Political uncertainty and policy innovation

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by

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Abstract

This paper provides an analysis of the interaction between policy experimentation and political incentives. In particular we ask: how well does a political system with elections work in separating selfish from benevolent politicians and providing innovative policies? and, how does the interaction between the democratic system and the incentives to innovate change as the information context becomes richer? Two contrasting forces in shaping political outcomes are identified. On the one hand the availability of external information improves the working of the political system but on the other hand it reduces the incentives to innovate. It is shown that, contrary to conventional wisdom, an increase in external information may reduce welfare.

Keywords: Policy uncertainty; Political uncertainty; Fiscal federalism; Policy innovation; Experimentation.
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1 Introduction

A commonly held view is that fiscal federalism promotes innovative public programs, speeds up the process of policy experimentation and its diffusion. This view is rooted in the argument that the division of the economy into a number of independent local authorities gives them the opportunity to independently experiment with new policies.[1] However satisfactory this argument is it neglects the political economy dimension of the process of policy experimentation. As emphasised also by Besley (2000) whether or not innovative policies are indeed carried out depends to a large extent on the incentives faced by politicians.[2]

In spite of the vast and growing political economy literature the interactions between experimentation and political incentives have been surprisingly neglected. It is the objective of this paper to provide a first step towards an analysis of these interactions. The starting point is the observation that innovative policies might be a natural vehicle for selfish politicians to appropriate rents without being detected, and consequently punished, in the elections. By the very nature of an experiment, one does not know in advance whether the experimenting policy is indeed better than an alternative and well known policy. Moreover, it is reasonable to assume that, after having experimented, politicians have superior information about the quality of the policy than the citizens. This advantage in information can be exploited by a rent-seeking politician. When faced with an unsatisfactory outcome voters do not know whether the experiment has been unsuccessful or whether the experiment was successful but the politician has diverted some of the benefits to herself. This ignorance gives the opportunity to selfish politicians to mimick a benevolent but unlucky politician.

Such behaviour would be prevented, or to a large extent mitigated, if voters had access to additional external information they could use in order to evaluate the observed outcome. In the context of federalism this information can naturally be thought of as coming from a neighboring jurisdiction. Voters may exploit the information gathered from jurisdictions with the similar characteristics in order to evaluate the performance of their own politicians. If, for instance, the same policy experiment has been carried out elsewhere then voters could infer the type of their politician by simply comparing the outcomes realised in their own jurisdiction to those realised in those other jurisdictions.[3] Although the present paper is motivated by the fiscal federalism literature the analysis can equally well be applied more widely. This is because, in general, any source of external information will have similar consequences on political competition and experimentation. As an example consider the arrival of the internet which undoubtedly

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[1]See, for instance, Oates (1999), Inman and Rubinfeld (1997), and Kollman et al. (1999).

[2]This view is shared by many political commentators too. In a commentary, for example, J. Podhoretz notes, '...although he is not a bold politician, Bush is an innovator. On all these issues [education, social security and medicare] he has fresh proposals that derive from state and local politics – from **experiments** by the Republican governors like himself who have come to dominate the 50 state capitals.' The Times, October 13, 2000. Commentary: 'Gore has made his bed, but nobody wants to lie in it.' Bold face emphasis added.

[3]This is consistent with the agency theory which argues that the incentives for agents in correlated environments should be based on their relative performance, Holmström (1982). Besley and Case (1995) provide evidence for relative performance evaluation of politicians in the U.S.

has facilitated access to external information. As explored by Besley and Burgess (2001) and Strömberg (2000) the information provided by the media may play an important role in enhancing political competition by increasing the scrutiny of policies.

External information at the same time creates an externality which affects the incentives to experiment. If the politicians expect to be informed about the quality of the innovative policy they might be reluctant to incur the cost associated with the experimented policy.[4] Thus, the presence of external information creates a tension between the working of the political system and the extent of innovation.

This paper presents a model that investigates the interaction between the democratic system and the incentives to innovate. Specifically, we ask: (a) How well does a politico-economic system with elections work in separating selfish from benevolent politicians and providing innovative policies in equilibrium? and, (b) How does the interaction between the democratic system and the incentives to innovate change as the external information is enhanced?

The model features two types of politicians, a selfish and a benevolent one, who decide whether to innovate or to continue using an old policy and whether to divert rents to themselves. The use of the innovative policy provides the selfish politician with the opportunity to appropriate rents without being detected but it also provides useful information for the future. External information regarding the new policy becomes available and shapes voters' election decision affecting at the same time the incentives to innovate. Since each type of politician may choose the new or the old policy there are four possible equilibrium configurations. We provide conditions under which each of these equilibria exists. Also we investigate how the equilibria behave as more external information becomes available. Finally, we look at voters' welfare. Surprisingly, we show that an increase in external information may reduce welfare. This is because the selfish politician is detected more often and so reacts by behaving more aggressively experimenting at the same time less frequently. On balance this cost is greater than the benefit from detecting the selfish politician.

The model combines features from the models presented in Besley and Case (1995), and Coate and Morris (1995). In addition to Coate and Morris (1995) we incorporate learning externalities. Recent multi-jurisdiction extensions of Coate and Morris (1995) are Besley and Smart (2001), Belleflamme and Hindriks (2001), and Hindriks and Makris (2001). Besley and Smart (2001) analyse the impact of enhanced tax competition on the political equilibrium. Belleflamme and Hindriks (2001) analyse the impact of inter-jurisdictional comparisons on the political system whereas Hindriks and Makris (2001) focus on fiscal competition as a device to tame selfish politicians. Contrary to all these contributions we focus on the incentives of the politicians to experiment.

The paper is organised as follows. Section 2 describes the model. Section 3 analyses the second period choices while section 4 describes the citizen's beliefs. Section 5 analyses the equilibria of the model and presents the comparative statics results. Section 6 provides results on welfare. Finally, Section 7 concludes.

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[4]Walker (1969) offers an early study of innovation and diffusion of innovation between the U.S. states emphasising the importance of learning externalities. Strumpf (2000) identifies conditions under which, due to this type of externality, a decentralised system induces too little experimentation.

2 Description of the model

We consider a dynamic two period model which incorporates signaling.[5] In both periods politicians decide whether to introduce a *new* and *innovative* public policy, denoted by n, or to continue using an *old* public policy denoted by o. The quality of the policy is denoted by q. The return of the innovative policy is probabilistic; with probability[6] θ its quality[7] is high q_h, and with complementary probability $1 - \theta$ low, q_l. The quality of the old policy is q_o with certainty. It is assumed that the new policy could be superior or inferior to the old policy, that is $q_h > q_o > q_l$.[8] After having chosen policy in each period the politician can make transfers to herself denoted by τ.

A single representative citizen derives utility $u = q - \tau$ from public policy. The only decision the citizen makes in this framework is whether to reelect the incumbent at the end of the first period. Voting therefore is retrospective.

In each period the politician must decide which policy to implement and what transfers to divert towards herself. There are two types of politicians, 'good', $i = g$, and 'bad', $i = b$. The good politician derives utility only from the utility of the voters and so maximises the difference between quality and transfers that is, $q - \tau$. The bad type places no weight on the utility of the voters. Consequently she is only interested in transfers τ. If the incumbent is not reelected in the second period her utility is zero. Second period utility for both types is discounted by $\delta \in (0, 1)$. The choice of transfers is discrete in the following sense.[9] If the quality of the project is q_h then the politicians can appropriate one of the transfers $\tau \in \{q_h, q_h - q_l, 0\}$. If the quality is q_l they can appropriate transfers $\tau \in \{q_l, 0\}$ whereas if the old policy is chosen $\tau \in \{q_o, 0\}$.

There are two kinds of uncertainty; policy and political. Policy uncertainty refers to the quality of the new policy. Ex ante neither the politicians nor voters know whether this quality is q_h or q_l. The quality will be only found out by the politicians if they choose the new policy. After each policy choice and after the politicians have decided on transfers external information regarding the true quality of the new policy may become available to both voters and politicians. This information is denoted by $y = q_h, q_l, \emptyset$, where $y = q_h$ ($y = q_l$) means that citizens and politicians are informed that the quality is high (low). Conditional on the quality being high (low) this occurs with probability π. With complementary probability $1 - \pi$ no such information becomes available. This is denoted by $y = \emptyset$. If the incumbent is defeated in the election the successor has access to the same information. It is so clear that in the second period politicians are

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[5]It has to be noted though that this is not a typical signaling model because the relationship between the 'sender' and the 'receiver' is blurred by the policy uncertainty and external information. Standard equilibrium refinements in this context, hence, do not work in this context. See also the discussion in Coate and Morris (1995).

[6]All probabilities are restricted to be between 0 and 1.

[7]Policies are costly and, without loss of generality, their cost has been suppressed.

[8]If this did not hold the issue of experimentation, at the heart of this paper, would not be present.

[9]This specification is innocuous and imposed merely for simplicity. Even with continuous transfers the structure of the model together with the beliefs specified below would imply the discrete choice of transfers assumed here. An earlier version of this paper verifies this.

informed about the quality of the new policy if they have experimented with it or they have obtained external information.

Political uncertainty refers to the type of the politicians. The citizens do not know the type of the politicians and attribute an equal prior probability[10] λ to the incumbent being of either type. Therefore they have to infer it from the signals they observe. Citizens observe the record $r(p, u)$ consisting of the policy p and utility $u = q - \tau$, and external information y. They then form beliefs about the type that has produced this record taking into account external information. The belief $\mu(r(p, u), y)$ is the posterior probability that the incumbent is of the good type given record $r(p, u)$ and information y.

In the election at the end of the first period citizens either vote for the incumbent or for the challenger. The challenger is of the good type with probability λ_c. λ_c is called reputation and drawn from a uniform cumulative distribution function G with the property $G(1) = 1$ and $G(0) = 0$. Therefore the expected probability that the challenger is good is $E_G(\lambda_c) = \lambda$. Each type of challenger has the same preferences as the corresponding type of incumbent. At this stage citizens have all the information to vote for the incumbent: They observe a record, update their beliefs regarding the type who generated this record, and compare this probability to the probability that the challenger is of a certain type.

This model defines a signaling game between the incumbent, challenger, and voters. At the beginning of the game Nature chooses the type of the incumbent $i \in \{b, g\}$. A strategy for the incumbent has three components. The first is a rule that specifies a policy decision for each type the incumbent might be. The second component is a rule that specifies a transfer decision in the first period for each policy decision. The third is a rule that specifies the policy choice and transfer decision should the incumbent be elected. Formally, $\sigma_p(p|i)$ gives the probability with which type $i = b, g$ chooses policy $p = n, o$, and $\sigma_\tau(\tau|p, q, i)$ denotes the probability that type i chooses a transfer τ after policy p given that the quality of the policy is q. A strategy for the challenger is simply a rule that specifies the policy and transfer choices should she be elected. A strategy for the citizen is a rule that specifies for which record, external information, and reputation of the challenger she reelects the incumbent.

A perfect Bayesian equilibrium of this game consists of a strategy for each type of the incumbent, a strategy for each type of the challenger and a strategy as well as beliefs for the voters, with the following properties. First, both types of incumbent, both types of challenger, and the citizen choose optimal strategies at all information sets where they are called upon to decide, given the strategies and beliefs of the other players. The second requirement for equilibrium is that the citizens' beliefs are consistent with the incumbent's strategy in the sense that they are generated, whenever possible, by Bayes' updating. We solve for the equilibrium of the game by means of backwards induction.

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[10]The analysis does not attempt to explore all dimensions of the parameter space of the model. This simplification allows us to focus on the main issue which is the interaction of policy uncertainty with external information.

3 Second period choices and the election

In this Section we analyse the politician's choices in the second period after the first period election. Since the challenger has the same preferences as the incumbent of the (same) type who is voted out the choice of the politician in the second period depends solely on her type. In the second period politicians have no reelection motives anymore and thus take the decision which provides them with the highest short run benefit. If the politician is of type bad and the quality of the policy is q_h, q_l then she takes transfers $\tau = q_h, q_l$ with utility q_h, q_l, respectively. If, on the other hand, the old policy was chosen she takes $\tau = q_o$ with utility q_o. It then follows that the bad politician always chooses the unrestricted transfers. Clearly the good politician does not take transfers.

While the good and the bad politician have opposed preferences regarding the choice of transfers they both want to choose the policy with the highest quality. This choice depends on whether the quality of the new policy is known. Both types opt for the new policy whenever the quality is known to be high, following on $q_h > q_o$, and the old whenever the new policy is known to be of low quality, following on $q_l < q_o$.

The availability of information regarding the quality of the new policy depends on the policy choice of the first period. Experimentation of the new policy makes the politician fully informed of the policy's quality. If the old policy was chosen, in the second period the elected politician could benefit from externalities that take the form of costless information provided by other localities. With probability $\theta\pi$ such information regarding q_h becomes available. With probability $(1 - \theta)\pi$ information regarding q_l becomes also available to the politician. In these events the policy choice is clear; the new policy is optimal in the former, and the old policy is optimal in the latter. With probability $1 - \pi$ such information is unavailable and so the politician must evaluate the expected utility of the new policy and compare it to the benefit of the old policy q_o. It then follows that an uninformed politician chooses in period two the new (old) policy iff $\theta q_h + (1 - \theta)q_l \geqslant (<) q_o$.[11] This consideration implies that the expected discounted second period payoff of both types is

$$\delta[\theta\pi q_h + (1 - \theta)\pi q_o + (1 - \pi)\max\{\theta q_h + (1 - \theta)q_l; q_o\}] . \tag{1}$$

Rent seeking behaviour on the part of the politicians is undesirable for the voters and therefore they will elect the candidate who has the highest probability of being the good type. Their choice reduces to a comparison of the belief regarding the type of the incumbent to the reputation of the challenger that is, voters reelect the incumbent if and only if $\mu(r(p, b), y) \geq \lambda_c$. The probability of this happening is $G(\mu(r(p, b), y))$. Because G is uniform the probability of the incumbent being reelected is just the belief $\mu(r(p, b), y)$.

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[11]In order to avoid tedious case distinctions we adopt the following tie-breaking rule. Whenever a politician is indifferent between both policies she opts for the new one whereas the bad politician in case of indifference in transfer choices opts for the maximal transfers.

4   Beliefs

The beliefs in equilibrium must be, whenever possible, computed, for any first period combination of a record and external information that arises with positive probability, from the incumbent's strategy via Bayes's rule. That is,

$$\mu(r(p,u),y) = \frac{\Pr\{g, r(p,u), y\}}{\sum_{j \in \{b,g\}} \Pr\{j, r(p,u), y\}} \ , \tag{2}$$

where $\Pr\{j, r(p,u), y\}$ denotes the probability that the incumbent is of type j, record r was produced and external information y became available to the electorate.

Given the complex interactions of policy uncertainty with the learning and informational externalities, there is no property that can pin down the citizen's beliefs out of equilibrium in any general way. Instead we base the beliefs on the following intuitive reasoning.[12] Voters use all information available to them to infer the type of the politicians and vote out the bad incumbent. Whenever voters can be sure that there were no transfers, they believe it's the good type. Similarly, whenever the citizens can figure out that a transfer was taken, they infer it is the bad type. This reasoning gives rise to the beliefs collected in Table 1.

		p				
		n			o	
		$u = 0$	$u = q_l$	$u = q_h$	$u = 0$	$u = q_o$
	q_l	0	1	–	0	1
y	q_h	0	0	1	0	1
	$\emptyset$	0	?	1	0	1

Table 1: Beliefs.

The table maps, where applicable, the record r, consisting of the policy choice p and the realised outcome u, together with the information parameter y into the belief μ. To give an example, consider the belief $\mu(r(n, q_l), q_h)$. This belief can be found by looking up the column corresponding to the record $r(n, q_l)$ and the row for $y = q_h$; that is, $\mu(r(n, q_l), q_h) = 0$. The justification for this belief is that external information reveals to voters that transfers have been taken and thus allows them to infer the type of the politician. Whenever the benefit outcome is $u = 0$, the table states that the induced belief is $\mu(r(p, 0), y) = 0$. This is because voters observe an outcome which cannot arise from honest policy decision making and so they infer that the incumbent is of the bad type. Similarly, if voters observe a benefit outcome q_h or q_o, they infer that they face a good type because there is no better outcome which could be realised, independently of external information.

Table 1 does not specify the belief $\mu(r(n, q_l), \emptyset)$ for the following reason. Voters cannot infer the type of the politician with certainty when the record observed consists of policy

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[12]This reasoning is in line with the monotonicity assumption in Coate and Morris (1995). See also footnote 5.

n and benefit q_l. For in this case this information set can be reached from two different paths. Firstly, the politician might have been of type good that has chosen the new policy, taken no transfers, but Nature drew the bad outcome q_l, or secondly, she might have been the bad type that has chosen the new policy and has taken transfers equivalent to $q_h - q_l$, which amounts to producing the outcome q_l.

The equilibria analysed in the following Section are distinguished by the value taken on by this belief. Depending on whether voters are uninformed or not about what happened in this situation, we have an equilibrium where the two types are undistinguishable (pooling equilibrium) or distinguishable (separating equilibrium).

5   Analysis of equilibrium

Let (g, b) denote the equilibrium choice of the good and bad incumbent. Then, regarding the policy choice only, the set of possible equilibria is $\{(n, n), (n, o), (o, o), (o, n)\}$. To bring out the different incentives of politicians to experiment, in what follows, we provide a characterisation of this set of equilibria.

5.1   Pooling on new policy (n, n)

We start the analysis postulating an equilibrium in which both politicians choose the new policy and the bad politician always takes transfers. Formally the strategies of the politicians are

$$\sigma_p^*(n|i) \;=\; 1, \quad i = g, b, \tag{3}$$

$$\sigma_\tau^*(0|p, q, g) \;=\; 1, \quad p = n, o, \quad q = q_h, q_o, q_l, \tag{4}$$

$$\sigma_\tau^*(q_h - q_l|n, q_h, b) \;=\; 1, \tag{5}$$

$$\sigma_\tau^*(q_l|n, q_l, b) \;=\; 1, \tag{6}$$

$$\sigma_\tau^*(q_o|o, q_o, b) \;=\; 1. \tag{7}$$

Briefly, the equalities in (3) say that both types of politicians choose the new policy with probability one. The other equalities describe the transfer choices. (4) says that the good politician will take zero transfers with probability one. The remaining strategies refer to the bad politician. In particular, following (5), if nature has drawn quality q_h then she takes transfers $\tau = q_h - q_l$. In the case where nature has drawn q_l she takes, following (6), the maximal transfers. Finally, (7) says that if she chooses the old policy then she also takes maximal transfers.

This equilibrium is supported by the beliefs of Table 1 and[13]

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[13]The belief in (8) is derived by calculating the probabilities

$$
\begin{aligned}
\Pr\{g, r(n, q_l), \emptyset\} \;&=\; \lambda \sigma_p^*(n|g) \left[\theta \sigma_\tau^*(q_h - q_l|q_h, g)(1 - \pi) + (1 - \theta)\sigma_\tau^*(0|q_l, g)(1 - \pi)\right], \\
&=\; \lambda(1 - \theta)(1 - \pi), \quad \text{and} \\
\Pr\{b, r(n, q_l), \emptyset\} \;&=\; (1 - \lambda)\sigma_p^*(n|b) \left[\theta \sigma_\tau^*(q_h - q_l|q_h, b)(1 - \pi) + (1 - \theta)\sigma_\tau^*(0|q_l, b)(1 - \pi)\right], \\
&=\; (1 - \lambda)(1 - \pi)\theta,
\end{aligned}
$$

$$\mu(r(n, q_l), \emptyset) = 1 - \theta \ . \tag{8}$$

In this equilibrium when voters observe the outcome q_l without any external information they cannot perfectly infer the type of the incumbent. For this outcome may have been generated by the good politician who drew the low quality outcome or by the bad politician who realised the good outcome but appropriated transfers. Since priors are the same for both types voters assess the probability of the incumbent being of good type according to the probability of the low quality outcome.

We derive now, in a series of Lemmas,[14] the optimal transfer policies and policy strategies, conditional on the beliefs specified above, of the bad politician.

Lemma 1 *With the quality of the new policy being q_h the bad politician appropriates transfers $\tau^*(q_h) = q_h - q_l$ iff*

$$\delta > \delta_h(\theta, \pi) \stackrel{\text{def}}{=} \frac{q_l}{(1 - \theta)(1 - \pi)q_h} \ . \tag{9}$$

Lemma 2 *With the quality of the new policy being q_l the bad politician appropriates transfers $\tau^*(q_l) = q_l$ iff*

$$\delta \leq \delta_l(\theta, \pi) \stackrel{\text{def}}{=} \frac{q_l}{[1 - \theta(1 - \pi)]q_o} \ . \tag{10}$$

Recall from Section 3 that in the case in which the old policy has been chosen in the first period and therefore the politician has not experimented with the new policy what matters, following (1), is her expectation regarding the quality of the new policy.

Lemma 3 *With the old policy being chosen in the first period the bad politician appropriates transfers $\tau^*(q_o) = q_o$ iff*

$$\delta \leq \delta_o(\theta, \pi) \stackrel{\text{def}}{=} \frac{q_o}{\theta\pi q_h + (1 - \theta)\pi q_o + (1 - \pi)\max\{\theta q_h + (1 - \theta)q_l; q_o\}} \ . \tag{11}$$

Moving backwards we now verify that, given the optimal transfers, the policy strategies in (3) are optimal.

Lemma 4 *Anticipating the optimal transfer choices of Lemmas 1 to 3, the bad politician chooses the new policy iff*

$$\delta \geq \delta_b(\theta, \pi) \stackrel{\text{def}}{=} \frac{\theta(2q_l - q_h) + (q_o - q_l)}{\theta(1 - \pi)(1 - \theta)q_h} \ . \tag{12}$$

We now turn to the good politician. The incentives of this politician depend on how the expected quality of the new policy compares to the quality of the old policy.

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and inserting them into Bayes' formula using $\lambda = 1 - \lambda$.

[14]All proofs have been relegated to the Appendix.

Lemma 5 *If $\theta \geq (q_o - q_l)/(q_h - q_l)$ and if $q_h - q_l > q_0$, the good politician chooses the new rather than the old policy for all δ and π with $0 \leq \delta, \pi \leq 1$.*

Lemma 6 *If $\theta < (q_o - q_l)/(q_h - q_l)$ and $q_h \geq 2q_o$, the good politician chooses the new rather than the old policy iff*

$$\delta \geq \delta_g(\theta, \pi) \stackrel{\text{def}}{=} \frac{\theta q_h + (1 - \theta)q_l - q_o}{\theta(1 - \pi)[q_o(2 - \theta) - q_h]} . \tag{13}$$

The focus of the analysis is on the incentives of the politicians to experiment with the new policy. For this reason Lemma 6 is particularly interesting. After all the essence of experimentation is to choose the new policy even though its expected quality falls short of the quality of the well known policy. Therefore, we want to ensure that Lemma 6 is applicable. This is achieved by restricting attention to a policy innovation with a technology that satisfies $q_h = 2q_o$.[15] The added benefit from doing so is that the exposition is simplified by avoiding cumbersome case distinctions. Given this restriction it seems natural to place a similar restriction on q_l, q_o. These two restrictions seem perfectly reasonable. They simply imply that replacing the old by the new policy either doubles the value of the policy or halves it that is, $q_h/q_o = q_o/q_l = 2$.

In the following proposition we characterise the space of parameters δ, θ, for various π, for which a pooling equilibrium on the new policy exists. This characterisation makes use of the Lemmas 1 to 6. These Lemmas give lower or upper bounds on the discount factor δ for given θ and π. Now define the binding lower and upper bounds on δ as

$$\underline{\delta}(\theta, \pi) \stackrel{\text{def}}{=} \max\{\delta_g(\theta, \pi), \delta_b(\theta, \pi), \delta_h(\theta, \pi)\}, \tag{14}$$

$$\overline{\delta}(\theta, \pi) \stackrel{\text{def}}{=} \min\{\delta_l(\theta, \pi), \delta_o(\theta, \pi)\} . \tag{15}$$

Then we have

Proposition 1 *There are functions $\underline{\theta}(\pi), \overline{\theta}(\pi)$ such that*

$$\forall \pi \in [0, .4] : 0 < \underline{\theta}(\pi) \leq \overline{\theta}(\pi) < 1 ,$$
$$\forall \pi \in [0, .4] \text{ and } \forall \theta \in [\underline{\theta}(\pi), \overline{\theta}(\pi)] : 0 < \underline{\delta}(\theta, \pi) \leq \overline{\delta}(\theta, \pi) < 1 .$$

Moreover, if $\pi \in [0, .4]$, $\forall \theta \in [\underline{\theta}(\pi), \overline{\theta}(\pi))$, and $\delta \in (\underline{\delta}(\theta, \pi), \overline{\delta}(\theta, \pi)]$, then an equilibrium with the following properties exists:
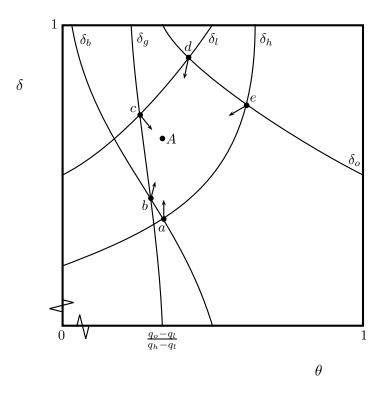
(i) Both politicians choose to experiment with the new policy in the first period.

(ii) The good politician always takes zero transfers, while the bad politician takes the 'mimicking' transfers $\tau^*(q_h) = q_h - q_l$ when the quality of the new policy is high, and the unrestricted transfers $\tau^*(q_l) = q_l$ and $\tau^*(q_o) = q_o$ when the quality of the new policy is low and when the old policy is chosen, respectively.

(iii) Beliefs are as in Table 1 and (8).

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[15]Without this restriction condition (13) would change sign for θ less than the $\tilde{\theta}$ solving $q_o(2 - \tilde{\theta}) - q_h = 0$. This could not be satisfied for any positive δ. By imposing $q_h = 2q_o$ we reduce $\tilde{\theta}$ to zero. By doing so we make sure that the act of experimentation might take place even for values of θ close to zero.

(iv) In the second period both politicians implement the new policy iff its quality has been high and choose the old policy iff the quality of the new policy has been low.

Proposition 1 is illustrated in Figure 1.

Figure 1: **Equilibrium $\{n, n\}$ with comparative statics.**

The equilibrium exists if (θ, δ) is in the region (a, b, c, d, e).
For $\pi = .4$ this space shrinks to A.

To provide the intuition of Proposition 1 it is most instructive to start with the situation without any external information that is, $\pi = 0$. Consider the good politician first. She faces three different incentives, one referring to the first period payoffs, the other two referring to the second period payoffs. More specifically, in the first period she evaluates the expected benefit of the new policy relative to the benefit of the old policy. Having chosen the new policy in the first period induces a cost and a benefit in the second period. The cost consists of the risk of being mimicked by the bad politician and voted out of office. The benefit comes from the information on the quality of the new policy gathered by experimentation. Thus, the tradeoff in the second period payoffs is between the political risk of being mimicked and the risk of a mistake in policy choice.

For values of θ such that the expected benefit of the new policy is less than the benefit of the old policy ($\theta < (q_o - q_l)/(q_h - q_l)$) the first period consideration is in favour of the old policy. Second period considerations though are against choosing the old policy in the first period. For low θ the disutility of being mimicked is less than the cost of not knowing the quality of the new policy in the second period. The reason for that is that citizens do not penalise the occurrence of the low quality outcome q_l very heavily, as is

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implied by the belief $\mu(r(n, q_l), \emptyset) = 1 - \theta$. Therefore the good politician is still reelected with a high probability even if she was unlucky.

Since first and second period considerations point towards different directions, the relative weight of both periods is critical. It turns out then that if the future is sufficiently important, i.e., δ is high, then the net second period gain conferred by choosing the new policy in the first period outweighs the first period cost.

For sufficiently high θ the expected first period benefit of the new policy is higher than the benefit of the old policy. The balance of the second period considerations is in favour of the old policy. For in this case the undeserved punishment, as implied again by the belief $\mu(r(n, q_l), \emptyset) = 1 - \theta$, of the good politician when the citizens cannot distinguish her from the bad politician is severe relative to the benefit of experimentation. However, first period considerations dominate for all admissible values of the discount factor δ.

We turn now to the bad politician. The first period tradeoff is similar to the tradeoff faced by the good politician. However, this type does not care about being uninformed after having chosen the old policy in the first period. This is because the risk of a mistake in policy due to non-experimentation is not present for her. For in this case she takes the unrestricted transfers, reveals herself and consequently she is voted out of office. However, this politician too finds the new policy attractive. The reason simply being that the new policy allows her, in the eventuality in which the high quality is realised, to mimic the good politician. If this happens she is reelected with positive probability, determined by the belief $\mu(r(n, q_l), \emptyset) = 1 - \theta$, although she has appropriated rents. Clearly then second period effects are in favour of the new policy.

For sufficiently high θ first and second period payoffs are both in favour of choosing the new policy in the first. For sufficiently low θ choosing the new policy in the first period is optimal if the second period advantage is highly valued relative to the first period loss that is, δ is high enough.

We describe now how the equilibrium changes as π increases above 0.

Proposition 2 *An increase in π monotonically reduces the upper bound $\overline{\delta}(\theta, \pi)$ and increases the lower bound $\underline{\delta}(\theta, \pi)$. This implies that as external information becomes more available the space of parameters for which the pooling equilibrium of Proposition 1 exists decreases.*

Proposition 2 reveals how the incentives of the two types of politicians change as more information becomes available. Notice that first period payoffs are unaffected by the presence of external information. In the second period the incentives identified above are less marked as π increases. This is because, after choosing the old policy, the good politician enjoys the opportunity to free ride on the information externality and hence is less interested in experimentation. Since also voters benefit from the same information externality, they detect the mimicking behaviour more often. For the good politician this implies that the cost of being mimicked decreases with π. Naturally, this makes the new policy also more attractive. Although both policies become more attractive, relative to the new, the old policy becomes still more desirable. For the equilibrium to still exist after an increase in π, a higher discount factor δ is needed. For the bad politician the

payoff of the mimicking option is reduced. Hence this type of politician is less inclined to choose the new policy, and also for her, a higher discount factor δ is needed to support the equilibrium.

Clearly then, Proposition 2 reveals two interesting but conflicting features of the politico-economic environment. On the one hand relative performance evaluation (by means of the information parameter) is desirable because the bad type (increasingly) reveals herself but on the other hand it is bad because the good type experiments with the new policy less frequently by free riding on the information externalities.

In Figure 1, the arrows indicate the comparative statics of changes in π on the space of parameters supporting the equilibrium. This space shrinks monotonically to point A at which $\pi = .4$. Further increases in external information destroy the equilibrium.

5.2 Separating on policy (n, o)

In this Section an equilibrium is constructed with the following features. Firstly, the good type chooses the new policy whereas the bad sticks to the old one. Secondly, the bad politician takes unrestricted transfer in all circumstances. Formally, the strategies in the first period are

$$\sigma_p^*(n|g) = 1 , \tag{16}$$

$$\sigma_p^*(o|b) = 1 , \tag{17}$$

$$\sigma_\tau^*(0|p, q_i, g) = 1 , \quad \text{for all } p = o, n, \ i = h, o, l , \tag{18}$$

$$\sigma_\tau^*(q_i|p, q_i, b) = 1 , \quad \text{for all } p = o, n, \ i = h, o, l . \tag{19}$$

The beliefs are summarised in Table 1. Compared to the (n, n) equilibrium only the beliefs related to the record $r(n, q_l)$ with $y = \emptyset$ changes. For this equilibrium we postulate,[16]

$$\mu(r(n, q_l), \emptyset) = 1. \tag{20}$$

We first verify the optimality of the transfer choices. In analogy to Lemma 1, if the quality of the new policy is q_h then $\tau^*(q_h) = q_h$ is optimal iff

$$\delta \leq \delta_h^{n,o}(\pi) \stackrel{\text{def}}{=} \frac{q_l}{(1 - \pi)q_h} . \tag{21}$$

(21) differs from inequality (9) of Lemma 1 by the factor $(1-\theta)$ reflecting the fact that in the present equilibrium mimicking would lead to a sure reelection whereas in the pooling

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[16]It is straightforward to see that this belief is generated by the equilibrium strategies. Recall $\Pr\{g, r(n, q_l), \emptyset\}$ from footnote (8). Then compute

$$\Pr\{b, r(n, q_l), \emptyset\} = (1 - \lambda)\sigma_p^*(n|b)[\theta\sigma_\tau^*(q_h - q_l|q_h, b)(1 - \pi) + (1 - \theta)\sigma_\tau^*(0|q_l, b)(1 - \pi)] = 0 .$$

Inserting this and $\Pr\{g, r(n, q_l), \emptyset\}$ into Bayes' rule yields $\mu(r(n, q_l), \emptyset) = 1$.

equilibrium (n,n) the reelection probability is only $1-\theta$. Consider now the transfer choice $\tau^*(q_l) = q_l$ of the bad politician after the new policy was chosen and a low benefit q_l materialised. In this event equation (10) of Lemma 2 becomes

$$\delta \le \delta_l^{n,o} \stackrel{\text{def}}{=} \frac{q_l}{q_0} . \tag{22}$$

This value differs from (10) since in this equilibrium there is no risk of being voted out of office. Finally, Lemma 3 remains the same in this equilibrium.

Turning to the policy choice of the bad politician we note that since she always takes maximal transfers she is always voted out of office. Hence only the first period payoffs matter and so she chooses the old policy whenever

$$\theta < \frac{q_0 - q_l}{q_h - q_l} . \tag{23}$$

The good politician is always reelected with probability 1. By analogy to Lemmas 5 and 6, the good politician chooses the new policy iff $\theta \ge (q_o - q_l)/(q_h - q_l)$ or $\theta < (q_o - q_l)/(q_h - q_l)$ and

$$\delta \ge \delta_g^{n,o}(\theta, \pi) \stackrel{\text{def}}{=} \frac{q_o - [\theta q_h + (1-\theta)q_l]}{\theta(1-\pi)(q_h - q_o)} . \tag{24}$$

This bound on δ differs from the bound on δ in Lemma 6 because in the present equilibrium there is no risk of being mimicked. This makes the new policy more attractive relative to the old.

Choose now $\underline{\delta}^{n,o}(\theta, \pi) = \delta_g^{n,o}(\theta, \pi)$ and

$$\overline{\delta}^{n,o}(\pi) = \begin{cases} \delta_h^{n,o}(\pi) & \text{if} \quad \pi \le (q_h - q_0)/q_h , \\ \delta_l^{n,o} & \text{if} \quad \pi > (q_h - q_0)/q_h . \end{cases} \tag{25}$$

As in Proposition 1 these function give the lower and upper bounds on the discount factor δ such that for given θ and π the separating equilibrium (n,o) exists. We so have

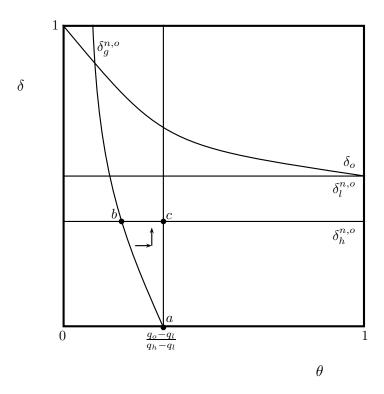**Proposition 3** *There is a function $\underline{\theta}^{n,o}(\pi)$, satisfying*

$$\forall \pi \in [0,1] : 0 < \underline{\theta}^{n,o}(\pi) \le (q_o - q_l)/(q_h - q_l),$$

$$\forall \pi \in [0,1] \text{ and } \theta \in [\underline{\theta}^{n,o}(\pi), (q_o - q_l)/(q_h - q_l)) : 0 < \underline{\delta}^{n,o}(\theta, \pi) \le \overline{\delta}^{n,o}(\pi) < 1.$$

Moreover, if $\pi \in [0,1]$, $\theta \in [\underline{\theta}^{n,o}(\pi), (q_o - q_l)/(q_h - q_l))$, and $\delta \in [\underline{\delta}^{n,o}(\theta, \pi), \overline{\delta}^{n,o}(\pi)]$, then an equilibrium with the following properties exists:

(i) *The good politician experiments with the new policy in the first period, while the bad politician chooses the old policy in the first period.*

(ii) *The good politician never takes transfers, while the bad politician takes the unrestricted transfers in each instance.*

(iii) *Beliefs are as in Table 1 and (20).*

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Figure 2: **Equilibrium $\{n, o\}$ with comparative statics.**

The equilibrium exists if (θ, δ) is in the region (a, b, c).

(iv) In the second period the good politician implements the experimented policy if its quality has been high and switches to the old policy if its quality has been low. The bad politician is voted out.

Figure 2 illustrates the Proposition.

This equilibrium exists for low values of the discount factor. This implies that the incentive of the bad politician to mimick is reduced, as compared to the pooling equilibrium (n, n), inducing her to take maximal transfers. Since she is voted out in all eventualities what matters to her is first period payoffs. For low values of $\theta < (q_o - q_l)/(q_h - q_l)$ the old policy is preferable. The good politician is never mimicked and so the cost associated with the new policy in the pooling equilibrium (n, n) is absent. This makes her more willing to experiment with the new policy.

Proposition 3 shows that it is possible to have two attractive features of the political system at the same time. Firstly, political competition works well enough inducing the bad politician to reveal her type instead of mimicking the good type. Secondly, the good politician has sufficient incentives to experiment with the new policy. For her, it is worthwhile to learn its quality by trying out the new policy rather than free riding on the information gathered elsewhere.

To investigate the effect of external information on these two features of the economic environment, we now perform comparative statics with respect to π on the space for which this separating equilibrium exists. In doing so we arrive at

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Proposition 4 *For $\theta < (q_o - q_l)(q_h - q_l)$ an increase in π strictly increases the lower bound $\underline{\delta}^{n,o}(\theta, \pi)$ required for the equilibrium (n, o). It also strictly increases the upper bound $\overline{\delta}^{n,o}(\pi)$ iff $\pi < (q_h - q_0)/q_h$.*

On the one hand, the information externality makes the good politician less willing to experiment. On this score the space of parameters supporting the equilibrium shrinks. On the other hand, a higher π makes the mimicking option for the bad politician less attractive since she is detected more often. Thus, she will choose the unrestricted transfers for even higher values of the discount factor. On that score the space of parameters increases. Comparative statics are indicated by the arrows in Figure 2.

5.3 A 'pooling' equilibrium on old policy (o, o)

We turn now to the equilibrium in which both politicians choose the old policy. The transfer choices are as in the pooling equilibrium on new policy (n, n). Formally the strategies of the politicians are given by $\sigma_p^*(o|i) = 1, i = g, b$ and (4) to (7). This equilibrium is supported by the same beliefs as the (n, n) equilibrium.[17]

Since transfer choices and beliefs are the same as in the (n, n) equilibrium the δ functions supporting that equilibrium define also the space of parameters for which the (o, o) equilibrium exists. Specifically, Lemmas 1 to 3 continue to hold. Since policy choices are opposite to the (n, n) equilibrium the inequality referring to the bad politician given in Lemma 4 reverses sign. For the good type we note from Lemma 5 that only for $\theta < (q_o - q_l)/(q_h - q_l)$ she will choose the old policy. She will do so iff the inequality in Lemma 6 reverses sign.

The space of parameters δ, θ, for various π, for which a pooling equilibrium on the old policy exists is defined by the following lower and upper bounds

$$\underline{\delta}^{o,o}(\theta, \pi) \overset{\text{def}}{=} \delta_h(\theta, \pi), \tag{26}$$

$$\overline{\delta}^{o,o}(\theta, \pi) \overset{\text{def}}{=} \min\{\delta_l(\theta, \pi), \delta_b(\theta, \pi), \delta_g(\theta, \pi)\}. \tag{27}$$

Proposition 5[18] *There exists a function $\overline{\theta}^{o,o}(\pi)$ such that:*

$$\forall \pi \in [0, .5] : 0 \leq \overline{\theta}^{o,o}(\pi) < (q_o - q_l)/(q_h - q_l),$$

$$\forall \pi \in [0, .5] \text{ and } \theta \in [0, \overline{\theta}^{o,o}(\pi)] : 0 < \underline{\delta}^{o,o}(\theta, \pi) \leq \overline{\delta}^{o,o}(\pi) < 1.$$

Moreover if $\pi \in [0, .5), \forall \theta \in (0, \overline{\theta}^{o,o}(\pi))$ and $\delta \in (\underline{\delta}^{o,o}(\theta, \pi), \overline{\delta}^{o,o}(\theta, \pi))$ then an equilibrium with the following properties exists:
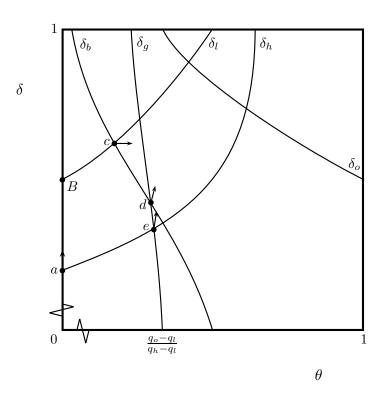
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[17]A word of clarification is in order here. Belief $\mu(r(n, q_l), \emptyset) = 1 - \theta$ as well as all beliefs relating to the new policy are now out-of-equilibrium beliefs. According to the intuitive reasoning leading to the beliefs of Table 1 voters when forming their beliefs place more emphasis on what they know about the transfers appropriated rather than on the policy choice. This means that in the present equilibrium if voters observe the out-of-equilibrium policy choice n they should form the beliefs considering only the transfer choice. This is because voters perceive both types of politicians as being equally likely to make a policy mistake but very unlikely to make a mistake in transfers. Therefore if voters observe q_l without external information they should assign the same belief as in the (n, n) equilibrium.

[18]The proofs of Propositions 5 and 7 parallel closely the proof of Proposition 1 and are omitted to save space. The proofs are available from the authors upon request.

(i) *Both types of politicians do not experiment but choose the old policy.*

(ii) *The good politician never takes transfers while the bad takes the transfers of Proposition 1.*

(iii) *Beliefs are as in Table 1 and (8).*

(iv) *In the second period the good type is voted in. She chooses the new policy with probability $\theta\pi$ and with probability $(1 - \theta\pi)$ she chooses the old policy. The bad politician is voted out.*

Proposition 5 is illustrated in Figure 3.

Figure 3: **Equilibrium $\{o, o\}$ with comparative statics.**

The equilibrium exists if (θ, δ) is in the region (a, B, c, d, e).
For $\pi = .5$ this space shrinks to B.

In this seemingly pooling equilibrium there is no experimentation but both politicians choose the old policy. The characterisation 'seemingly' stems from the fact that the existence of transfers, after the choice of the old policy by both types, allows voters to infer the type of politicians in equilibrium and so vote out of office the bad incumbent. Naturally, this equilibrium occurs if θ is low so the new policy is very unlikely to be of high quality and if δ is low so the second period advantage of the new policy is discounted heavily.

We turn now to the comparative statics of π on the parameter space for which this equilibrium exists.

Proposition 6 *An increase in the revelation probability π strictly increases the lower bound $\underline{\delta}^{o,o}(\theta, \pi)$ required for the (o, o) equilibrium. For $\pi > \sqrt{6}/6$ the upper bound $\overline{\delta}^{o,o}(\pi)$ is decreasing in π and therefore the parameter space decreases monotonically.*

The intuition for this Proposition is similar to the intuition offered in Proposition 2. This is simply because the bounds δ_h, δ_l are the same as in the (n, n) equilibrium. The only distinction between both equilibria is that here these bounds apply to the optimal continuation of the game after the off-the-equilibrium choice of the new policy has occurred. The arrows in Figure 3 indicate the comparative statics.

5.4 Separating on policy choices (o, n)

In this Section we construct an equilibrium in which the bad politician chooses the new policy and takes unrestricted transfers in all eventualities whereas the good politician chooses the old policy and never takes transfers. Formally the strategies of the politicians are as in the separating equilibrium (n, o) with the exception of $\sigma_p^*(o|g) = 1$, $\sigma_p^*(n|b) = 1$. The interesting belief is the one related to low quality outcome without external information. In this equilibrium this is[19]

$$\mu(r(n, q_l), \emptyset) = 0 . \tag{28}$$

This belief implies that the bad politician faces certain defeat in the election when the outcome q_l occurs. She has, therefore, no incentive to take the mimicking transfers $q_h - q_l$ after the high quality was realised. It thus follows that $\tau^*(q_h) = q_h$ is the optimal choice. If now the low quality outcome is realised then, in analogy to Lemma 2, she chooses the maximal transfers iff

$$\delta \leq \delta_l^{o,n}(\pi) \stackrel{\text{def}}{=} \frac{q_l}{\pi q_o} . \tag{29}$$

This is because of the belief in (28) which implies that when she takes no transfers she is only reelected if there is external information. Lemma 3 is unaffected by the present belief and so remains valid.

For the policy choices we note the following. The bad politician is always voted out and hence she only considers first period payoffs. Therefore she chooses the new policy iff $\theta \geq (q_o - q_l)/(q_h - q_l)$. The good politician, if she chooses the new policy, is voted in in all instances except when q_l occurs and there is no external information. This leads to the payoff $\theta(q_h - q_l) + q_l + \delta[\theta q_h + (1 - \theta)\pi q_o]$. If now she opts for the old policy she obtains, with $\theta > (q_o - q_l)/(q_h - q_l)$, $q_o + \delta\{\theta q_h + (1 - \theta)[\pi q_o + (1 - \pi)q_l]\}$. A comparison of these payoffs reveals that the good politician chooses the old policy iff

$$\delta > \delta_g^{o,n} \stackrel{\text{def}}{=} \frac{\theta(q_h - q_l) - (q_o - q_l)}{(1 - \theta)(1 - \pi)q_l} . \tag{30}$$

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[19]The use of the belief $\mu(r(n, q_l), \emptyset)$ of the (n, n) and (n, o) equilibria would imply that the good politician faces the same incentives as in these equilibria. Therefore the good type would never choose the old policy for $\theta \geq (q_o - q_l)/(q_h - q_l)$. The bad type, however, chooses the new policy in the equilibrium o, n only if the latter inequality is satisfied.

The next Proposition gives the space of parameters for which the (o, n) equilibrium exists. We make use of

$$\underline{\delta}^{o,n}(\theta, \pi) \stackrel{\text{def}}{=} \delta_g^{o,n}(\theta, \pi), \tag{31}$$

$$\overline{\delta}^{o,n}(\theta, \pi) \stackrel{\text{def}}{=} \min\{\delta_l^{o,n}(\pi), \delta_o(\theta, \pi)\} . \tag{32}$$

Then we have

Proposition 7 *There is a function $\overline{\theta}^{o,n}(\pi)$ such that*

$\forall \pi \in [0, 1) : (q_o - q_l)/(q_h - q_l) < \overline{\theta}^{o,n}(\pi) < 1 ,$
$\forall \pi \in [0, 1) \ \ and \ \ \forall \theta \in [(q_o - q_l)/(q_h - q_l), \overline{\theta}^{o,n}(\pi)] : 0 < \underline{\delta}^{o,n}(\theta, \pi) \leq \overline{\delta}^{o,n}(\theta, \pi) < 1 .$

Moreover, if $\pi \in [0, 1)$, $\forall \theta \in [(q_o - q_l)/(q_h - q_l), \overline{\theta}^{o,n}(\pi)]$, and $\delta \in (\underline{\delta}^{o,n}(\theta, \pi), \overline{\delta}^{o,n}(\theta, \pi)]$, then an equilibrium with the following properties exists:

(i) *The good politician chooses the old policy whereas the bad experiments with the new policy.*

(ii) *The good politician never takes transfers while the bad takes the maximal transfers.*

(iii) *All beliefs are as in Table 1 and (28).*

(iv) *In the second period the good politician is voted in and chooses the new policy unless it has been shown to be of low quality. The bad politician is voted out.*
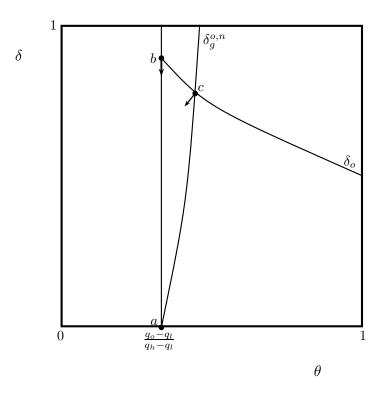
Figure 4 illustrates Proposition 7.

In this equilibrium experimentation takes place by the bad politician who reveals herself by taking maximal transfers. The good politician, given that the bad plays the new policy, responds by playing the old and getting reelected in the second period. She refrains from experimenting even for relatively high values of θ because in doing so she would be voted out if the low outcome occurs without external information.

As π increases and the low outcome occurs the good politician is reelected more often. This makes the new policy more attractive. For her to continue choosing the old policy she needs to place a higher weight on the second period payoffs. For the bad politician higher π makes zero transfers more attractive. For her to continue choosing maximal transfers future must be discounted more heavily. We so have[20]

Proposition 8 *An increase in π increases the lower bound $\underline{\delta}^{o,n}(\theta, \pi)$ and decreases the upper bound $\overline{\delta}^{o,n}(\theta, \pi)$. The space of parameters for which the equilibrium (o, n) exists therefore decreases.*

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[20]The proof straightforwardly follows from differentiating $\delta_l^{o,n}(\pi)$, $\delta_o(\theta, \pi)$, $\delta_g^{o,n}(\theta, \pi)$.

Figure 4: **Equilibrium $\{o, n\}$ with comparative statics.**

The equilibrium exists if (θ, δ) is in the region (a, b, c).

6 Welfare analysis

Having analysed the four equilibria we now turn to voters' welfare. This necessitates to consider two issues. Firstly, whether the availability of more external information improves voters' welfare within each of the equilibria analysed. Secondly, whether an increase in information is beneficial for voters if it induces a change in the equilibrium. A pairwise comparison of all equilibria, though feasible, would be quite tedious and probably not very interesting. For this reason, we restrict attention to a comparison between the (n, n) and the (n, o) equilibria. As it has been discussed the (n, n) equilibrium combines the attractive feature of experimentation with the drawback of mimicking behaviour which makes the political system perform poorly. In the (n, o) equilibrium on the other hand democracy works perfectly but at the cost of reducing innovation. Consequently, the comparison of these two equilibria reveals whether it is worthwhile for the voters to trade off some innovation for detecting the types of the politicians.

6.1 Welfare analysis for a given type of equilibrium

Having more external information produces two externalities. The first one refers to the politicians whereas the other concerns the voters. Both types of politicians more often make informed policy choices in the second period after the old policy was chosen in the first period. Whenever the second period politician is of the good type, this also enhances voters' welfare while it does not hurt them if the bad politician is in office in the second period. Voters are better informed about the type of the incumbent and

therefore vote out the bad type more often and the good type less often. This finding highlights an important aspect of the politico-economic environment. In general, the availability of more external information improves on the inefficiencies of the democratic process. All these effects are beneficial to voters as is stated in the following proposition.

Proposition 9 *Consider* (θ, δ, π) *such that the same equilibrium exists before and after a small increase in* π. *In this equilibrium, an increase in* π *strictly improves citizens' welfare.*

6.2 Welfare analysis with a change in the type of equilibrium

We now consider a change in π such that the equilibrium switches from (n, n) to (n, o). For this to be meaningful we hold all parameters but π constant and restrict attention to such values of (θ, δ) with the property that as π changes both equilibria exist. Propositions 1 and 3 indicate that such (θ, δ) exist.[21] Moreover, there is no π such that for this π and for given (θ, δ) both equilibria co-exist.[22] Finally, Proposition 2 shows that if for given (θ, δ) the (n, n) equilibrium exists for any π, then it also exists for $\pi = 0$. Together with the preceding remark, this implies that an increase in π can produce a switch from the (n, n) equilibrium to the (n, o) equilibrium but not the other way round. Then we have

Proposition 10 *Consider* (θ, δ) *and* $\pi_1 < \pi_2$ *such that there exists an* (n, n) *equilibrium for* (θ, δ, π_1) *and an* (n, o) *equilibrium for* (θ, δ, π_2). *Then citizens are at least as well off in the* (n, n) *equilibrium and strictly better off if* $\pi_1 > 0$ *or* $\pi_2 < 1$.

This result shows that increased information ceases to be unambiguously better for the citizens once a change of behaviour by the politicians occurs. If there is little external information the bad politician mimics the good one by choosing the new policy and appropriating less than maximal rents. This leaves citizens with some first period utility. In addition, the bad politician produces information on the quality of the new policy which will be helpful next period if a good challenger is in office then. On the other hand the political system sometimes fails by evicting a good or retaining a bad incumbent. Improving external information makes the mimicking strategy unattractive for the bad type. Now the election works perfectly but at the cost of higher rent extraction and less experimentation. Overall these two kinds of cost dominate the beneficial effect of the improved performance of the political system.

7 Concluding remarks

In this paper we have constructed a simple dynamic model that investigated the conflicting interaction between political uncertainty and the incentives to experiment with new policies. Selfish politicians can disguise their behaviour behind the policy uncertainty intrinsic in innovative programmes by mimicking a benevolent politician. The reason is

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[21]An example is θ close to but slightly below than $1/3$ and δ slightly above $3/8$. Here, for $\pi = 0$, the (n, n) equilibrium exists while the (n, o) equilibrium does not. For $\pi > 1/3$ the reverse is true.

[22]This can be seen, for instance, from observing that the (n, n) equilibrium exists only if $\delta > \delta_h(1/3, \pi) = 3/8(1 - \pi)$, while the (n, o) equilibrium exists only if $\delta \leq \delta_h^{n,o}(\pi) = 1/4(1 - \pi)$.

that, when faced with a bad outcome of a policy experiment, citizens may be unable to distinguish between an honest politician who just happened to be unlucky and a selfish politician who diverted part of the return of the successful innovation to herself. It was shown that this behaviour occurs less often if there is external information which, however, at the same time creates an externality that reduces the incentives to innovate.

It was also shown that external information improves welfare as long as the behaviour of the politicians is unaffected. However, if external information changes the equilibrium, from one where both types of politicians innovate to one where only the benevolent politician does so, voters' welfare decreases. The reason being that the selfish politician is detected more often and consequently behaves more aggressively appropriating more rents. This and the cost incurred by voters due to reduced experimentation dominate the beneficial effect of the improved performance of the political system.

The paper suggests a number of extensions. A natural step forward would be to endogenise the availability of external information. In the fiscal federalism setting that would require modelling several competing jurisdictions and analysing the game between the incumbents of these jurisdictions. This will allow to study the impact of a more decentralised system on the availability of information and consequently on the extent of innovation and the working of the political system throughout the federation. Another road to follow will be to incorporate career prospects of politicians and investigate whether these are enhanced by performing experiments rather than by copying existing policies.

Appendix

Appendix A

Proof of Lemma 1 Recall, that in the case of q_h the strategies available to the bad politician are $\tau \in \{q_h, q_h - q_l, 0\}$. Firstly, consider $\tau = q_h$. In this case, according to belief $\mu(r(n, 0), y) = 0$ for $y = q_h, \emptyset$, she is voted out with first period utility q_h. Secondly, she can take $\tau = q_h - q_l$ and generate the outcome q_l. In this case the bad type, according to $\mu(r(n, q_l), q_h) = 0$, is voted out if there is external information and is reelected, according to $\mu(r(n, q_l), \emptyset) = 1 - \theta$, with probability $1 - \theta$ when there is no external information. In the second period she chooses unrestricted transfers q_h with second period payoff $\delta(1 - \pi)(1 - \theta)q_h$. Altogether $\tau = q_h - q_l$ yields $q_h - q_l + \delta(1 - \pi)(1 - \theta)q_h$. Thirdly, she can take no transfers and receive utility zero in the first period. In doing so, she generates an outcome q_h implying a reelection with certainty through $\mu(r(n, q_h), y) = 1$ for $y = q_h, \emptyset$. Once in office the bad politician chooses $\tau = q_h$ which confers utility q_h. In total, utility after $\tau = 0$ is $0 + \delta q_h$. Comparison of the payoffs under the alternative transfer strategies, following on $\delta < 1$, implies that $\tau = q_h$ is preferable to $\tau = 0$ and $\tau = q_h - q_l$ is preferable to $\tau = q_h$ iff the condition in Lemma 1 is satisfied. $\square$

Proof of Lemma 2 Recall that with quality q_l the bad politician takes $\tau \in \{q_l, 0\}$. $\tau = q_l$, according to $\mu(r(n, 0), y) = 0$, implies no reelection and therefore utility q_l. With $\tau = 0$ the bad type behaves exactly as the good (receiving zero utility in the first period) reaping the benefit of reelection with probability one in the case of external information, according to $\mu(r(n, q_l), q_l) = 1$, and with probability $1 - \theta$, according to $\mu(r(n, q_l), \emptyset) = 1 - \theta$, in the case of no external information. In the second period she chooses $\tau = q_o$ with total second period discounted utility $\delta\{\pi + (1 - \pi)(1 - \theta)\}q_o$. It then follows that for the bad politician to choose the unrestricted transfers (10) must be satisfied. $\square$

Proof of Lemma 3 Recall that the transfer strategies available to the bad type are $\tau \in \{q_o, 0\}$. If this politician chooses $\tau = q_o$ then—following $\mu(r(o, 0), y) = 0$ —she is voted out obtaining zero second period discounted utility. The first period utility is q_o. If she now chooses $\tau = 0$ then she behaves like the good politician and, according to $\mu(r(o, q_o), y) = 1$, is voted in with expected second period discounted utility given by (1). It so follows that for this politician to choose $\tau^*(q_o) = q_o$ condition (11) must be satisfied. $\square$

Proof of Lemma 4 Consider the choice of the new policy by the bad politician in the first period, given the equilibrium transfer strategies of Lemmas 1-3. When choosing the new policy, with probability θ the quality is high giving her transfers $\tau = q_h - q_l$ that confer first period utility $q_h - q_l$. There is also probability $1 - \theta$ that the policy is of low quality giving utility (from unrestricted transfers $\tau = q_l$) q_l. It is clear then that the expected first period payoff is $\theta(q_h - 2q_l) + q_l$. If the quality is low she is voted out while if the quality is high she is reelected with probability $(1 - \pi)(1 - \theta)$ and obtains q_h in the second period. Therefore, the expected utility after choosing the new policy is $q_l + \theta(q_h - 2q_l) + \delta\theta(1 - \pi)(1 - \theta)q_h$. The old policy on the other hand provides a payoff of q_o in the first period and no chance of reelection. Condition (12) then follows. $\square$

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Proof of Lemma 5 The good politician, having experimented with the new policy, is reelected with certainty if the policy turned out to be of high quality. This gives her expected discounted second period utility $\theta\delta q_h$. If now the realisation of the quality is low, then the availability of external information matters. With probability π she is reelected according to $\mu(r(n, q_l), q_l) = 1$. With probability $1 - \pi$ she is reelected only with probability $1 - \theta$ according to $\mu(r(n, q_l), \emptyset) = 1 - \theta$. If reelected, in the second period she returns to the old policy with payoff q_o. Altogether, the discounted expected second period payoff from the new policy is $\delta\{\theta q_h + (1 - \theta)[\pi + (1 - \pi)(1 - \theta)]q_o\}$.

If the good politician now chooses the old policy in the first period she is reelected with certainty. From (1) it follows that if $\theta \geq (q_o - q_l)/(q_h - q_l)$ she obtains a discounted expected payoff $\delta\{\theta q_h + (1 - \theta)[\pi q_o + (1 - \pi)q_l]\}$. Subtracting now the second period benefit of the new policy from the second period benefit of the old policy and simplifying yields $\delta(1 - \theta)(1 - \pi)\{q_l - (1 - \theta)q_o\}$. The new policy is preferable if its first period advantage $\theta q_h + (1 - \theta)q_l - q_o$ outweighs the second period advantage of the old policy, that is

$$\theta q_h + (1 - \theta)q_l - q_o \geq \delta(1 - \theta)(1 - \pi)\{q_l - (1 - \theta)q_o\} . \tag{A.1}$$

For $\theta \geq (q_o - q_l)/(q_h - q_l)$, the l.h.s. of (A.1) is non-negative. Thus, if the r.h.s. is non-positive, the Lemma is true. Consider therefore the case where $q_l - (1 - \theta)q_o > 0$. Since, by assumption, $\theta(q_h - q_l) > \theta q_0$ we have

$$\begin{aligned}
\theta q_h + (1 - \theta)q_l - q_o &= \theta(q_h - q_l) + q_l - q_o , \\
&> \theta q_o + q_l - q_o , \tag{A.2} \\
&= q_l - (1 - \theta)q_o .
\end{aligned}$$

With $q_l - (1 - \theta)q_o > 0$, the last expression is greater than $\delta(1 - \theta)(1 - \pi)\{q_l - (1 - \theta)q_o\}$. $\square$

Proof of Lemma 6 The proof proceeds exactly as the derivation of (A.1) but with the second period payoff after the old policy is chosen being replaced by $\delta[\theta\pi q_h + (1 - \theta\pi)q_o]$ and using $q_h \geq 2q_o$ when solving for δ. $\square$

Appendix B

Proof of Proposition 1
The proof proceeds in five steps. After some preliminaries in step 1, the functions $\underline{\delta}$ and $\overline{\delta}$ are characterised in step 2. In step 3, the functions $\underline{\theta}$ and $\overline{\theta}$ are defined and characterised. In step 4, the inequalities claimed in the Proposition are verified. With that in place, it will be easily shown in step 5 that the mentioned strategies are optimal, given that (θ, δ, π) satisfy the constraints stated in the proposition.

Step 1: Preliminaries. In the course of the proof, we make various use of the values of θ which, for any given π, yield pairwise equalities of the critical values $\delta_b, \delta_g, \delta_h, \delta_l$ and δ_o. Using $q_h/q_o = q_o/q_l = 2$ in the right-hand-sides of (9) to (13) and routinely solving

the ensuing equations reveals that these θ's are uniquely given by

$$
\begin{aligned}
\theta_{b,l}(\pi) &= \tfrac{5-3\pi-\sqrt{9\pi^2-14\pi+9}}{8(1-\pi)} : & \delta_b(\theta,\pi) &= \delta_l(\theta,\pi), & \text{with} \quad \theta < 1/2, \\
\theta_{g,l}(\pi) &= \tfrac{4-\pi-\sqrt{8+\pi^2}}{4(1-\pi)} : & \delta_g(\theta,\pi) &= \delta_l(\theta,\pi), & \text{with} \quad \theta < 1, \\
\theta_{b,g} &= \tfrac{9-\sqrt{17}}{16} : & \delta_b(\theta,\pi) &= \delta_g(\theta,\pi), & \text{with} \quad \theta < 1/2, \\
\theta_{b,h} &= \tfrac{1}{3} : & \delta_b(\theta,\pi) &= \delta_h(\theta,\pi), & & \\
\theta_{l,o}(\pi) &= \tfrac{3-\pi}{7-5\pi} : & \delta_l(\theta,\pi) &= \delta_o(\theta,\pi), & & \\
\theta_{h,o}(\pi) &= \tfrac{7-9\pi}{11-9\pi} : & \delta_h(\theta,\pi) &= \delta_o(\theta,\pi), & & \\
\theta_{l,h}(\pi) &= \tfrac{1-2\pi}{1-\pi} : & \delta_l(\theta,\pi) &= \delta_h(\theta,\pi) . & &
\end{aligned}
\tag{B.1}
$$

The proof also makes use of the derivatives of the δ functions.

$$
\frac{\partial \delta_h(\theta,\pi)}{\partial \theta} = \frac{q_l}{q_h(1-\pi)(1-\theta)^2} > 0 ,
\tag{B.2}
$$

$$
\frac{\partial \delta_l(\theta,\pi)}{\partial \theta} = \frac{(1-\pi)q_l}{[1-\theta(1-\pi)]^2 q_o} > 0 .
\tag{B.3}
$$

$$
\frac{\partial \delta_o(\theta,\pi)}{\partial \theta} =
\begin{cases}
\frac{-q_o\{q_h-q_l-\pi(q_o-q_l)\}}{\{\theta q_h+(1-\theta)[\pi q_o+(1-\pi)q_l]\}^2} < 0 , & \text{iff} \quad \theta > (q_o-q_l)/(q_h-q_l) , \\[2mm]
\frac{-\pi q_o(q_h-q_o)}{[\theta\pi q_h+(1-\pi\theta)q_o]^2} < 0 , & \text{iff} \quad \theta < (q_o-q_l)/(q_h-q_l) .
\end{cases}
\tag{B.4}
$$

$$
\frac{\partial \delta_b(\theta,\pi)}{\partial \theta} = \frac{(1-\pi)q_h[\theta^2(2q_l-q_h)-(q_o-q_l)(1-2\theta)]}{[\theta(1-\pi)(1-\theta)q_h]^2} < 0 .
\tag{B.5}
$$

$$
\frac{\partial \delta_g(\theta,\pi)}{\partial \theta} = \frac{[q_o(2-\theta)-q_h](q_o-q_l)+\theta q_o[\theta q_h+(1-\theta)q_l-q_o]}{(1-\pi)\{\theta[q_o(2-\theta)-q_h]\}^2} < 0 .
\tag{B.6}
$$

Step 2: Characterisation of $\underline{\delta}(\theta,\pi)$ and $\overline{\delta}(\theta,\pi)$.

Lemma 7 *For any given π,*

$$
\underline{\delta}(\theta,\pi) =
\begin{cases}
\delta_g(\theta,\pi) & \text{for} \quad 0 < \theta \leq \theta_{b,g} , \\
\delta_b(\theta,\pi) & \text{for} \quad \theta_{b,g} < \theta \leq \theta_{b,h} , \\
\delta_h(\theta,\pi) & \text{for} \quad \theta_{b,h} < \theta < 1 .
\end{cases}
\tag{B.7}
$$

Proof of Lemma 7 We first compare δ_b and δ_h. Recall that $\theta = \theta_{b,h}$ uniquely solves $\delta_b(\theta,\pi) = \delta_h(\theta,\pi)$. Moreover, from (B.2) and (B.5), $\partial \delta_h/\partial \theta > 0$ and $\partial \delta_b/\partial \theta < 0$. Hence the function $\delta_h(\theta_{b,h},\pi)$ cuts the function $\delta_b(\theta_{b,h},\pi)$ from below at $\theta_{b,h}(\pi)$. It then follows

$$
\delta_b(\theta,\pi) \lesseqgtr \delta_h(\theta,\pi) \quad \text{if} \quad \theta \gtreqless \theta_{b,h} .
\tag{B.8}
$$

Next consider δ_b and δ_g for $\theta < \theta_{b,h}$. Again, $\theta = \theta_{b,g}$ is the only root of $\delta_b(\theta, \pi) = \delta_g(\theta, \pi)$. Evaluation of the slopes of these functions, using (B.5) and (B.6), at $\theta = \theta_{b,g}$, reveals that,

$$0 > \frac{\partial \delta_b(\theta, \pi)}{\partial \theta} = \frac{-2\theta^2 + 2\theta - 1}{4(1 - \pi)\theta^2(1 - \theta)^2} > \frac{\partial \delta_g(\theta, \pi)}{\partial \theta} = \frac{3\theta - 2}{4(1 - \pi)\theta^3} . \tag{B.9}$$

Hence, we conclude

$$\delta_b(\theta, \pi) \gtreqqless \delta_g(\theta, \pi) \quad \text{if} \quad \theta \gtreqqless \theta_{b,g} . \tag{B.10}$$

To summarise we note that for $0 < \theta \leq \theta_{b,g}$ it holds that $\delta_g(\theta, \pi) \geq \delta_b(\theta, \pi) > \delta_h(\theta, \pi)$. For $\theta_{b,g} < \theta \leq \theta_{b,h}$, one has $\delta_b(\theta, \pi) > \delta_g(\theta, \pi)$ and $\delta_b(\theta, \pi) \geq \delta_h(\theta, \pi)$. Finally, for $\theta > \theta_{b,h}$, it holds $\delta_h(\theta, \pi) > \delta_b(\theta, \pi) > \delta_g(\theta, \pi)$. These inequalities prove the Lemma. $\square$

Lemma 8 *For any given π,*

$$\overline{\delta}(\theta, \pi) = \begin{cases} \delta_l(\theta, \pi) & for \quad \theta \leq \theta_{l,o}(\pi) , \\ \delta_o(\theta, \pi) & for \quad \theta_{l,o}(\pi) < \theta . \end{cases} \tag{B.11}$$

Proof of Lemma 8   From (B.1) we have that $\delta_l(\theta, \pi) = \delta_o(\theta, \pi)$ is uniquely solved by $\theta = \theta_{l,o}(\pi)$. Since, from (B.3) and (B.4), $\delta_l(\theta, \pi)$ and $\delta_o(\theta, \pi)$ are, respectively, increasing and decreasing functions of θ, we have

$$\delta_l(\theta, \pi) \gtreqqless \delta_o(\theta, \pi) \quad \text{if} \quad \theta \gtreqqless \theta_{l,o}(\pi) . \tag{B.12}$$

Lemma (8) then readily follows. $\square$

Step 3: Construction of $\underline{\theta}(\pi)$ and $\overline{\theta}(\pi)$. For any π consider the equality

$$\underline{\delta}(\theta, \pi) = \overline{\delta}(\theta, \pi) \quad \text{with} \quad \theta \leq \theta_{b,h} . \tag{B.13}$$

Given that, for $\theta < \theta_{b,h}$, $\underline{\delta}(\theta, \pi)$ and $\overline{\delta}(\theta, \pi)$ are decreasing and increasing in θ, respectively, there can be at most one such θ satisfying (B.13). For θ close to zero we have $\underline{\delta}(0, \pi) = \delta_g(0, \pi) \to \infty$, and $\overline{\delta}(0, \pi) = \delta_l(0, \pi) = 1/2$. Hence $\underline{\delta}(\theta, \pi) > \overline{\delta}(\theta, \pi)$ for θ close to zero. At $\theta = \theta_{b,h} = 1/3$ we find that $\underline{\delta}(1/3, \pi) = 3/[8(1 - \pi)]$ and $\overline{\delta}(1/3, \pi) = 3/[2(2 + \pi)]$. It then follows that $\underline{\delta}(1/3, \pi) < \overline{\delta}(1/3, \pi)$ for $\pi < .4$. Hence for $0 \leqq \pi < .4$, by continuity, there exists a θ solving (B.13). Denote this by $\underline{\theta}(\pi)$. It then follows from $\theta_{l,o}(\pi) > \theta_{b,h}$, (B.7), (B.11) and the slopes of δ_g, δ_l that

$$\underline{\theta}(\pi) = \max\{\theta_{g,l}(\pi), \theta_{b,l}(\pi)\} . \tag{B.14}$$

Similarly consider, for any π, the set of θ such that,

$$\underline{\delta}(\theta, \pi) = \overline{\delta}(\theta, \pi) \quad \text{and} \quad \theta > \theta_{b,h} . \tag{B.15}$$

As shown, at $\theta = \theta_{b,h} = 1/3$, it holds $\underline{\delta}(1/3, \pi) < \overline{\delta}(1/3, \pi)$ if $\pi < .4$. For $\theta \to 1$, we obtain $\underline{\delta}(\theta, \pi) = \delta_h(\theta, \pi) = 1/4(1 - \pi)(1 - \theta) \to \infty$. Also $\overline{\delta}(1, \pi) = \delta_o(1, \pi) = 1/2$. Hence an intersection exists. From the construction of $\underline{\delta}(\theta, \pi)$ and $\overline{\delta}(\theta, \pi)$ this is uniquely given by

$$\overline{\theta}(\pi) = \min\{\theta_{l,h}(\pi), \theta_{h,o}(\pi)\} . \tag{B.16}$$

Step 4: The inequalities $0 < \underline{\theta}(\pi) \leq \overline{\theta}(\pi) < 1$ **and** $0 < \underline{\delta}(\theta, \pi) \leq \overline{\delta}(\pi, \theta) < 1$. Notice that $\underline{\theta}(\pi) < \theta_{b,h} < \overline{\theta}(\pi)$. From $\underline{\theta}(\pi) = \max\{\theta_{l,g}(\pi), \theta_{l,b}(\pi)\}$ one verifies that, for all π, $\underline{\theta}(\pi) > 0$. From $\overline{\theta}(\pi) = \min\{\theta_{h,o}(\pi), \theta_{l,o}(\pi)\}$ one also concludes that $\overline{\theta}(\pi) < 1$.

At $\theta = \theta_{b,h} = 1/3$, for all $\pi \in [0, .4)$, $\underline{\delta}(1/3, \pi) < \overline{\delta}(1/3, \pi)$. Moreover, since for $\theta < \theta_{b,h} = 1/3$ there is no other θ but $\underline{\theta}(\pi)$ such that $\underline{\delta}(\theta, \pi) = \overline{\delta}(\theta, \pi)$, it is true, for all $\underline{\theta}(\pi) < \theta < \theta_{b,h}$, that $\underline{\delta}(\theta, \pi) < \overline{\delta}(\theta, \pi)$. By similar reasoning this is also true for $\theta_{b,h} < \theta < \overline{\theta}(\pi)$. For any given π, from (B.7) and the slopes of δ_b, δ_g, and δ_h, $\underline{\delta}(\theta, \pi)$ is minimal for $\theta = \theta_{b,h} = 1/3$. From $\underline{\delta}(1/3, \pi) = \delta_h(1/3, \pi)$, it is obvious that $\underline{\delta}(1/3, \pi) > 0$. Similarly the maximum of $\overline{\delta}(\theta, \pi)$ is reached at $\theta = \theta_{l,o}(\pi)$. It can be easily verified that $\overline{\delta}(\theta_{l,o}, \pi) < 1$.

Step 5: Optimality of the strategies. Note that $\underline{\delta}(\theta, \pi)$ and $\overline{\delta}(\theta, \pi)$ are constructed so as to reflect the binding lower and upper bounds on δ required for the optimality conditions as stated in Lemmas 1 to 5. Hence, any triple (θ, π, δ) with $0 \leq \pi \leq .4$, $\underline{\theta}(\pi) \leq \theta < \overline{\theta}(\pi)$ and $\underline{\delta}(\theta, \pi) < \delta \leq \overline{\delta}(\theta, \pi)$ satisfies all conditions for an equilibrium. $\square$

Proof of Proposition 2
The Proposition follows from differentiating the functions defining the upper and lower bounds.

$$\frac{\partial \delta_g(\theta, \pi)}{\partial \pi} = -\frac{1}{\theta(1-\pi)^2[q_o(2-\theta) - q_h]} > 0. \tag{B.17}$$

$$\frac{\partial \delta_b(\theta, \pi)}{\partial \pi} = \frac{\theta(1-\theta)q_h[\theta(2q_l - q_h) + (q_o - q_l)]}{[\theta(1-\pi)(1-\theta)q_h]^2} > 0, \tag{B.18}$$

with the sign following on $\theta < (q_l - q_o)/(2q_l - q_h)$.

$$\frac{\partial \delta_h(\theta, \pi)}{\partial \pi} = \frac{q_l}{q_h(1-\pi)^2(1-\theta)} > 0. \tag{B.19}$$

$$\frac{\partial \delta_l(\theta, \pi)}{\partial \pi} = \frac{-\theta q_l}{[1 - \theta(1-\pi)]^2 q_o} < 0. \tag{B.20}$$

$$\frac{\partial \delta_o(\theta, \pi)}{\partial \pi} = \begin{cases} \frac{-q_o(1-\theta)(q_o - q_l)}{\{\theta q_h + (1-\theta)[\pi q_o + (1-\pi)q_l]\}^2} < 0, & \text{iff} \quad \theta > (q_o - q_l)/(q_h - q_l), \\ \frac{-\theta q_o(q_h - q_o)}{[\theta \pi q_h + (1-\pi\theta)q_o]^2} < 0. & \text{iff} \quad \theta \leq (q_o - q_l)/(q_h - q_l). \end{cases} \tag{B.21}$$

$\square$

Appendix C

Proof of Proposition 3
Observe that $\lim_{\theta \to 0} \delta_g^{n,o}(\theta, \pi) = +\infty$. For $\theta = (q_0 - q_l)/(q_h - q_l)$, we have $\delta_g^{n,o}(\theta, \pi) = 0$. Moreover,

$$\frac{\partial \delta_g^s(\theta, \pi)}{\partial \theta} = -\frac{(1-\pi)(q_h - q_0)(q_0 - q_l)}{[\theta(1-\pi)(q_h - q_0)]^2} < 0. \tag{C.1}$$

Since $\overline{\delta}^{n,o}$ is constant in θ, for each π, there is a unique $\underline{\theta}^{n,o}(\pi)$ such that $\underline{\delta}(\underline{\theta}^{n,o}(\pi), \pi) = \overline{\delta}^{n,o}(\pi)$ with $0 < \underline{\theta}^{n,o}(\pi) < (q_0 - q_l)/(q_h - q_l)$. It also follows that $\underline{\delta}^{n,o}(\theta, \pi) < \overline{\delta}^{n,o}(\pi)$ for

$\underline{\theta}^{n,o}(\pi) < \theta < (q_0 - q_l)/(q_h - q_l)$. Finally, in this range of θ, $\underline{\delta}^{n,o}(\theta, \pi) > 0$ and $\overline{\delta}^{n,o}(\pi) < 1$ holds.

In the text it is shown that the claimed strategies are optimal given the beliefs if (11) and (21) to (24) are satisfied simultaneously. To see that this is the case, note first that the denominator of the r.h.s. of (11) cannot exceed q_h. Hence (11) is satisfied if $\delta \leq q_0/q_h$. Using the assumption $q_l/q_0 = q_0/q_h$, one concludes that (11) is always true if (22) holds. Moreover, comparing (21) and (22), one finds that (21) implies (22) for $\pi_h \leq (q_h - q_0)/q_h$ and vice versa for $\pi_h > (q_h - q_0)/q_h$. The inequality $\delta \leq \overline{\delta}^{n,o}(\pi)$ postulates that the stricter one of these requirements is true. Hence $\delta \leq \overline{\delta}^{n,o}(\pi)$ implies (11), (22) and (21). Turning to the policy choices, one notices that (24) is satisfied for $\delta \geq \underline{\delta}^{n,o}(\theta, \pi)$. Finally, the inequality (23) for the policy choice by the bad policy maker is clearly satisfied for the range of θ given. $\qquad\square$

Proof of Proposition 4 Following (24) we have

$$\frac{\partial \delta_g^{n,o}(\theta, \pi)}{\partial \pi} = \frac{\theta(q_h - q_0)\{q_0 - [\theta q_h + (1-\theta)q_l]\}}{[\theta(1-\pi)(q_h - q_0)]^2} > 0 , \qquad (C.2)$$

with the inequality following from $\theta < (q_0 - q_l)/(q_h - q_l)$. The upper bound, given by (25), is increasing in π iff $\pi < (q_h - q_0)/q_h$. $\qquad\square$

Proof of Proposition 6 The lower bound was shown to be decreasing in π in (B.19). Following the line of argument presented in the proof of Proposition 1 one can verify that for $\pi > \sqrt{6}/6$ and $\theta < \overline{\theta}^{o,o}(\pi)$ the upper bound $\overline{\delta}^{o,o}(\theta, \pi) = \delta_l(\theta, \pi)$. This is decreasing, following on (B.20), in π. $\qquad\square$

Appendix D

Proof of Proposition 9 In the (n, n) equilibrium, we note the following. The good type behaves according to the wishes of the electorate. This gives, depending on the realisation of the new policy's quality, first period utility of q_h or q_l to voters. Also, if in the second period a good politician is in office citizens enjoy utility of q_h or q_o. A bad second period government on the other hand will take unlimited transfers implying zero second period utility for the electorate. The good incumbent is reelected with certainty if either q_h is realised or q_l has occurred and external information is available. She is reelected with probability $1 - \theta$ if q_l has occurred and there is no external information. With the remaining probability θ the challenger is elected who has expected reputation $E_G(\lambda_c) = \lambda$. Altogether, after the outcome q_l the probability of having a good second period politician is $\pi + (1-\pi)(1 - \theta + \theta\lambda)$. Denoting by $EU_{nn}(i; \theta, \delta, \pi)$ the expected utility of voters along the (n, n) equilibrium path when the type of the incumbent is $i = b, g$, this implies

$$EU^{nn}(g; \theta, \delta, \pi) = \theta(1 + \delta)q_h + (1 - \theta)\{q_l + \delta[\pi + (1-\pi)(1 - \theta + \theta\lambda)]q_o\} . \qquad (D.1)$$

Similarly, we find

$$EU^{nn}(b; \theta, \delta, \pi) = \theta q_l + \delta\lambda\{\theta[\pi + (1-\pi)\theta]q_h) + (1 - \theta)q_o\} . \qquad (D.2)$$

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By analogous reasoning the expected utility of voters in the other three equilibria can be derived yielding

$$EU^{no}(g; \theta, \delta, \pi) = \theta(1 + \delta)q_h + (1 - \theta)(q_l + \delta q_o) , \tag{D.3}$$

$$EU^{no}(b; \theta, \delta, \pi) = \delta\lambda[\theta\pi q_h + (1 - \theta\pi)q_o] , \tag{D.4}$$

$$EU^{oo}(g; \theta, \delta, \pi) = q_o + \delta[\theta\pi q_h + (1 - \theta\pi)q_o] , \tag{D.5}$$

$$EU^{oo}(b; \theta, \delta, \pi) = \delta\lambda[\theta\pi q_h + (1 - \theta\pi)q_o] , \tag{D.6}$$

$$EU^{on}(g; \theta, \delta, \pi) = q_o + \delta\{\theta q_h + (1 - \theta)[\pi q_o + (1 - \pi)q_l]\} , \tag{D.7}$$

$$EU^{on}(b; \theta, \delta, \pi) = \delta\lambda[\theta q_h + (1 - \theta)q_o] . \tag{D.8}$$

In all four equilibria, at least one of the equations is strictly increasing in π while none is decreasing. Therefore, ex ante expected welfare is strictly increasing in π. Finally, from Propositions 1, 3, 5 and 7 one can verify that for each equilibrium there exists a triplet of parameters (θ, δ, π) such that the equilibrium exists before and after a small change in π. $\qquad\square$

Proof of Proposition 10 Using (D.1) to (D.4) the change in ex ante welfare induced by an increase from π_1 to π_2 is

$$\lambda[EU^{nn}(g; \theta, \delta, \pi_1) - EU^{no}(g; \theta, \delta, \pi_2)] + (1 - \lambda)[EU^{nn}(b; \theta, \delta, \pi_1) - EU^{no}(b; \theta, \delta, \pi_2)] . \tag{D.9}$$

Since from Proposition 9 welfare is increasing in π as long as the type of equilibrium stays the same (D.9) is greater than or equal to (D.9) with π_1 replaced by 0. Denote this by

$$
\begin{aligned}
D &= \lambda[EU^{nn}(g; \theta, \delta, 0) - EU^{no}(g; \theta, \delta, \pi_2)] + (1 - \lambda)[EU^{nn}(b; \theta, \delta, 0) - EU^{no}(b; \theta, \delta, \pi_2)] \\
&= \lambda(1 - \theta)\theta(\lambda - 1)\delta q_o + (1 - \lambda)\theta\{q_l + \delta\lambda[(\theta - \pi_2)q_h - (1 - \pi_2)q_o]\} \\
&= \frac{\theta q_l}{2}[1 + \delta(3\theta - 2 - \pi_2)] , \tag{D.10}
\end{aligned}
$$

where the last equality follows from $\lambda = 1/2$ and $q_h/q_o = q_o/q_l = 2$. From (23) the (n, o) equilibrium exists only if $\theta < 1/3$ implying $(3\theta - 2 - \pi_2) < 0$. From (22) $\delta \le 1/2$ must hold in order for the (n, o) equilibrium to exist. It then, from (D.10), follows

$$D \ge \frac{\theta q_l}{4}(3\theta - \pi_2) . \tag{D.11}$$

From (24) any triplet (θ, δ, π_2) such that the (n, o) equilibrium exists satisfies furthermore $(1 - 3\theta)/[2\theta(1 - \pi_2)] \le \delta \le 1/2$. Solving for θ leads to $\theta \ge 1/(4 - \pi_2)$. Using this in (D.11) yields

$$D \ge \frac{\theta q_l}{4}\left(\frac{3}{4 - \pi_2} - \pi_2\right) . \tag{D.12}$$

(D.12) is decreasing, in the relevant range, in π_2 and so we have $D \ge 0$. To see that welfare in the (n, n) equilibrium is strictly greater than in the (n, o) equilibrium if $\pi_1 > 0$ observe that (D.9) is strictly increasing in π_1. It is clear that (D.12) is strictly positive if $\pi_2 < 1$. $\qquad\square$

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