$

$$\alpha \mu_{1H} + (1-\alpha)\mu_{1L} = \alpha,$$

while $\mu_{1L} < \mu_{1H}$. Therefore, $\mu_0 > \mu_{1L}$.

Both the RHS and LHS of (7) are continuous in ρ. Furthermore, it is straightforward to show that the LHS strictly increases with ρ, while the RHS strictly decreases with ρ. Hence, we conclude that there must exist a unique $\rho^* \in (0, 1)$ that solves (7). ■

Proof of Theorem 2

Proof. Consider the equilibrium condition (7). We have shown above that the left hand side of (7) is increasing in ρ and the right hand side decreasing in ρ. Note that A, B, and C do not contain α in their expressions. Thus, we may write

$$\frac{\partial (LHS - RHS) \text{ of } (7)}{\partial \alpha} = -\frac{1}{\alpha^2}\left[-\frac{A}{(1+\lambda(\alpha)A)^2} + \frac{1}{2} \cdot \frac{B}{(1+\lambda(\alpha)B)^2} + \frac{1}{2} \cdot \frac{C}{(1+\lambda(\alpha)C)^2}\right].$$

We want to evaluate the above derivative at the value of ρ that satisfies (7). Observe that $0 < B < C$ as $q \geq 3/4$, we may conclude then $B < A < C$ based on (7). From (7), we can also see that $1 - \frac{A}{1+\lambda(\alpha)A} = 1 - [\frac{1}{2} \cdot \frac{B}{1+\lambda(\alpha)B} + \frac{1}{2} \cdot \frac{B}{1+\lambda(\alpha)C}] = 1 - [\frac{1}{2} \cdot \frac{B}{1+\lambda(\alpha)B} + \frac{1}{2} \cdot \frac{B}{1+\lambda(\alpha)C}]$, which yields

$$\frac{A}{1+\lambda(\alpha)A} = \frac{1}{2} \cdot \frac{B}{1+\lambda(\alpha)B} + \frac{1}{2} \cdot \frac{C}{1+\lambda(\alpha)C}.$$

Therefore,

$$\begin{aligned} & \frac{1}{2} \cdot \frac{B}{(1+\lambda(\alpha)B)^2} + \frac{1}{2} \cdot \frac{C}{(1+\lambda(\alpha)C)^2} \\ = \; & \frac{A}{1+\lambda(\alpha)A} \left[\frac{\frac{B}{1+\lambda(\alpha)B}}{\frac{B}{1+\lambda(\alpha)B} + \frac{C}{1+\lambda(\alpha)C}} \cdot \frac{1}{1+\lambda(\alpha)B} + \frac{\frac{C}{1+\lambda(\alpha)C}}{\frac{B}{1+\lambda(\alpha)B} + \frac{C}{1+\lambda(\alpha)C}} \cdot \frac{1}{1+\lambda(\alpha)C} \right]. \end{aligned}$$

The expression in the brackets is a convex combination of $\frac{1}{1+\lambda(\alpha)B}$ and $\frac{1}{1+\lambda(\alpha)C}$. Since $0 < B < C$, the former is larger, but the coefficient on the former is smaller than $\frac{1}{2}$. Using (7), we have

$$\frac{1}{2} \cdot \frac{B}{(1+\lambda(\alpha)B)^2} + \frac{1}{2} \cdot \frac{C}{(1+\lambda(\alpha)C)^2} < \frac{A}{(1+\lambda(\alpha)A)^2}.$$

Hence, at the value of ρ that satisfies (7),

$$\frac{\partial(LHS - RHS) \text{ of } (7)}{\partial\alpha} > 0.$$

Thus, by the implicit function theorem, the probability of reform by the low type, ρ, is decreasing in α, the probability of high type. ■

Proof of Theorem 3

Proof. Recall the equation (12) that defines the equilibrium condition:

$$G(\rho, q) = [1 + (1-\rho)\kappa(\bar{\theta})] - \frac{\rho(\lambda\rho + 1)}{4q(1-q) + \lambda\rho}.$$

Since $q \geq \frac{3}{4}$, $G(\rho, q)$ is decreasing with q. Further,

$$\frac{\partial G(\rho, q)}{\partial \rho} = -\left[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1 - [4q(1-q)]^2]}{[4q(1-q) + \lambda\rho]^2}\right] < 0.$$

We then obtain $\frac{d\rho^*}{dq} = -\frac{\frac{\partial G(\rho^*, q)}{\partial q}}{\frac{\partial G(\rho^*, q)}{\partial \rho^*}} < 0$. ■

Proof of Theorem 4

Proof. Because $\frac{\partial \rho^*}{\partial \alpha} < 0$, we only need to show $\left|(1-\alpha)\frac{\partial \rho^*}{\partial \alpha}\right| + \rho^* > 1$. We have

$$\begin{aligned} & \left|(1-\alpha)\frac{\partial \rho^*}{\partial \alpha}\right| + \rho^* \\ = \;& \frac{(1-\alpha)}{\alpha^2} \frac{\frac{\rho^{*2}[1-[4q(1-q)]}{[4q(1-q)+\lambda(\alpha)\rho^*]^2}}{[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]}{[4q(1-q)+\lambda(\alpha)\rho^*]^2}]} + \rho^* \end{aligned}$$

By the equilibrium, $(1-\rho^*)\kappa = \frac{\rho^*(\lambda(\alpha)\rho^*+1)}{4q(1-q)+\lambda(\alpha)\rho^*} - 1 = \frac{\rho^*(\lambda(\alpha)\rho^*+1)-4q(1-q)-\lambda(\alpha)\rho^*}{4q(1-q)+\lambda(\alpha)\rho^*} = \frac{\lambda(\alpha)\rho^{*2}+\rho^*-\lambda(\alpha)\rho^*-4q(1-q)}{4q(1-q)+\lambda(\alpha)\rho^*}$, which yields

$$\kappa = \frac{\lambda(\alpha)\rho^{*2} + \rho^* - \lambda(\alpha)\rho^* - 4q(1-q)}{[4q(1-q) + \lambda(\alpha)\rho^*](1-\rho^*)}, \tag{22}$$

and therefore

$$\begin{aligned} \kappa(\bar{\theta}) + 1 &= \frac{\lambda(\alpha)\rho^{*2} + \rho^* - \lambda(\alpha)\rho^* - 4q(1-q) + [4q(1-q) + \lambda(\alpha)\rho^*](1-\rho^*)}{[4q(1-q) + \lambda(\alpha)\rho^*](1-\rho^*)} \\ &= \frac{\rho^*[1-4q(1-q)]}{[4q(1-q) + \lambda(\alpha)\rho^*](1-\rho^*)}. \end{aligned} \tag{23}$$

Hence,

$$\begin{aligned} & [\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]}{[4q(1-q)+\lambda(\alpha)\rho^*]^2}] \\ = \;& \frac{\rho[1-4q(1-q)]}{[4q(1-q) + \lambda(\alpha)\rho^*](1-\rho^*)} + \frac{4q(1-q)[1-[4q(1-q)]}{[4q(1-q)+\lambda(\alpha)\rho^*]^2} \\ = \;& \frac{1-4q(1-q)}{[4q(1-q) + \lambda(\alpha)\rho^*]^2(1-\rho^*)}[4q(1-q) + \lambda(\alpha)\rho^{*2}]. \end{aligned} \tag{24}$$

We then obtain

$$\begin{aligned} & \left|(1-\alpha)\frac{\partial \rho^*}{\partial \alpha}\right| + \rho^* \\ = \;& \frac{(1-\alpha)}{\alpha^2} \cdot \frac{\frac{\rho^{*2}[1-[4q(1-q)]}{[4q(1-q)+\lambda(\alpha)\rho^*]^2}}{\frac{1-4q(1-q)}{[4q(1-q)+\lambda(\alpha)\rho^*]^2(1-\rho^*)}[4q(1-q) + \lambda(\alpha)\rho^{*2}]} + \rho^* \\ = \;& \frac{(1-\alpha)}{\alpha^2} \cdot \frac{(1-\rho^*)\rho^{*2}}{[4q(1-q) + \lambda(\alpha)\rho^{*2}]} + \rho^*. \end{aligned} \tag{25}$$

To our purpose, we only need to show $\frac{(1-\alpha)}{\alpha^2} \cdot \frac{\rho^{*2}}{[4q(1-q)+\lambda(\alpha)\rho^{*2}]} > 1$. Rewrite it as $\frac{(1-\alpha)}{\alpha^2} \cdot \frac{\rho^{*2}}{[4q(1-q)+\lambda(\alpha)\rho^{*2}]} = \frac{1}{\alpha} \cdot \frac{\lambda(\alpha)\rho^{*2}}{[4q(1-q)+\lambda(\alpha)\rho^{*2}]} = \frac{1}{\alpha} \cdot \frac{1}{[\frac{4q(1-q)}{\lambda(\alpha)\rho^{*2}}+1]}$. Hence, it suffices to show $\frac{1}{[\frac{4q(1-q)}{\lambda(\alpha)\rho^{*2}}+1]} > \alpha$. We claim $\frac{1}{[\frac{4q(1-q)}{\lambda(\alpha)\rho^{*2}}+1]} > \frac{1}{2} > \alpha$, i.e., $4q(1-q) > \lambda(\alpha)\rho^{*2}$. To show that, recall the equilibrium condition $1 + (1-\rho^*)m] = \frac{\rho^*(\lambda(\alpha)\rho^*+1)}{4q(1-q)+\lambda(\alpha)\rho^*}$, which implies $\frac{\rho^*(\lambda(\alpha)\rho^*+1)}{4q(1-q)+\lambda(\alpha)\rho^*} > 1 \Leftrightarrow \rho^*(\lambda(\alpha)\rho^*+1) > 4q(1-q)+\lambda(\alpha)\rho^* \Leftrightarrow \lambda(\alpha)\rho^{*2}+\rho^* > 4q(1-q)+\lambda(\alpha)\rho^*$. Because $\lambda(\alpha) > 1$, $\lambda(\alpha)\rho^{*2} > 4q(1-q)$ must hold.

Q.E.D ■

Proof of Theorem 5

Proof. Consider the equilibrium condition (7). Since $F(\cdot)$ first order stochastically dominates $G(\cdot)$, we have $F(\overline{\theta}) < G(\overline{\theta})$. This implies that for any given ρ, LHS of (7) for F is lower than that for G, since $\kappa(\overline{\theta})$ is larger for F than for G.

As we have shown above, LHS of (7) strictly increases with ρ, while RHS strictly decreases. Thus, only if $\rho > \rho'$ can (7) hold for both distributions. ■

Proof of Theorem 6

Proof. Recall the equilibrium condition (12). When $\bar{\theta}$ increases, $\kappa(\bar{\theta}) \equiv \frac{1-F(\bar{\theta})}{F(\bar{\theta})}$ must decrease, which causes $G(\rho, \overline{\theta})$ to decrease. Further, as we have shown in the proof for previous results, $G(\rho, \overline{\theta})$ strictly decreases with ρ. By the implicit function theorem, we establish that when $\overline{\theta}$ increases, ρ^* must decrease. ■

Proof of Theorem 7

Proof. First, we claim that when $\bar{\theta}$ increases, $E(u_H)$ and $E(u_L)$ change in opposite directions. Therefore, the first part of the theorem implies the second part. This claim is an implication of the fact $\alpha E(u_H) + (1-\alpha)E(u_L) = \alpha$, or

$$E(u_H) = 1 - \lambda(\alpha)E(u_L).$$

Now, we prove the first part of the theorem. For a low-type politician, $E(u_L) = \mu_0$ because $\mu_0 = \frac{1}{2}\mu_1' + \frac{1}{2}\mu_1''$. Hence, we need only verify $\frac{d\mu_0}{d\overline{\theta}} > 0$. Define

$$H(\rho, \overline{\theta}) = \underbrace{\frac{\alpha}{1 + \frac{(1-\alpha)(1-\rho)[1-F(\overline{\theta})]}{F(\overline{\theta})}}}_{\mu_0} - \frac{1}{2}[\underbrace{\frac{\alpha}{\alpha + (1-\alpha)\frac{\frac{1}{2}\rho}{q}}}_{\mu_1'} + \underbrace{\frac{\alpha}{\alpha + (1-\alpha)\frac{\frac{1}{2}\rho}{1-q}}}_{\mu_1''}].$$

We have

$$\frac{d\mu_0}{d\overline{\theta}} = \frac{\partial\mu_0}{\partial\overline{\theta}} + \frac{\partial\mu_0}{\partial\rho^*} \cdot \frac{\partial\rho^*}{\partial\overline{\theta}} = \frac{\partial\mu_0}{\partial\overline{\theta}} + \frac{\partial\mu_0}{\partial\rho} \cdot [-\frac{\partial H(\rho^*, \overline{\theta})}{\partial\overline{\theta}} \Big/ \frac{\partial H(\rho^*, \overline{\theta})}{\partial\rho}].$$

Because $\frac{\partial H(\rho^*, \overline{\theta})}{\partial\overline{\theta}} = \frac{d\mu_0}{d\overline{\theta}}$, we then have $\frac{d\mu_0}{d\overline{\theta}} = \frac{\partial\mu_0}{\partial\overline{\theta}}[1 - \frac{d\mu_0}{d\rho^*} \Big/ \frac{\partial H(\overline{\theta}, \rho^*)}{\partial\rho}]$. We must have $1 - \frac{d\mu_0}{d\rho^*} \Big/ \frac{\partial H(\overline{\theta}, \rho^*)}{\partial\rho} > 0$ because $\frac{\partial H(\rho^*, \overline{\theta})}{\partial\rho} = \frac{\partial\mu_0}{\partial\rho} - (\frac{\partial\mu_1'}{\partial\rho^*} + \frac{\partial\mu_1''}{\partial\rho})$, while $\frac{\partial\mu_0}{\partial\rho} > 0$, $\frac{\partial\mu_1'}{\partial\rho}$, $\frac{\partial\mu_1''}{\partial\rho} < 0$. ■

Proof of Theorem 8

Proof. Consider an arbitrary equilibrium with a cutoff $\overline{\theta} > 4(1-q)$. Suppose that an unexpected reform is undertaken, and the public observes that the reform has a potential value $\theta \in [4(1-q), \overline{\theta})$. Define $\epsilon \equiv \frac{\alpha \widetilde{\rho}_t(\theta)}{\alpha \widetilde{\rho}_t(\theta)+(1-\alpha)\widetilde{\rho}_l(\theta)}$. Hence, by taking this reform, the high type has an ex ante expected payoff

$$\begin{aligned}\mu_H(\theta;\epsilon) &= q \times \frac{\epsilon q}{\epsilon q + \frac{1}{2}(1-\epsilon)} + (1-q) \times \frac{\epsilon(1-q)}{\epsilon(1-q)+\frac{1}{2}(1-\epsilon)} \\ &= q \times \frac{1}{1+\frac{1}{2\epsilon q}(1-\epsilon)} + (1-q) \times \frac{1}{1+\frac{1}{2\epsilon(1-q)}(1-\epsilon)}. \end{aligned} \tag{26}$$

She has an incentive to deviate if and only if $\pi_H(\theta) - \mu_0 \geq 0$. The low type, by contrast, has an ex ante expected payoff

$$\mu_L(\theta;\epsilon) = \frac{1}{2} \times \frac{1}{1+\frac{1}{2\epsilon q}(1-\epsilon)} + \frac{1}{2} \times \frac{1}{1+\frac{1}{2\epsilon(1-q)}(1-\epsilon)}. \tag{27}$$

She has an incentive to deviate if and only if $\pi_L(\theta) - \mu_0 \geq 0$. Because $\frac{1}{1+\frac{1}{2\epsilon q}(1-\epsilon)} > \frac{1}{1+\frac{1}{2\epsilon(1-q)}(1-\epsilon)}$, we see that $\mu_H(\theta) - \mu_0 > 0$ whenever $\mu_L(\theta) - \mu_0 \geq 0$. It implies that the high type is always more likely to deviate by undertake an expected reform than the low type. The out-of-equilibrium belief must require $\epsilon \geq \alpha$ to reflect this fact.

We now prove $\mu_H(\theta) > \alpha$. Given $\epsilon \geq \alpha$, we only need to show

$$\frac{q^2}{\epsilon q + \frac{1}{2}(1-\epsilon)} + \frac{(1-q)^2}{\epsilon(1-q)+\frac{1}{2}(1-\epsilon)} > 1. \tag{28}$$

Rewrite LHS as $\frac{\epsilon q^2(1-q)+\frac{1}{2}(1-\epsilon)q^2+\epsilon q(1-q)^2+\frac{1}{2}(1-\epsilon)(1-q)^2}{[\epsilon q+\frac{1}{2}(1-\epsilon)][\epsilon(1-q)+\frac{1}{2}(1-\epsilon)]} = \frac{\epsilon q(1-q)+\frac{1}{2}(1-\epsilon)q^2+\frac{1}{2}(1-\epsilon)(1-q)^2}{[\epsilon q+\frac{1}{2}(1-\epsilon)][\epsilon(1-q)+\frac{1}{2}(1-\epsilon)]}$. We then set out to show

$$\begin{aligned} & \epsilon q(1-q) + \frac{1}{2}(1-\epsilon)q^2 + \frac{1}{2}(1-\epsilon)(1-q)^2 \\ \geq \; & \epsilon^2 q(1-q) + \frac{1}{4}(1-\epsilon)^2 + \frac{1}{2}\epsilon(1-\epsilon). \end{aligned} \tag{29}$$

Comparing LHS with RHS yields

$$\begin{aligned} & LHS - RHS \\ = \; & \epsilon(1-\epsilon)q(1-q) + \frac{1}{2}(1-\epsilon)[q^2+(1-q)^2 - \frac{1}{2}(1+\epsilon)] \\ = \; & \frac{1}{2}(1-\epsilon)[2\epsilon q(1-q) + q^2 + (1-q)^2 - \frac{1}{2}(1+\epsilon)] \\ = \; & \frac{1}{2}(1-\epsilon)[q^2+(1-q)^2+2q(1-q) - 2(1-\epsilon)q(1-q) - \frac{1}{2}(1+\epsilon)] \\ = \; & \frac{1}{2}(1-\epsilon)[\frac{1}{2}(1-\epsilon) - 2(1-\epsilon)q(1-q)] \\ = \; & \frac{1}{4}(1-\epsilon)^2[1-4q(1-q)], \end{aligned} \tag{30}$$

which is apparently positive because $4q(1-q) < 4 \times \frac{3}{16} = \frac{3}{4}$.

Given such a belief, the high type must deviate when θ is realized, because his expected payoff $\mu_H(\theta) > \alpha > \mu_0$. ■

6.1 Proof of Lemma 2

Proof. Consider the value of $\alpha[\overline{\theta}' - 4(1-q)] + (1-\alpha)\ \rho^*|_{\overline{\theta}=\overline{\theta}'}\ (\overline{\theta}' - 2)$. When $\overline{\theta}' = 4(1-q)$, it must be negative. When $\overline{\theta}'$ approaches $\widehat{\theta}$, we have its value approach $\alpha[\widehat{\theta} - 4(1-q)] + (1-\alpha)\underline{\rho}(\widehat{\theta} - 2)$, which is positive if and only if $\frac{(1-\alpha)\underline{\rho}}{\alpha} < \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$. Further recall that $E(y|\,\overline{\theta}')$ strictly increases with $\overline{\theta}'$. There must exist a unique $\widetilde{\theta}$ that solves the equation. ■

Proof of Lemma 3

Proof. Recall the equilibrium condition

$$G(\rho^*, m) = [1 + (1-\rho^*)m] - \frac{\rho^*(\lambda\rho^* + 1)}{4q(1-q) + \lambda\rho^*} = 0,$$

where $m \equiv \frac{1-F(\bar{\theta})}{F(\bar{\theta})}$. Hence, we have $\frac{\partial G(\rho^*,m)}{\partial m} = \lambda(1-\rho^*)$. Because $\frac{\partial G(\rho^*,m)}{\partial \rho^*} = -[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho]^2}] < 0$, we must have

$$\frac{d\rho^*}{dm} = \frac{1-\rho^*}{\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}}, \tag{31}$$

and therefore

$$\frac{d\rho^*}{d\bar{\theta}} \diagup f(\bar{\theta}) = -\frac{1-\rho^*}{[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2}. \tag{32}$$

We now claim $-\frac{d\rho^*}{d\bar{\theta}} \diagup f(\bar{\theta})$ strictly decreases with $\bar{\theta}$. We have

$$\frac{d[-\frac{d\rho^*}{d\bar{\theta}} \diagup f(\bar{\theta})]}{d\bar{\theta}} = \frac{\left[\begin{array}{c} -\frac{d\rho^*}{d\bar{\theta}}[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2 \\ -(1-\rho^*)\frac{d\{[\kappa(\bar{\theta})+1+\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2\}}{d\bar{\theta}} \end{array}\right]}{\{[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2\}^2}. \tag{33}$$

Note that $-\frac{d\rho^*}{d\bar{\theta}}[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2 = (1-\rho^*)f(\bar{\theta})$. We then only need to prove $\frac{d\{[\kappa(\bar{\theta})+1+\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2\}}{d\bar{\theta}} > f(\bar{\theta})$. Rewrite $[\kappa(\bar{\theta})+1+\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2$ as $F(\bar{\theta}) + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}[F(\bar{\theta})]^2$. When $\bar{\theta}$ increases, both $\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}$ and $F(\bar{\theta})$ strictly increases. Hence, $\frac{d\{\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}][F(\bar{\theta})]^2\}}{d\bar{\theta}} > 0$. Furthermore, $\frac{dF(\bar{\theta})}{d\bar{\theta}} = f(\bar{\theta})$. We then establish our claim.

Q.E.D. ■

Proof of Theorem 9

Proof. If $\frac{(1-\alpha)\underline{\rho}}{\alpha} \geq \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$, then $\widetilde{\theta}$ does not exist. Any reform with a value $\theta < \widehat{\theta}$ must lead to negative expected output. Hence, no reform is ex ante beneficial, which implies $\overline{\theta}^* = \widehat{\theta}$.

If $\frac{(1-\alpha)\rho}{\alpha} < \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$, then $\widetilde{\theta}$ exists. $\frac{dW(\overline{\theta})}{d\overline{\theta}} \big/ f(\overline{\theta})\Big|_{\overline{\theta}=\widetilde{\theta}} > 0$, but $\frac{dW(\overline{\theta})}{d\overline{\theta}} \big/ f(\overline{\theta})\Big|_{\overline{\theta}=\widehat{\theta}} < 0$ (because $\frac{(1-\alpha)\rho}{\alpha} < \frac{\widehat{\theta}-4(1-q)}{2-\widehat{\theta}}$), then there must exist a unique $\overline{\theta}^* \in (\widetilde{\theta}, \widehat{\theta})$ that solves $\frac{dW(\overline{\theta})}{d\overline{\theta}} \big/ f(\overline{\theta}) = 0$. ■

Proof of Theorem 10

Proof. Suppose that an interior optimum with $\overline{\theta}^* \in (0, \widehat{\theta})$ exists. Define $k \equiv [-\frac{d\rho^*}{d\overline{\theta}} \big/ f(\overline{\theta})]$. Then the optimal condition is

$$\upsilon(\overline{\theta}, \alpha) = \alpha[\overline{\theta} - 4(1-q)] + (1-\alpha)\rho(\overline{\theta})(\overline{\theta} - 2) - (1-\alpha)k \int_{\overline{\theta}}^{\widehat{\theta}} (2 - \overline{\theta}) f(\theta) d\theta = 0. \tag{34}$$

Apparently, $\frac{d\upsilon(\overline{\theta},\alpha)}{d\overline{\theta}} = -\frac{d\frac{\frac{dW(\overline{\theta})}{d\overline{\theta}}}{f(\overline{\theta})}}{d\overline{\theta}} > 0$. We now claim $\frac{d\upsilon(\overline{\theta},\alpha)}{d\alpha} > 0$. Taking first order derivative of $\upsilon(\overline{\theta}, \alpha)$ yields

$$\begin{aligned} \frac{d\upsilon(\overline{\theta}, \alpha)}{d\alpha} &= [\overline{\theta} - 4(1-q)] - \rho^*(\overline{\theta} - 2) + (1-\alpha)\frac{d\rho^*}{d\alpha}(\overline{\theta} - 2) \\ &\quad + k \int_{\overline{\theta}}^{\widehat{\theta}} (2 - \overline{\theta}) f(\theta) d\theta - (1-\alpha)\frac{\partial k}{\partial \alpha} \int_{\overline{\theta}}^{\widehat{\theta}} (2 - \overline{\theta}) f(\theta) d\theta. \end{aligned} \tag{35}$$

It suffices to show k strictly decreases with α and q. Recall by the proofs of previous results:

$$-\frac{d\rho^*}{d\alpha} = \frac{\frac{\rho^{*2}[1-[4q(1-q)]}{[4q(1-q)+\lambda\rho^*]^2}}{[\kappa(\overline{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]} \cdot \left|\frac{d\lambda}{d\alpha}\right|. \tag{36}$$

Note $-\frac{d\frac{d\rho}{d\overline{\theta}}}{d\alpha} = -\frac{d\frac{d\rho}{d\alpha}}{d\overline{\theta}}$. Hence, we now evaluate $-\frac{d\rho^*}{d\alpha}$ with respect to $\overline{\theta}$. We first rearrange it as

$$\begin{aligned} -\frac{d\rho^*}{d\alpha} &= \frac{\frac{\rho^{*2}[1-[4q(1-q)]}{[4q(1-q)+\lambda\rho^*]^2}}{[\kappa(\overline{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]} \cdot \left|\frac{d\lambda}{d\alpha}\right| \\ &= \frac{(1-\rho)}{[\kappa(\overline{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]} \cdot [1 - [4q(1-q)] \\ &\quad \cdot \frac{\rho^{*2}}{1-\rho^*} \cdot \frac{1}{[4q(1-q)+\lambda\rho^*]^2}. \end{aligned} \tag{37}$$

We have established in the proof of Lemma 2 that $\frac{(1-\rho^*)}{[\kappa(\overline{\theta})+1+\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]}$ would strictly decrease with $\overline{\theta}$. So we only need to show $\frac{\rho^{*2}}{1-\rho^*} \cdot \frac{1}{[4q(1-q)+\lambda\rho^*]^2}$ decreases with $\overline{\theta}$ as well. Taking first order derivative of it with respect to $\overline{\theta}$ yields

$$\begin{aligned} &\frac{\rho^*(2-\rho^*)\frac{d\rho^*}{d\overline{\theta}}}{(1-\rho^*)^2} \cdot \frac{1}{[4q(1-q)+\lambda\rho^*]^2} \\ &+ \frac{\rho^{*2}}{1-\rho^*} \cdot \frac{-2\lambda\frac{d\rho^*}{d\overline{\theta}}}{[4q(1-q)+\lambda\rho^*]^3}. \end{aligned} \tag{38}$$

Because $\frac{d\rho}{d\bar{\theta}} < 0$, we need to show $(2-\rho^*)[4q(1-q)+\lambda\rho^*] - 2\lambda\rho^*(1-\rho^*) > 0$, which is obvious because $(2-\rho^*)[4q(1-q)+\lambda\rho^*] - 2\lambda\rho^*(1-\rho^*) = (2-\rho^*)[4q(1-q)+\lambda\rho^*] - \lambda\rho^*(2-2\rho^*)$, and $2-\rho^* > 2-2\rho^*$. We further claim $\overline{\theta}^*$ decreases with q. To show that, we have to prove $\frac{d\upsilon(\overline{\theta},q)}{dq} > 0$. We have

$$\frac{d\upsilon(\overline{\theta},q)}{dq} = 4\alpha + (1-\alpha)\frac{d\rho^*}{dq}(\overline{\theta}-2) - (1-\alpha)\frac{dk}{dq}\int_{\overline{\theta}}^{\widehat{\theta}}(2-\overline{\theta})f(\theta)d\theta. \tag{39}$$

It would suffice to show $\frac{dk}{dq} < 0$. We use the same technique as above. We have

$$-\frac{d\rho^*}{dq} = \frac{\frac{4(2q-1)\rho^*(\lambda\rho^*+1)}{[4q(1-q)+\lambda\rho^*]^2}}{[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]}. \tag{40}$$

We then claim $-\frac{\partial^2\rho}{\partial q\partial\overline{\theta}} < 0$. Rewrite $-\frac{d\rho}{dq}$ as

$$-\frac{d\rho^*}{dq} = \frac{1-\rho^*}{[\kappa(\bar{\theta}) + 1 + \frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]} \cdot \frac{1}{1-\rho^*} \cdot \frac{4(2q-1)\rho^*(\lambda\rho^*+1)}{[4q(1-q)+\lambda\rho^*]^2}. \tag{41}$$

Because $\frac{1-\rho^*}{[\kappa(\bar{\theta})+1+\frac{4q(1-q)[1-[4q(1-q)]^2]}{[4q(1-q)+\lambda\rho^*]^2}]}$ and $\frac{1}{1-\rho^*}$ decreases with $\overline{\theta}$, we only need to show $\frac{\rho^*(\lambda\rho^*+1)}{[4q(1-q)+\lambda\rho^*]^2}$ decreases with $\overline{\theta}$. Taking first order derivative of it with respect to $\overline{\theta}$ yields

$$\begin{aligned}
\frac{d\frac{\rho^*(\lambda\rho^*+1)}{[4q(1-q)+\lambda\rho^*]^2}}{d\overline{\theta}} &= \frac{\left[\begin{array}{c} (2\lambda\rho^*+1)\frac{d\rho^*}{d\overline{\theta}}[4q(1-q)+\lambda\rho^*]^2(1-\rho^*) \\ -2\rho^*(\lambda\rho^*+1)(1-\rho^*)[4q(1-q)+\lambda\rho^*]\lambda\frac{d\rho^*}{d\overline{\theta}} \\ +\rho^*(\lambda\rho^*+1)[4q(1-q)+\lambda\rho^*]^2\frac{d\rho^*}{d\overline{\theta}} \end{array}\right]}{(1-\rho^*)^2[4q(1-q)+\lambda\rho^*]^4} \\
&= \frac{\frac{d\rho^*}{d\overline{\theta}}}{[4q(1-q)+\lambda\rho^*]^3} \\
&\quad \times \left[\begin{array}{c} (2\lambda\rho^*+1)[4q(1-q)+\lambda\rho^*](1-\rho^*) - 2\lambda\rho^*(\lambda\rho^*+1)(1-\rho^*) \\ +\rho^*(\lambda\rho^*+1)[4q(1-q)+\lambda\rho^*] \end{array}\right]
\end{aligned} \tag{42}$$

The item in bracket is definitely positive because

$$\begin{aligned}
&\left[\begin{array}{c} (2\lambda\rho^*+1)[4q(1-q)+\lambda\rho^*](1-\rho^*) - 2\lambda\rho^*(\lambda\rho^*+1)(1-\rho^*) \\ +\rho^*(\lambda\rho^*+1)[4q(1-q)+\lambda\rho^*] \end{array}\right] \\
> \ & \lambda\rho^*\left[\begin{array}{c} (2\lambda\rho^*+1)(1-\rho^*) - 2(\lambda\rho^*+1)(1-\rho^*) \\ +\rho^*(\lambda\rho^*+1) \end{array}\right] \\
= \ & \lambda\rho^*[-\rho^* + \rho^*(\lambda\rho^*+1)] > 0.
\end{aligned} \tag{43}$$

Q.E.D. ■

Proof of Proposition 1

Proof. We prove the first part by the implicit function theorem. It suffices to show

$$\frac{\partial w}{\partial \hat{\theta}} = -\frac{3\alpha\bar{\theta}^2}{4\hat{\theta}^2} + \frac{2\alpha\bar{\theta}}{\hat{\theta}^2} - \frac{\alpha}{4} > 0,$$

which is equivalent to

$$\frac{4-\sqrt{16-3\hat{\theta}^2}}{3} < \bar{\theta}^* < \frac{4+\sqrt{16-3\hat{\theta}^2}}{3}.$$

Since $\hat{\theta} \leq 2$, the right boundary is greater than or equal to $\hat{\theta}$. So, we just need to check the first half of the inequality. By Part 1, $\bar{\theta}^*$ is decreasing in α. Therefore, it is sufficient to check the condition for $\alpha = 1/2$. Solving the first order condition, we obtain $\bar{\theta}^* = \left(3\hat{\theta} + 4 - \sqrt{12\hat{\theta}^2 + 16}\right)/3$, which indeed satisfies the above inequality as $\hat{\theta} \leq 2$. This concludes the proof of Part 2.

Let $p \equiv F(\bar{\theta}) = 1/2 + \bar{\theta}/2\hat{\theta}$. We may rewrite the first order condition into

$$v(p) = 3p^2\hat{\theta}\alpha + 2p\hat{\theta}\left(-1-\alpha-\frac{2\alpha}{\hat{\theta}}\right) + 2\left(\frac{1}{2}+\frac{1}{\hat{\theta}}\right)\hat{\theta}.$$

We have

$$\frac{\partial v}{\partial p} = 6p\hat{\theta}\alpha + 2\hat{\theta}\left(-1-\alpha-\frac{2\alpha}{\hat{\theta}}\right) \leq (4\alpha-2)\,\hat{\theta} - 4\alpha < 0,$$

as $p \leq 1$ and $\alpha \leq 1/2$. Note that when we keep p fixed and vary $\hat{\theta}$, $\bar{\theta}$ has to be adjusted. Thus, the derivative of v with respect to $\hat{\theta}$ is different from that of w. Observe that

$$\frac{\partial v}{\partial \hat{\theta}} = \left[\frac{3\alpha}{4}(2p-1) - 1 + \frac{\alpha}{2}\right](2p-1) - \frac{\alpha}{4} \leq \left[\frac{3\alpha}{2} - \frac{\alpha}{4} - 1\right](2p-1) - \frac{\alpha}{4} < 0,$$

as $1/2 \leq p \leq 1$ and $\alpha \leq 1/2$. Hence, $F(\bar{\theta}^*)$ is decreasing in $\hat{\theta}$. Therefore, the probability of reform, $1 - F(\bar{\theta}^*)$ is increasing in $\hat{\theta}$. It is straightforward to see that the total probability of reform, $[\alpha + (1-\alpha)\rho]\left[1 - F(\bar{\theta}^*)\right]$, also increases with $\hat{\theta}$ as ρ increases when $F(\bar{\theta}^*)$ decreases.

Q.E.D. ■

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