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Abstract

This paper formalizes in a fully-rational model the popular idea that politicians perceive an electoral cost in adopting costly reforms with future benefits and reconciles it with the evidence that reformist governments are not punished by voters. To do so, it proposes a model of elections where political ability is ex-ante unknown and investment in reforms is unobservable. On the one hand, elections improve accountability and allow to keep well-performing incumbents. On the other, politicians make too little reforms in an attempt to signal high ability and increase their reappointment probability. Although in a rational expectation equilibrium voters cannot be fooled and hence reelection does not depend on reforms, the strategy of underinvesting in reforms is nonetheless sustained by out-of-equilibrium beliefs. Contrary to the conventional wisdom, uncertainty makes reforms more politically viable and may, under some conditions, increase social welfare. The model is then used to study how political rewards can be set so as to maximize social welfare and the desirability of imposing a one-term limit to governments. The predictions of this theory are consistent with a number of empirical regularities on the determinants of reforms and reelection. They are also consistent with a new stylized fact documented in this paper: economic uncertainty is associated to more reforms in a panel of 20 OECD countries.

JEL Classification: E6, H3

Keywords: Elections, Reforms, Asymmetric Information, Uncertainty.

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1 Introduction

Among the fundamental questions in political economy are why governments often fail to adopt reforms that are widely believed to be welfare-improving and what conditions make their adoption more likely. For instance, while most observers tend to agree that promoting product market competition, providing free access to markets and reducing public debt are often essential to preserve economic growth, the extent to which such measures are adopted varies enormously across countries. The existing literature has identified several explanations for an anti-reform bias, most of them placing distributional conflicts as the cornerstone. For instance, interest groups who may lose from a reform may lobby to block it (e.g., Grossman and Helpman, 2001). Alternatively, uncertainty about the distribution of costs and benefits may lead to a *status quo bias* (e.g., Fernandez and Rodrik, 1991) or to a war of attrition between parties resulting in an inefficient delay (Alesina and Drazen, 1991). A popular view among policy makers, instead, is that governments are afraid of losing votes due to the short-run costs that reforms typically entail. As Jean-Claude Juncker, Prime Minister of Luxembourg and President of the Eurogroup, once said, "We all know what to do, but we don't know how to get reelected once we have done it." Consistently, governments that are forced to adopt reforms in times of crisis often blame markets or external pressures in an attempt to shift away the political responsability of their actions. Ever since the work of Peltzman (1992), however, economists and political scientists did not find evidence that reforms affect adversely the chances of reelection.[1] If governments do not seem to be systematically punished at the ballot box for engaging in reforms, the question of why they are so politically difficult remains an unresolved puzzle.

In this paper, we formalize in a fully-rational model the view that politicians perceive an electoral cost in adopting reforms and we reconcile it with the evidence that their adoption does not seem to have a negative effect on reelection prospects. We do so using a model of political accountability through elections where the key elements are informational asymmetries and uncertainty. Similarly to the existing literature, we find that incumbent governments have too weak an incentive to invest in reforms. Contrary to existing works, however, we find that uncertainty is likely to make reforms politically more viable. Our theory builds on the premise that the cost of reforms is immediately observable to voters, while their actual implementation and payoffs often are not. For example, an increase in fiscal pressure is immediately evident to taxpayers, while it may take time to see how effectively tax revenues are spent. In such a situation, the incumbent may not dare to embark in reforms, even when they are unambiguously welfare-improving,

[1] We discuss this literature more in details in the next Section.

for the fear of losing votes and hence office. This bias against reforms holds, even when citizens are rational and aware of political incentives, under two conditions. The first is that ability of politicians is not directly observable to voters, so that it must be inferred on the basis of performance. The second is an informational asymmetry between citizens and the incumbent so that effort and resources invested in reforms with future returns are not perfectly observed by voters. These assumptions generate a "political cost" of reforms: there is an incentive to invest less in reforms in an effort to signal high ability and thus increase the reelection probability. Despite this, however, in a rational-expectation equilibrium voters correctly foresee the strategy of the incumbent and also his expected ability. As a result, politicians *cannot* manipulate their reelection probability. Still, their choice to underinvest is sustained by hidden information out of equilibrium: the fact that the politician can *deviate* from his equilibrium strategy in ways unknown to voters.[2]

Interestingly, the "political cost" of reforms depends crucially on the sources of uncertainty affecting the precision of the signal that voters can see. If observable measures of performance are poor signals of ability, for instance because the economy is going through a period of high turbulence, the perceived probability of being reelected becomes less sensitive to the choice of reforms thereby reducing their political cost. Thus, perhaps surprisingly, the type of uncertainty highlighted in this paper promotes unambiguously the adoption of efficient reforms. Yet, the welfare effects are ambiguous because uncertainty worsens both electoral accountability, thereby inducing the incumbent to put less effort, and the ability to select good politicians. By comparing these effects, we find a simple condition for welfare to increase or decrease with various forms of uncertainty.

The high tractability of our model allows us to use it to answer two substantive normative questions. First, we study the effect of political rewards on social welfare. By increasing the value to stay in power, higher rewards exacerbate the underinvestment in reforms, but also induce the incumbent to exert more effort. We characterize the socially optimal level of compensation arising from this trade-off and find that politicians should be rewarded more when effort is relatively more important than reforms and uncertainty is high. Second, since the political cost of reforms arises because incumbents care about reelection, we ask under what conditions imposing a one-period term limit may be welfare improving. A term limit promotes the adoption of reforms, but reduces political accountability and hence effort, and gives up the benefit of keeping well-performing politicians in office.[3] We find that imposing such a limit is welfare reducing when uncertainty is high

[2] Glaeser et al. (2005) show how a similar mechanisms may explain strategic extremism in a model where policy statements are not directly observable and parties compete for voters.

[3] Consistently with our theory, Conconi et al. (2011) show that US senators who hold safe seats or have announced their retirement are more likely to vote in favor of trade reforms.

and effort is important. Next, we show that the main results of our model are robust to alternative assumptions. When reforms are modelled as a discrete choice, their political cost is found to be proportional to their size. Finally, we briefly discuss how alternative assumptions on the information set of agents can make the politcal cost of reforms consistent with a positive (or a negative) correlation between reformist effort and the reelection probability.

The conflict of interest between voters and politicians is an old theme in a vast literature.[4] Our paper builds on agency models where the role of elections is to select the most competent politician. This approach has been used extensively (e.g. see Nordhaus, 1975, Alesina, 1987, Rogoff and Sibert, 1988, Rogoff, 1990, Persson and Tabellini, 1990, Lohman, 1998 and Drazen, 2000a) to explain political business cycles, i.e., the incentive for incumbents to perform well just before elections so as to appear talented to the voters. Despite some similarities, these papers do not study the role of uncertainty and economic shocks on political incentives to undertake reforms, while we are not interested in studying how political incentives vary in election and non-election years.

In line with the literature on electoral accountability, initiated by Barro (1973), we consider the disciplining role of elections on effort choices. Yet, we argue that, when it comes to investing in reforms, electoral incentives are more likely to induce myopic behavior. Recent contributions by Alesina and Tabellini (2007, 2008) compare models of electoral accountability and career-concerns to study how the optimal accountability mechanism depends on the characteristics of policy tasks. The effect of political compensation on the quality of politicians has instead been studied, among others, by Caselli and Morelli (2004), Besley (2004), Besley and Smart (2007), and Mattozzi and Merlo (2008). Once again, none of these papers focuses on uncertainty and on the choice of reforms.

Important contributions on the political economy of reforms in the presence of uncertainty are Fernandez and Rodrik (1991), Ciccone (2004), Cukierman et al. (1992), Alesina and Drazen (1991). The influential paper by Fernandez and Rodrik (1991) has shown how uncertainty regarding the distribution of gains and losses may lead to a *status quo bias*. Alesina and Drazen (1991) have instead shown that reforms may be postponed due to a war of attrition. Drazen (2000b) discusses why reforms may be more likely in periods of crisis. Alesina and Cukierman (1990), instead, have shown that uncertainty allows the politicians to follow their most preferred policy, even at the expenses of voters. Similarly to these papers, we find that politicians have a bias against adopting reforms. Our result, however, is based on rational myopia rather than redistributional conflicts and can explain why reforms are so politically difficult even when they do not seem to

[4] Persson and Tabellini (2000) provide an excellent introduction to this field.

be punished by voters. Morover, the result that uncertainty *lowers* the political cost of reforms is to our knowledge novel. Finally, a recent literature on institutional change has emphasized that (adverse) economic shocks may speed up the transition towards more democratic political regimes (see for example Acemoglu and Robinson, 2001 and 2006, and the evidence in Brückner and Ciccone, 2009). Differently from these papers, however, we restrict attention to economic reforms in representative democracies only.

Finally, the general insight that uncertainty may improve the equilibrium along some dimensions in agency models has been explored in Dewatripont, Jewitt and Tirole (1999), Holmström (1999), and Prat (2005), among others. Yet, the argument that uncertainty may improve welfare by stimulating the adoption of reforms with future payoffs has not been made in the literature and appears of first order relevance to understand the political economy of reforms.

The rest of the paper is organized as follows. Section 2 discusses the empirical observations motivating our analysis. It reviews the existing evidence that reelection probability is affected by economic outcomes, but not by the adoption of reforms, and it discusses the empirical determinants of reforms. It also unveils a new pattern in the data: in a panel of OECD countries, periods of high economic volatility are associated to a higher propensity to implement reforms. Section 3 builds a two-period model of elections and reforms that can rationalize these empirical observations. It contains the main result of the paper, that reforms entail a political cost, even if their equilibrium choice does not affect the reelection probability of the incumbent government. It also shows that, by reducing the perceived political cost of reform, uncertainty promotes their adoption. Section 4 examines the implications of the model for social welfare. It provides conditions for uncertainty to be welfare improving, it shows how political rewards can be set so as to maximize the expected utility of citizens and studies the desirability of imposing a one-term limit. Section 5 explores the robustness of the main results to alternative assumptions. Section 6 concludes.

2 Motivating Evidence

In this Section, we review the main stylized facts motivating this paper. First, there is growing consensus that, while economic performance often affects the probability that politicians stay in power, the incidence of fiscal and structural reforms – despite the economic and political costs they may entail – does not. Second, reforms are more likely to occur during times of crisis. Since the literature has not explored the link between uncertainty and reforms, we provide some original evidence suggesting that economic volatility is associated to a more reformist stance on behalf of governments.

2.1 Crisis, Reforms and Reelection

The hypothesis that reelection prospects depend on current economic performance received early support in the works of Fair (1978, 2008), Kiewiet and Rivers (1985) and Alesina and Rosenthal (1995). In particular, Kiewiet and Rivers (1985) find, using data on U.S. and Western European elections, that a 1-percent decline in real income is associated with a reduction of the incumbent party's vote share of between 0.5 percent and 1 percent. More recently, a series of papers have provided evidence that good economic performance increases the likelihood that politicians stay in power. Brender and Drazen (2008) show on a sample of 73 countries that high growth during the term in office increases the reelection probability, particularly in less developed countries. Using a sample of 21 OECD countries, Buti et al. (2010) find that high levels and growth rates of the cyclical component of GDP have a positive impact on the chances of reelection for incumbent governments. Finally, Wolfers (2007) provides evidence from U.S. gubernatorial elections that good economic performance increases the likelihood that incumbent parties stay in office.

On the contrary, many papers have failed to identify empirically the often-blamed electoral cost of reforms. Buti et al. (2010), using data on product and labor market reforms across OECD countries, show that reforms in general do not affect the reelection probability of incumbent governments. Alesina, Perotti and Tavares (1998) and Alesina, Carloni and Lecce (2010) study the political consequences of fiscal adjustments in a cross section and a panel of OECD countries and find that fiscal austerity has positive or no political effects. Brender and Drazen (2008) find that loose fiscal policies have a negative effect on the probability of reelection in a panel of 74 countries over the period 1960-2003. Peltzman (1992), Brender (2003), and Drazen and Eslava (2010) examine the effect of fiscal performance on reelection at the state and local level in a single country (the United States, Israel, and Colombia, respectively) and find that voters punish—rather than reward—loose fiscal policies.

2.2 Crisis, Volatility and the Likelihood of Reforms

The literature on the determinants of reforms such as marcoeconomic stabilization, trade liberalization and deregulation, is vast. After reviewing the experiences of developing countries with market-oriented reforms, Tommasi and Velasco (1996) conclude that the hypothesis that crises lead to stabilization is part of the conventional wisdom. Systematic empirical works on the determinants of reforms (see, among others, Alesina and Ardagna, 1998, Drazen and Easterly, 2001, Hamann and Prati, 2002) confirm that the adoption of stabilization plans aimed at reducing inflation, government deficit and the black market

premium, is more likely in periods of crisis, i.e., when inflation, deficit and black market premium are particularly high. Recently, Alesina et al. (2006) provide evidence from a large panel of countries that fiscal reforms are more likely to occur during times of crisis, when new governments take office and when governments are "strong." Periods of economic crisis are also found to favor the adoption of structural reforms targeted to the markets for financial instruments (Abiad and Mody, 2003) goods and services, and labor (Høj et al., 2006). Although crisis and volatility are likely to be correlated, there is to our knowledge no evidence on the relationship between reforms and economic uncertainty. This is unfortunate because in periods of high volatility it might be easier for policy makers to blame economic shocks instead of taking responsibility for the costs of their actions, and this may relax their political constraints. In other words, governments may perceive unpopular reforms to be politically more viable in times of turmoil. We now provide some preliminary evidence on this hypothesis.

To do so, we study how economic volatility is empirically related to the likelihood and the size of deficit stabilization in a panel of 20 OECD countries observed between 1975 and 2000.[5] To start with, we follow the existing literature in constructing a discrete indicator of reform using data on the annual variation of central government deficit as a ratio of GDP (DEFICIT), from the IMF Government Finance Statistics (2001). We define as a reform an episode of annual fall in DEFICIT above the 80th percentile of the empirical distribution, corresponding to reductions by more than 1.17 percentage points in our sample. Our measure of macroeconomic volatility is the standard deviation of the output gap, i.e., the difference between actual and potential GDP over potential GDP, as computed by the OECD based on estimations of the production functions. This variable is meant to capture unexpected variations in economic performance.

Figure 1 plots the overall number of reforms observed between 1975 and 2000 in the sample against the standard deviation of the output gap in the same period and provides a synthetic description of the data. The line interpolating the points exhibits a positive and significant slope, suggesting the existence of positive correlation between volatility and reforms.

A first step to corroborate this graphical evidence is to test whether the cross-sectional correlation holds after controlling for other variables. The coefficients estimated with ordinary least squares are reported in Table 1. In column 1, we simply replicate the linear interpolation plotted in Figure 1, showing a positive and significant correlation between

[5] These countries are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States.

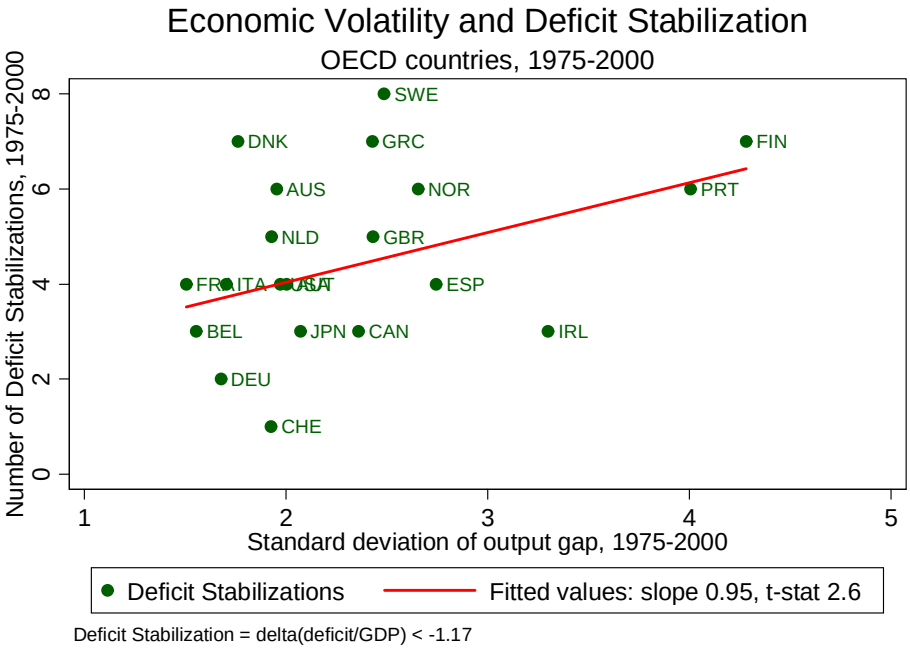

Figure 1: Economic Volatility and Deficit Stabilizations.

volatility over the period and the number of reforms. Next, we control for initial real GDP per capita and the average level of DEFICIT, in columns 2 and 3. While these variables are not significantly correlated with the number of reforms, the coefficient for volatility remains positive and significant. Following the literature on crises and reforms, we also control for the number of fiscal crises, defined as episodes in which government deficit as a share of GDP is above the 20th percentile (i.e., over 7.5 per cent). As columns 4 and 5 show, the number of fiscal crises is not significantly correlated to the number of reforms. Finally, we also control for the following political variables: the number of left-wing governments (left), the number of governments in the first two years of office (younggov) and a dummy for parliamentary systems. These indicators are obtained from the 2006 release of the Database of Political Institutions compiled by the World Bank. Consistently with previous evidence (e.g., Alesina et al., 2006), a larger number of left-wing governments is associated to more fiscal adjustments, while the coefficients for the other political variables are not significant. Throughout all specifications, economic volatility remains significantly and positively correlated to the number of reforms.[6]

[6]The results are also robust to controlling for average political fractionalization and proportional (as opposed to majoritarian) system. The estimated coefficients for these variables are non significant.

To better exploit the information in the dataset we now use the annual panel to estimate the following logit for the likelihood of reforms:

$$\Pr[REF_{it} = 1 \mid SD_{it-1,t-5}, \mathbf{X}_{it-1}] = \frac{\exp\left(b_0 + b_1 SD_{it-1,t-5} + b_2 \mathbf{X}_{it-1} + u_i + e_{it}\right)}{1 + \exp\left(b_0 + b_1 SD_{it-1,t-5} + b_2 \mathbf{X}_{it-1} + u_i + e_{it}\right)} \tag{1}$$

where REF_{it} is the dummy indicator of fiscal adjustment in country i and year t, $SD_{it-1,t-5}$ is the standard deviation of the output gap over the five-year period between $t-1$ and $t-5$, $\mathbf{X}_{it-1}$ is a vector of control variables, u_i is the country fixed effect and e_{it} is the error term. All regressors are lagged one period to account for the fact that policies may be decided the year before they are enacted, and to avoid simultaneity. Moreover, we always include among the regressors the level of deficit to control for the fact that reforms may be more likely when the deficit is particularly high.

The results are reported in Table 2. The first specification suggests that the probability of reforms increases with volatility, and, consistently with the empirical literature on the determinants of reforms, it is higher the larger is the deficit as a ratio of GDP in the previous period. Since both variables are significant, we keep them in the estimation and add other covariates in the following regressions. First, we control for indicators of economic activity such as the output gap and real GDP per capita, to let the likelihood of reforms vary over the cycle. While the coefficient for the output gap, in column 2, is not significantly different from zero, the one for real output, in column 3, is negative, pointing to the fact that reforms are adopted more often in periods of bad economic performance. In column 4, we replace real GDP per capita with the indicator of fiscal crisis (i.e., deficit level above 7.5 per cent of GDP) and find a significant and positive coefficient, confirming the existing evidence that a fiscal adjustment is more likely after a fiscal crisis. When we consider both economic performance and deficit crises, in column 5, all covariates remain significant, which points to the importance of all these variables as determinants of reforms. Finally, column 6 shows that political factors such as the proximity of an election, ideology and the tenure of the government do not significantly affect the likelihood of fiscal stabilization. Independently of the covariates, the sign, magnitude and significance of the coefficient for economic volatility remain unaltered.

The evidence in Tables 1 and 2 refers to a discrete indicator of reforms, whose definition depends on a threshold value for the annual variation in the deficit to GDP ratio, and hence may be subject to discretion. To circumvent this problem and to study the intensive margin of reforms, we now replicate the panel analysis of Table 2 using as dependent

variable the annual change in deficit, $\Delta DEFICIT$. We therefore estimate:

$$\Delta DEFICIT_{it} = \rho DEFICIT_{it-1} + \beta_1 SD_{it-1,t-5} + \beta_2 X_{it-1} + \eta_i + \nu_{it}, \qquad (2)$$

where all variables and subscripts are the same as above. Since the lagged dependent variable is included among the regressors, OLS estimates may suffer from inconsistency. We address this problem by implementing the Kiviet (1995) correction of the standard errors, which requires us to re-write the estimation equation as:[7]

$$DEFICIT_{it} = \widetilde{\rho} DEFICIT_{it-1} + \beta_1 SD_{it-1,t-5} + \beta_2 X_{it-1} + \eta_i + \nu_{it},$$

with $\widetilde{\rho} = \rho - 1$.[8] If $\beta_1 < 0$, then an increase in volatility is associated with a drop in the deficit, i.e., a fiscal reform. Also, $\widetilde{\rho} < 1$ would imply that higher deficit to GDP ratios are followed by larger fiscal adjustments. Table 3 reports the estimated coefficients with robust and consistent standard errors under alternative specifications of equation (2). The estimates for lagged DEFICIT in the first row, significant and smaller than one, confirm the result that countries with larger deficits tend to implement stronger adjustments. The coefficients for the standard deviation of the output gap in the second row, negative and significant, confirm the evidence in Tables 1 and 2 that an increase in economic volatility is followed by a stronger reduction in deficits. Quantitatively, the effects are substantial: a one per cent increase in SD from its average (1.85 per cent) is followed by a 0.35 percentage points reduction in the deficit/GDP ratio. For the average country, this means a shift from a 0.2 percentage points increase to a 0.15 percentage points fall in deficit over GDP. When controlling for the output gap, in column 2, we do not find a significant estimate for this variable. The positive and significant coefficients for real GDP per capita in columns 3-5 confirm instead the result that bad economic performance tends to be followed by deficit reductions. The result that fiscal crises tend to be followed by deficit reductions is also confirmed by the negative and significant coefficients of columns 4 and 5.

In sum, the empirical evidence suggests that reelection is affected by economic performance, but not by the reformist stance of governments and that reforms are more likely to occur in times of crisis and high economic volatility. In the next section, we develop a model of the political cost of reforms that can rationalize these stylized facts.

[7] Since our panel is unbalanced, we implement this correction as proposed by Bruno (2005).

[8] Adopting the Blundell and Bond (1998) approach to dynamic panel yields similar estimates. The relatively large time-series and reduced cross-sectional dimensions, however, cause serious problems of over-fitting, which induced us not to report these results.

3 A Model of Politicians, Elections and Reforms

We study an agency model of political accountability and elections with two time periods. In the first period, a politician of unknown ability makes decisions about effort and an unobservable investment in reforms with a payoff in the second period. Between periods, there is an election in which voters choose between the incumbent and a challenger. Elections serve the purpose of ousting bad performing politicians. However, this selection *ex-post* also affects the incentives the incumbent faces *ex-ante*. We use this model to study the determinants of the choice of reforms, with a particular focus on the role of elections and uncertainty.

3.1 Preferences and Technology

The economy is populated by a continuum of risk neutral agents which live for two periods and discount the future at rate $\beta \in (0, 1]$. Expected utility of the representative citizen is given by

$$W = \mathbb{E}\left[y_t + \beta y_{t+1}\right], \tag{3}$$

where y_t is a suitable measure of economic performance (e.g., income per capita) in period t, which in turn depends on the actions of a politician. In the first period, a citizen is drawn at random to conduct economic policy and reforms, and for this he receives a reward $\gamma > 0$ for each period in office. His expected utility is

$$U = W + \gamma - \frac{a^2}{2} + \beta p \gamma, \tag{4}$$

where $a^2/2$ is the cost of exerting effort $a \in [0, a^{\max}]$ and p is the perceived probability of being reelected in the second period.[9]

Economic performance in the two periods, y_t and y_{t+1}, depends on the ability of the politician in office, θ_t, his choice of reforms, r, and effort, a, and a random shock ε_t:

$$\begin{aligned} y_t &= \theta_t + \kappa a - r + \varepsilon_t \\ y_{t+1} &= \theta_{t+1} + f(r) + \varepsilon_{t+1} \end{aligned} \tag{5}$$

Investing in reforms, r, has a cost in terms of current economic performance and a future

[9] This version of the citizen-candidate model provides the simplest microfoundation for a political objective function that is an average of social welfare, W, and private costs and benefit. A quadratic cost of effort is chosen for tractability. Any increasing and convex cost function would yield similar results. The upper bound on effort is not crucial, but it is introduced to simplify some of the normative results in Section 4.

return $f(r)$, where the return function $f(r)$ is assumed to be increasing, concave and three-times differentiable with $f'(0) = \infty$ and $f'(\infty) = 0$.[10] The social value of effort is parametrized by $\kappa > 0$. To focus on the interesting choice variables only, we disregard effort in the second period, although it would be straightforward to include. Ability of the politician in office at time t, θ_t, is unknown both to the citizens and to the incumbent, but it is drawn from a known distribution $\theta \sim N\left(\overline{\theta}, \sigma_\theta^2\right)$.[11] Finally, ε_t is an i.i.d. shock drawn from a known distribution $\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)$ and uncorrelated to ability ($\mathbb{E}[\theta\varepsilon] = 0$).[12]

The agency game between the citizens and the politician can be summarized as follows. The politician chooses reforms, r, and effort, a, before observing the realization of θ_t and ε_t, so as to maximize his payoff (4). After observing y_t only, citizens decide whether to keep the incumbent at $t+1$ or to replace him with a new random draw, so as to maximize (3). There are two important asymmetries between the incumbent and the society at large. First, the politician cares about social welfare, W, but also about his probability to stay in office, with a weight equal to γ on the latter goal. Second, citizens only observe y_t and not the actual choice of reforms and effort.[13]

3.2 Voters

We solve the model backward. First, we find the election rule chosen by citizens and then we solve for the investment in reforms and effort by the incumbent. Citizens face an inference problem: they want to reelect a politician with a high θ, but they only observe a noisy signal, $y_t = \theta_t + \kappa a - r + \varepsilon_t$. Thus, they must form expectations on the ability of the incumbent conditional on y_t. Citizens know the distributions of θ and ε, and they can foresee the equilibrium level of reforms and effort that the politician will choose, r^e and a^e respectively (to be solved in the next section). Given this information, as in a standard signal-extraction problem, the posterior belief on the incumbent's political ability is:

$$\widehat{\theta}_t = \mathbb{E}[\theta_t \mid y_t] = \frac{\sigma_\varepsilon^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}\overline{\theta} + \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_\varepsilon^2}\left(y_t - \kappa a^e + r^e\right). \tag{6}$$

[10] Modeling investment in r as a continuous variable allows us to study the intensive margin of reforms and is useful for analytical tractability. In Section 5 we study the extensive margin when the choice of reforms is discrete, i.e., when $r \in \{0, R\}$.

[11] The assumption that the incumbent ignores his own ability, which is rather common in this class of models (e.g., Alesina and Tabellini, 2007), is adopted for simplicity and it is relaxed in Section 5.

[12] Note that ε can equally be interpreted as a shock to the costs and benefits of reforms. Therefore, our model can capture both uncentanty about economic outcomes and uncertainty about the reform process.

[13] Since both effort and ability can be invested in reforms, we could have equivalently assumed that voters do not observe the effort the politician puts in implementing reforms.

That is, the posterior expectation is a weighted average of the "prior", $\overline{\theta}$, and the observed signal, $y_t - \kappa a_t^e + r^e$, with weights that depend on the precision of the signal: as the variance of noise increases relative to the variance of ability, the signal becomes less and less informative and the posterior expectation converges to the unconditional mean.

Note also that the distribution of the posterior belief on the incumbent's ability is normal:

$$\widehat{\theta}_t \sim N\left(\overline{\theta}, \frac{\sigma_\theta^4}{\sigma_\theta^2 + \sigma_\varepsilon^2}\right).$$

Intuitively, $\widehat{\theta}_t$ has the same mean as θ, but a smaller variance.

Given (6), it is optimal to reelect the incumbent if the belief of his ability is above average, $\widehat{\theta}_t \geq \overline{\theta}$, that is if $y_t \geq \overline{y}$, with

$$\overline{y} = \overline{\theta} + \kappa a^e - r^e. \tag{7}$$

Thus, the election rule takes a simple threshold form: voters support the incumbent if current economic performance exceeds a critical level. To find r^e and a^e, we now turn to the optimization problem of the politician.

3.3 Politicians

The incumbent chooses investment in reforms, r, and effort, a, so as to maximize his expected utility (4), given the voting strategy of citizens and his information set. Hence, given that $\mathbb{E}[\theta_t] = \overline{\theta}$ and $\mathbb{E}[\varepsilon] = 0$, his problem is:

$$\max_{\{r,a\}} \left\{ \overline{\theta} - r + \kappa a - \frac{a^2}{2} + \gamma + \beta \left[\mathbb{E}\theta_{t+1} + f(r) + p\gamma \right] \right\} \tag{8}$$

subject to:

$$\begin{aligned} p &= \Pr(y_t \geq \overline{y}) = \Pr(\theta + \kappa a - r + \varepsilon_t \geq \overline{y}) \\ &= 1 - G(\overline{y} + r - \kappa a), \end{aligned} \tag{9}$$

where $G(\cdot)$ is the c.d.f. of the realization $(\theta + \varepsilon_t)$, which is normally distributed with mean $\overline{\theta}$ and variance $\sigma_\varepsilon^2 + \sigma_\theta^2$, and density $g(\cdot)$.

Note that p is a decreasing function of reforms and an increasing function of effort:

$$\frac{\partial p}{\partial r} = -g(\overline{y} + r - \kappa a) < 0 \tag{10}$$

$$\frac{\partial p}{\partial a} = \kappa g(\overline{y} + r - \kappa a) > 0. \tag{11}$$

That is, a marginal increase in r lowers the observed realization of y_t and thus the probability to meet the threshold for reelection. Similarly, a marginal increase in a raises the observed realization of y_t and thus the perceived probability of being reelected. Note also that, by distorting the signal, reforms and effort may also affect $\mathbb{E}\theta_{t+1}$. However, it turns out that in the rational expectation equilibrium the election rule maximizes $\mathbb{E}\theta_{t+1}$ given the choice of r and a. Therefore, an envelope argument guarantees that $\partial\mathbb{E}\theta_{t+1}/\partial r = \partial\mathbb{E}\theta_{t+1}/\partial a = 0$. For this reason and to simplify the notation, we will use this equilibrium result to disregard the terms $\partial\mathbb{E}\theta_{t+1}/\partial r$ and $\partial\mathbb{E}\theta_{t+1}/\partial a$ in the first-order conditions.

The choice of r must satisfy the following equation:

$$\beta f'(r) = 1 - \frac{\partial p}{\partial r}\beta\gamma. \tag{12}$$

The LHS of (12) represents the marginal benefit of reforms, equal to the discounted marginal product of r. The RHS is the marginal cost, which has two components. The first one is the social cost of r due to foregone output today. The second component, instead, is what we call the "political cost" of reforms: by investing more in reforms the policy maker lowers current output and hence his probability to be reelected. This cost to the politician is proportional to the (discounted) value of staying in office, γ.

The first-order condition for effort is instead:[14]

$$a = \kappa + \frac{\partial p}{\partial a}\beta\gamma. \tag{13}$$

That is, the marginal cost of effort is equalized to the marginal social value, κ, plus the marginal private benefit due to a higher probability of being reelected. The latter term captures the "disciplining" role of elections.

3.4 Equilibrium Reforms, Effort and Political Selection

In the rational expectation equilibrium, citizens correctly predict reforms and effort so that we can impose $r = r^e$ and $a = a^e$. Thus, (10) and (11) become:

$$-\frac{\partial p}{\partial r} = \frac{1}{\kappa}\frac{\partial p}{\partial a} = g\left(\overline{\theta}\right) \equiv \overline{g} = [2\pi(\sigma_\theta^2 + \sigma_\varepsilon^2)]^{-1/2}, \tag{14}$$

[14] Throughout this Section, we assume that the constraint $a < a^{\max}$ is never binding in equilibrium and we therefore disregard it in the first-order conditions.

because $G \sim N\left(\overline{\theta}, \sigma_\theta^2 + \sigma_\varepsilon^2\right)$. Reforms and effort satisfy:

$$\beta f'(r) = 1 + \beta \overline{g} \gamma, \tag{15}$$

and

$$a = \kappa\left(1 + \beta \overline{g} \gamma\right). \tag{16}$$

What are the equilibrium determinants of reforms and effort? The next Proposition answers this question by showing the comparative statics of the choice of r and a to changes in the main parameters of interest for the politician: the degree of uncertainty, coming from the random ability draw (θ) and the noise shock (ε), and the value of staying in office (γ).[15]

Proposition 1 *The equilibrium level of reforms is increasing in the variance of both noise (σ_ε^2) and ability (σ_θ^2), and it is decreasing in the level of political compensation (γ):*

$$\frac{\partial r}{\partial \sigma_\varepsilon^2} > 0; \quad \frac{\partial r}{\partial \sigma_\theta^2} > 0; \quad \frac{\partial r}{\partial \gamma} < 0.$$

The equilibrium level of effort is decreasing in the variance of both noise (σ_ε^2) and ability (σ_θ^2), and it is increasing in the level of political compensation (γ):

$$\frac{\partial a}{\partial \sigma_\varepsilon^2} < 0; \quad \frac{\partial a}{\partial \sigma_\theta^2} < 0; \quad \frac{\partial a}{\partial \gamma} > 0.$$

Proof. *See Appendix* ■

The first notable result is that *uncertainty promotes reforms by lowering their political cost, $\overline{g}\gamma$*. To see why, recall that incumbents are reluctant to embark in reforms with future payoffs because they are afraid that their economic cost may be interpreted by voters as a sign of low ability. However, when ability and shocks are highly dispersed, the reelection probability depends more on the realization of θ and ε, rather than on the choice of r. Formally, from (14), $\overline{g}$ decreases as σ_ε^2 and σ_θ^2 rise:

$$\frac{\partial \overline{g}}{\partial \sigma_\varepsilon^2} = \frac{\partial \overline{g}}{\partial \sigma_\theta^2} = -\frac{\overline{g}}{2(\sigma_\theta^2 + \sigma_\varepsilon^2)}. \tag{17}$$

It follows that there is a lower incentive to inflate current performance at the expenses of reforms when $\left(\sigma_\varepsilon^2 + \sigma_\theta^2\right)$ is high. On the contrary, for a given $\overline{g}$, a high value of being

[15] Note that the variance of ability and of the noise shock determine the volatility of economic performance, $Var(y_t) = \sigma_\varepsilon^2 + \sigma_\theta^2$.

in office, γ, means that the incumbent cares more about reelection and this increases the political cost of reforms. Note also that there is an interesting interaction between these effects in that the impact of uncertainty is strong when the reward at stake is high and the impact of γ is strong when uncertainty is low.

The effect of uncertainty on effort is precisely the opposite. By the same reasoning as above, when uncertainty is high the marginal effect of an extra unit of effort on the probability of being reelected is small. For a given $\overline{g}$, instead, a high value of being in office, γ, increases the perceived value of effort. Thus, more uncertainty (σ_θ^2 and σ_ε^2) and a lower stake (γ) reduce the disciplining effect of elections and the equilibrium effort.

Imposing $r = r^e$ and $a = a^e$ into (7) and then using (9), the reelection probability turns out to be

$$p = \Pr\left(\theta_t + \varepsilon_t \geq \overline{\theta}\right) = \frac{1}{2},$$

which is just the unconditional probability that the incumbent be more able than the population average. Thus, *in equilibrium the choice of reform does not affect the probability of reelection.* Yet, what drives the "political cost" of reforms (i.e., $\partial p/\partial r < 0$ in 12) is hidden information out of equilibrium: the fact that politicians can deviate from their equilibrium strategy in ways unknown to voters. Note also that the "political cost" of reforms would disappear if there were no uncertainty about θ.

Finally, we can solve for $\mathbb{E}\theta_{t+1}$, i.e., the ex-ante expected ability of the politician in office in the second period, given the equilibrium behavior of voters and the incumbent. With probability $(1-p)$, the politician will be a new draw with expected ability $\overline{\theta}$. With probability p, it will instead be an incumbent who, by virtue of the voting strategy, is expected to be better than the average. Hence:

$$\begin{aligned} \mathbb{E}\theta_{t+1} &= (1-p)\,\overline{\theta} + p\mathbb{E}\left(\theta_{t+1} \mid \widehat{\theta}_t \geq \overline{\theta}\right) \\ &= \overline{\theta} + \frac{\delta}{2}, \end{aligned} \tag{18}$$

where δ represents the "selection effect", that is, the difference between the ex-ante expected ability of a reelected incumbent and the average. This is equal to the average of the posterior belief truncated from below at $\overline{\theta}$, minus the unconditional mean. Using standard properties of normal distributions yields:

$$\delta = \frac{2\sigma_\theta^2}{\sqrt{\left(\sigma_\theta^2 + \sigma_\varepsilon^2\right)2\pi}} = 2\sigma_\theta^2\overline{g}. \tag{19}$$

Note that reelected politicians tend to be better than the average and more so when ability

is highly dispersed (there is no benefit from selection if politicians are all alike) and when noise is low (so that it is less likely to reelect bad but lucky politicians).

4 Welfare Analysis

We now explore the implications of the model for social welfare. To start with, we compare the equilibrium derived above with a constrained efficient benchmark and show that politicians choose a suboptimally low level of reforms. Then, we examine the impact of uncertainty on welfare and derive conditions for the effect to be positive. We also study how the political reward affects welfare and show how it can be set so as to maximize the expected utility of citizens. Finally, we use the model to examine the role of elections and whether or not it is socially desirable to impose a one-term limit to the politician in office.

Using (3), (5) and (18), expected *ex-ante* social welfare is:

$$W = \overline{\theta} - r + \kappa a + \beta \left[\overline{\theta} + \frac{\delta}{2} + f(r) \right]. \tag{20}$$

where r and a solve (15) and (16), respectively. The above equilibrium is inefficient. A benevolent social planner subject to the same information set would choose reforms r^{FB} so as to equate the social benefit to the social cost:

$$\beta f'\left(r^{FB}\right) = 1. \tag{21}$$

Comparing (21) to (15), it is immediate to see that the level of reforms chosen by the politician is too low. This inefficiency arises from the political cost that reforms impose on the incumbent: the fact that, by deviating from the equilibrium strategy, he can increase his chance to be reelected.[16] In sum (proof in the text):

Proposition 2 *In the above environment, investment in reforms, r, is below the level that would maximize social welfare.*

Note also that, since W is increasing in a, a social planner would set effort to its maximum, $a^{\max}$.

[16] The same distortion leading to suboptimal reforms would arise even in the absence of elections if future political compensation was increasing in current economic performance, as empirically show by Di Tella and Fisman (2004) using data on US gubernatorial salaries.

In the next proposition, we characterize how uncertainty affects *ex-ante* expected social welfare (20).

Proposition 3 *The effect on social welfare of the variance of noise (σ_ε^2) and of ability (σ_θ^2) is ambiguous:*

$$\frac{\partial W}{\partial \sigma_\varepsilon^2} > 0 \Longleftrightarrow -\frac{\overline{g}\gamma^2}{f''(r)} > \sigma_\theta^2 + \kappa^2\gamma \tag{22}$$

$$\frac{\partial W}{\partial \sigma_\theta^2} > 0 \Longleftrightarrow \sigma_\theta^2 + 2\sigma_\varepsilon^2 - \frac{\gamma^2\overline{g}}{f''(r)} > \kappa^2\gamma \tag{23}$$

Proof. *See Appendix* ■

The variance of noise (σ_ε^2) has contrasting effects on welfare. First, Proposition 1 shows that noise promotes investment in reforms. Given that reforms are always suboptimally low, this effect tends to increase social welfare. Second, Proposition 1 also shows that noise reduces effort and this tends to lower social welfare. Third, by making luck relatively more important, a higher noise raises the probability to oust a talented incumbent or to confirm a bad one. Thus, σ_ε^2 reduces the selection premium, δ, and hence social welfare. The first effect dominates the other two, so that noise turns out to be welfare improving, when reforms are relatively more important than effort and selection. This is more likely to be the case when the political cost of reforms, $\overline{g}\gamma$, is high (so that underinvestment is severe), effort is not very valuable (low κ) and ability is very concentrated (low σ_θ^2). Given that $\overline{g} \to 0$ when $\sigma_\varepsilon^2 \to \infty$, condition (22) cannot be satisfied when σ_ε^2 is high enough. Thus, the negative welfare effect must dominate if noise is sufficiently high.

Without additional restrictions, welfare can be a highly non-monotonic function of σ_ε^2. Some examples are reported in Figure 2 for the case $f(r) = r^\alpha$ and a small κ. The dashed line represents the asymptotic level of welfare as $\sigma_\varepsilon^2 \to \infty$, i.e., when reforms are optimal but there is no benefit from selection. The upper curve displays the relationship between W and σ_ε^2 for a high value of σ_θ^2. When ability is very dispersed, selection is so important that an increase in noise is always welfare-reducing, despite its positive effect on reforms. The lower curve corresponds to the opposite scenario in which heterogeneity in ability is very low, so that selection is not very useful. In this case, welfare increases with uncertainty until σ_ε^2 becomes very large (the point at which the curve becomes downward sloping is not shown). Two intermediate examples make the non-monotonicity more evident.

The variance of ability (σ_θ^2) has contrasting welfare effects too. On the one hand, more dispersion in political ability increases reforms (Proposition 1) and the selection premium,

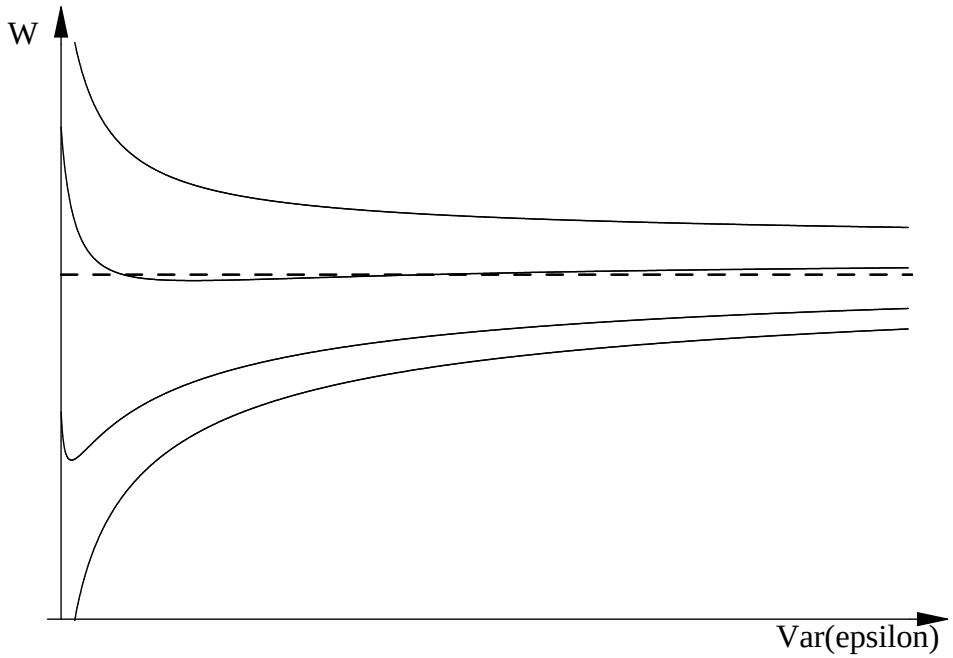

Figure 2: Welfare and Uncertainty (σ_ε^2)

δ (as can be seen from 19). These effects tend to increase social welfare. On the other hand, Proposition 1 shows that more heterogeneity reduces effort. The positive welfare effect will dominate when reforms and selection are relatively more important than effort. That is, when $\overline{g}\gamma$ is high (so that underinvestment is severe), effort is not very valuable (low κ) and ability is dispersed (high σ_θ^2). From (23), it is immediate to see that the positive welfare effect of heterogeneity must dominate if σ_θ^2 is sufficiently high.

4.2 Optimal Political Reward

What are the welfare effects of political rewards, γ? If rents from office increase, the politician will care more about reelection and this will induce him to exert more effort, but also to invest less in reforms (see Proposition 1).[17] The resulting trade-off suggests that there might exist a socially optimal level of political rewards. This possibility is worth exploring because, although γ includes psychological rents and private benefits that may be difficult to control, the pay to politicians in power can partly be chosen by the

[17] Some evidence that the wage paid to politicians affects their performance is provided, by Besley (2004) for the U.S., Ferraz and Finan (2009) for Brazil, and Gagliarducci and Nannicini (2009) for Italy.

society and varies considerably across countries.[18] Thus, we now turn to the analysis of the optimum γ and its determinant.

Differentiating expected social welfare, (20), w.r.t. γ yields:

$$\frac{\partial W}{\partial \gamma} = \kappa \frac{\partial a}{\partial \gamma} + \left[\beta f'(r) - 1\right] \frac{\partial r}{\partial \gamma}$$

The first term is the marginal value of political rewards, $MB(\gamma)$: one additional unit of γ increases effort by $\partial a/\partial \gamma$, with a value proportional to κ. The second term is instead the marginal cost, $MC(\gamma)$: an extra unit of γ biases reforms downward ($\partial r/\partial \gamma < 0$) and the cost of this is proportional to the severity of underinvestment in equilibrium, $[\beta f'(r) - 1] > 0$. Using (15) and (16) and simplifying terms, the first-order condition for an interior optimum is:

$$MB(\gamma) = \kappa^2 = -\frac{\partial r}{\partial \gamma}\gamma = MC(\gamma). \tag{24}$$

To characterize the solution to (24), in Figure 3 we plot both MB and MC as a function of γ. The MB curve is represented by the dashed, flat, line.[19] The MC curve (solid line) starts at zero and may be non monotonic (the Figure shows two possible cases). Its slope is analyzed formally in Lemma 1:

Lemma 1 *The marginal cost of γ is increasing if and only if*

$$f''(r)^2 > f'''(r)\,\overline{g}\gamma.$$

Proof. *See Appendix* ■

The condition in Lemma 1 is always satisfied when $\gamma \to 0$ and also if $f'''(r) < 0$. Yet, when $f'''(r) > 0$ (e.g., for $f = r^\alpha$ with $0 < \alpha < 1$), MC may be hump-shaped. In what follows, we restrict attention to the most interesting case in which MB and MC intersect once and only once over the relevant range $\gamma \in [0, (a^{\max}/\kappa - 1)/\overline{g}\beta]$.[20] Under this restriction, the solution, γ^*, to (24) is unique and interior, and the MC curve must be positively sloped at γ^*. We study the comparative statics of γ^* to changes in parameters

[18] For example, Besley (2004) reports that the US president is paid around $400,000, the British prime minister $270,000, while the French president $70,000. See Diermeier et al. (2005) for a pioneering attempt at quantifying and decomposing the returns to a career in the US Congress.

[19] The MB curve is flat because effort is linear in γ, which in turn depends on the assumption of a quadratic cost of a. Our results generalize to sufficiently convex cost functions.

[20] Recall that there exists an upper bound to effort, $a^{\max}$. Therefore, it is never optimal to offer a compensation higher than the minimum level inducing the maximum effort.

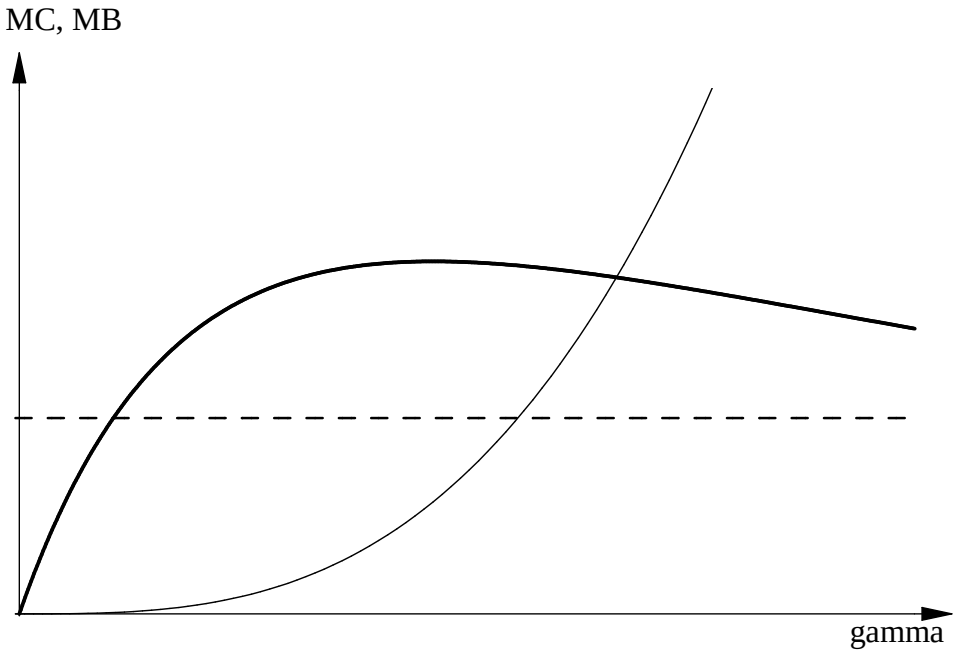

Figure 3: Opimal γ: Solid = MC, Dashed = MB

in the following proposition.[21]

Proposition 4 *The socially optimal political reward,*

$$\gamma^* = \frac{-\kappa^2 f''(r)}{\overline{g}},$$

is increasing in the variance of both noise (σ_ε^2) and ability (σ_θ^2), and in the value of effort (κ):

$$\frac{\partial \gamma^*}{\partial \sigma_\varepsilon^2} > 0; \quad \frac{\partial \gamma^*}{\partial \sigma_\theta^2} > 0; \quad \frac{\partial \gamma^*}{\partial \kappa} > 0.$$

Proof. *See Appendix* ■

An increase in uncertainty (due to either ability dispersion or noise) affects the marginal cost of political compensation while leaving its marginal benefit unaffected. Higher uncertainty means that chance plays a bigger role in reelection, implying that r becomes less reactive to γ. From (24) we see that this reduces the marginal cost of γ. As a result, optimal political compensation increases. A higher value of effort, κ, raises the

[21] Thus, the upper bound on a rules out the rather extreme and not very realistic case in which social welfare is maximized for $\gamma \to \infty$ and $a \to \infty$.

marginal benefit of γ while leaving the marginal cost unaffected. Therefore, the optimal compensation increases with the value of effort.

4.3 Term Limit

A key reason why reforms are too low is that incumbents care not only about social welfare, but also their reelection. Thus, a way to align the incentives of politicians to do reforms and those of the society would be to rule out the possibility of reelection by imposing a one-period term limit. This would set both p and $\partial p/\partial r$ to zero and restore the first-best investment in reforms. Yet, without electoral incentives, incumbents will put less effort. Moreover, by excluding reelection, citizens forego the opportunity of retaining well performing candidates.[22] Therefore, despite its negative effect on reforms, the prospect of reelection may be in the interest of the society, although a one-term limit might be optimal under some conditions. We now explore this possibility formally.

The equilibrium under a one-term limit is characterized by $r = r^{FB}$, $a = \kappa$ and $\delta = 0$. Ruling out reelection is socially optimal if it grants an ex-ante expected social welfare, W^{TL}, higher than W, i.e., when:

$$W^{TL} - W = \left[\beta f\left(r^{FB}\right) - r^{FB} - \left(\beta f\left(r\right) - r\right)\right] - \beta\left(\frac{\delta}{2} + \kappa^2\overline{g}\gamma\right) > 0.$$

The first term in square brackets, which is always positive, is the gain from a term limit due to the higher investment in reforms. The second term, instead, is the loss in social welfare for giving up selection and lowering effort. Rearranging and using (19) yields that a one-term limit is socially optimal if and only if:

$$\left[\beta f\left(r^{FB}\right) - r^{FB} - \left(\beta f\left(r\right) - r\right)\right] > \beta\overline{g}\left(\sigma_\theta^2 + \kappa^2\gamma\right) \tag{25}$$

This condition is more likely to hold when selection is not very useful or effective, ability has low value, and reforms are highly needed. More precisely, an increase in κ raises the RHS of (25) thereby making the optimality of a term-limit less likely.

The effect of uncertainty is instead more complex. First, note that σ_θ^2 and σ_ε^2 do not affect W^{TL}, but have ambiguous effects on W, as discussed in Proposition 3. More uncertainty lowers the LHS of (25), because it reduces the underinvestment in reforms (recall, r converges monotonically to r^{FB} as either $\sigma_\theta^2 \to \infty$ or $\sigma_\varepsilon^2 \to \infty$). This tends to make a term limit less attractive. Yet, the effect on the RHS of (25) may depend on

[22] See Besley and Case (1995) for evidence that term limits do apper to affect policy choices. Yet, from their results it is difficult to sort out the effects on effort and on reforms.

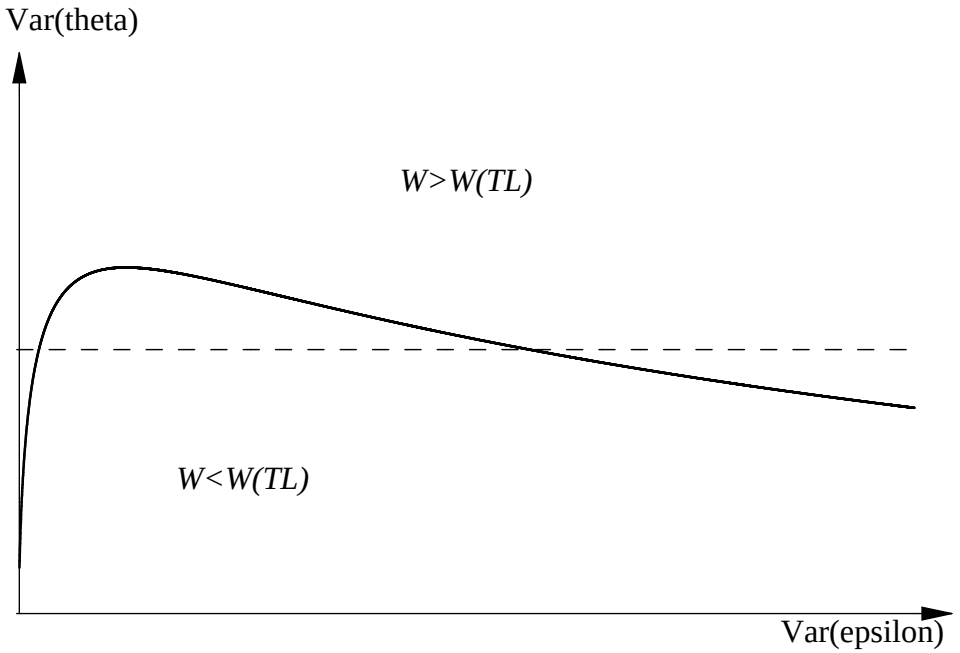

Figure 4: Uncertainty and Term Limit

the source of uncertainty. When there is more political heterogeneity (higher σ_θ^2) there is more to gain from ex-post selection, but there is also less effort in an equilibrium with reelections. The first effect dominates, so that the RHS of (25) increases if:

$$\frac{\partial\left[\overline{g}\left(\sigma_\theta^2+\kappa^2\gamma\right)\right]}{\partial\sigma_\theta^2}>0\Longleftrightarrow\sigma_\theta^2+2\sigma_\varepsilon^2>\kappa^2\gamma$$

Thus, if σ_θ^2 is sufficiently high, a term limit is never optimal.

An increase in σ_ε^2, instead, worsens selection and lowers the RHS of (25). Since it also lowers the LHS, it is unclear whether or not it makes a term-limit more attractive. Despite this ambiguity, it can be shown that, if σ_ε^2 is high enough, imposing the term limit cannot be optimal. The reason is that, as $\sigma_\varepsilon^2\to\infty$, W converges to W^{TL} and $\partial W/\partial\sigma_\varepsilon^2<0$ (the latter follows from Proposition 3), implying that W must converge from above. Thus, we must have $W>W^{TL}$ when the noise is sufficiently high. We summarize this discussion in the following Proposition (proof in the text):

Proposition 5 *There exists a threshold level of heterogeneity in political ability, $\widehat{\sigma}_\theta^2$, such that for $\sigma_\theta^2>\widehat{\sigma}_\theta^2$ holding elections without the term limit is socially optimal. There exists a threshold level of economic volatility, $\widehat{\sigma}_\varepsilon^2$, such that for $\sigma_\varepsilon^2>\widehat{\sigma}_\varepsilon^2$ holding elections without the term limit is socially optimal.*

More generally, the desirability of a term limit is depicted in Figure 4 in the space $(\sigma_\varepsilon^2, \sigma_\theta^2)$. In the region below the solid line, welfare is higher when a term limit is in place. Clearly, if σ_θ^2 is high enough so that selection is sufficiently important, a term limit is never optimal. Similarly, if σ_ε^2 is high enough, imposing the term limit cannot be optimal either. Moreover, as the figure shows, depending on parameters, a term limit may be more likely to be optimal for intermediate values of noise. For example, this is the case when the degree of heterogeneity in political ability corresponds to the dashed line. This happens because, for low σ_ε^2 selection is very effective and effort is high, this compensating the underinvestment in reforms.

5 Robustness and Extensions

We now study the robustness of the main results derived in Section 3 to alternative assumptions. In particular, we show that when politicians are aware of their own ability, their equilibrium choices (r and a) will depend on talent, θ. Yet, the political cost of reform is still present in this version of the model and is still decreasing in the degree of uncertainty they face. Next, we study the extensive margin of reforms in a version of the model where the choice of r is discrete and find the new result that the political cost is increasing in the size of reforms. Lastly, we discuss how the model can shed light on the empirical correlation between reforms and reelection.

5.1 Political Ability and Reforms

If the incumbent knows his ability θ_i before choosing reforms, the voting strategy does not change since citizens can only condition their choice on y_t and they cannot disentangle θ_i from ε_t. This means that the optimal rule is to reelect the incumbent if performance is above the level expected from the *average* politician, $y_t \geq \tilde{y} \equiv \overline{\theta} + \kappa a^e\left(\overline{\theta}\right) - r^e\left(\overline{\theta}\right)$, where $r^e\left(\overline{\theta}\right)$ and $a^e\left(\overline{\theta}\right)$ are the equilibrium level of reforms and effort chosen by politicians with ability $\theta_i = \overline{\theta}$.[23] The problem facing incumbent i is now different:

$$\max_{\{r,a\}} \left\{ \theta_i - r_i + \kappa a_i - \frac{a_i^2}{2} + \gamma + \beta \left[p_i \left(\theta_i + \gamma \right) + \left(1 - p_i \right) \overline{\theta} + f\left(r_i \right) \right] \right\} \tag{26}$$

[23] This is true so long as, given the equilibrium strategy of the incumbent, high-θ politicians generate, *ceteris paribus*, higher y_t. As shown below, this condition holds in the present case.

subject to:

$$\begin{aligned} p_i &= \Pr\left(y_t \geq \tilde{y}\right) = \Pr\left(\theta_i + \kappa a_i - r_i + \varepsilon_t \geq \tilde{y}\right) \\ &= 1 - H\left(\tilde{y} - \theta_i + r_i - \kappa a_i\right), \end{aligned} \tag{27}$$

where H is the c.d.f. of $\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)$, with density h. The perceived reelection probability, p_i, is still decreasing in reforms and increasing in effort:

$$\frac{\partial p_i}{\partial r_i} = -h\left(\tilde{y} - \theta_i + r_i - \kappa a_i\right) < 0, \tag{28}$$

$$\frac{\partial p_i}{\partial a_i} = \kappa h\left(\tilde{y} - \theta_i + r_i - \kappa a_i\right) > 0. \tag{29}$$

The first-order conditions to the incumbent's problem are:

$$\beta f'\left(r_i\right) = 1 - \beta \frac{\partial p_i}{\partial r_i}\left(\theta_i - \overline{\theta} + \gamma\right), \tag{30}$$

$$a_i = \kappa + \beta \frac{\partial p_i}{\partial a_i}\left(\theta_i - \overline{\theta} + \gamma\right). \tag{31}$$

The main difference with respect to equations (12) and (13) is that investment in reforms and effort now varies with ability. In particular, compared to (21), incumbents with very low ability ($\theta_i < \overline{\theta} - \gamma$) overinvest in reforms to voluntarily reduce their reelection probability, because the cost of having a bad politician outweighs their private benefit from remaining in office. All the other politicians (with $\theta_i > \overline{\theta} - \gamma$) adopt too little reforms, as in the previous section. Similarly, good politicians put more effort to increase their reelection probability p_i, because the value of staying in power is now increasing in θ_i.[24]

Although p_i, r_i and a_i are ability specific, it is important to characterize the equilibrium for the average politician (with $\theta_i = \overline{\theta}$), because it allows to solve for $\tilde{y}$. Imposing $\theta_i = \overline{\theta}$ and rational expectations ($r_i = r^e\left(\overline{\theta}\right)$ and $a_i = a^e\left(\overline{\theta}\right)$) into (28)-(31), the first-order conditions of the average-ability incumbent become:

$$\begin{aligned} \beta f'\left(r\left(\overline{\theta}\right)\right) &= 1 + \beta \overline{h} \gamma \\ a\left(\overline{\theta}\right) &= \kappa\left(1 + \overline{h}\beta\gamma\right) \end{aligned}$$

with $\overline{h} = \left[2\pi\sigma_\varepsilon^2\right]^{-1/2}$. Comparing these conditions to (15) and (16), we see that the average politician now makes less reforms and puts more effort than in Section 3. This is because the incumbent faces a lower degree of political uncertainty (he knows his own

[24] The result that good politicians make less reform may appear unappealing. Yet, this result can be overturned by assuming that good politicians are also relatively better at doing reforms, i.e., $\frac{\partial^2 f(r_i, \theta_i)}{\partial r_i \partial \theta_i} > 0$.

type, θ_i) and, as already discussed, lower uncertainty implies less reforms and more effort. For the same reason, $r\left(\bar{\theta}\right)$ and $a\left(\bar{\theta}\right)$ do not depend on σ_θ^2 anymore, since the only source of uncertainty for the incumbent is now the noise shock, ε. Yet, a higher volatility of ε increases (reduces) the average level of reforms (effort), precisely as in Proposition 1.

It is also interesting to note that, for politicians of very high or very low ability, uncertainty may now *increase* the political cost of reforms. Formally, from (28), $-\partial p_i/\partial r_i$ becomes a positive function of σ_ε^2 for sufficiently high or low θ_i, because the density $h(\cdot)$ in the tails gets fatter when the variance increases. Thus, uncertainty lowers investment in reforms of very good or very bad politicians, but politicians in the tails are a minority only. In sum, while the effects are now more nuanced, uncertainty still unambiguously reduces the political cost of reforms to the average politician.

5.2 Discrete Choice of Reforms

So far, we have modelled investment in reforms as a continuous variable. While this approach is useful to study the intensity of reforms and may be appropriate, for instance, for some budget policies, often times reforms – particularly the bigger ones – come rarely and discontinuously. We now consider this possibility by assuming that the incumbent faces the binary choice of whether or not to implement a reform of a given size $R > 0$. Formally, $r \in \{0, R\}$. It turns out that this case is somewhat simpler when politicians are aware of their ability.[25] We therefore maintain the assumption, introduced in the previous Section, that θ_i is known to the incumbent.

We also assume that the value of reforms, $f(r)$, is stochastic and is drawn from any non-degenerate distribution. This modeling strategy is standard in models where investment in some public good may fluctuate, as for example in Battaglini and Coate (2008), and will yield the result that reforms are implemented ($r = R$) only if the realized value, $f(R)$, is high enough. Consistently with the informational assumptions maintained so far, we consider the case in which the realization of $f(r)$ is equally known both to voters and the government. Thus, there are periods in which reforms, such as reducing deficits in order to avoid EU sanctions, are highly needed and this is public information. In this setting, a social planner would implement a reform of size R if its social value is greater than its cost:

$$\beta f(R) > R. \tag{32}$$

The problem of the incumbent is to choose $r \in \{0, R\}$ so as to maximize (26) subject

[25] The reason is that, with a discrete choice of r, we cannot apply anymore the envelope argument that allows us to disregard from the first-order conditions the effect of reforms on the expected ability of the politician in office in the second period.

to (27). The politician will choose $r = R$ if this yields a higher utility than $r = 0$. This is the case if the following condition is satisfied:

$$\beta f(R) > R + \beta (p_0 - p_R) \left[\theta_i - \overline{\theta} + \gamma\right],$$

where p_0 and p_R are the perceived probability of being reelected conditional on choosing $r = 0$ and $r = R$, respectively. That is, the reform is implemented if its social value (the LHS) is greater than its social cost (the first term on the RHS) plus its political cost (the second term on the RHS).

As before, we focus on the choice of the average politician. Imposing $\theta_i = \overline{\theta}$, we have that $r = R$ as long as:

$$\beta f(R) \geq R + \beta\gamma (p_0 - p_R), \tag{33}$$

where, from (27) and rational expectation, $p_0 = 1 - H(-R)$ and $p_R = 1 - H(0)$. Recalling that H is the c.d.f. of $\varepsilon \sim N\left(0, \sigma_\varepsilon^2\right)$ and using the properties of normal distributions, we have:

$$p_0 - p_R = \frac{1}{2} - H(-R) = \Phi\left(\frac{R}{\sigma_\varepsilon}\right) - \frac{1}{2} \geq 0 \tag{34}$$

where $\Phi(\cdot)$ is the c.d.f. of the standard normal distribution, $N(0, 1)$. Equations (33) and (34) confirm the existence of a political cost of reforms which is decreasing in the level of uncertainty, σ_ε. Moreover, this version of the model yields the new result that the political cost of reforms is higher when reforms are large (high R). Finally, even in this case, voters have rational expectations on whether the reform will be implemented or not and therefore the equilibrium choice over r has no bearings on the reelection probability. Yet, compared to (32), too few reforms are undertaken because of their out-of-equilibrium political cost.

5.3 Reforms and Reelection

We now briefly discuss how our model can help interpreting the empirical evidence on the correlation between reforms and reelection. Under the assumptions maintained so far, despite their political cost, reforms do not affect the reelection probablity. Yet, the model can be generalized to show how the relationship between r and p may depend on the information set of agents.

Suppose that the social *cost* of reforms is random and it is observed by the incumbent only. Then, a politician facing a lower than average cost of reforms will be able to increase both r, y and hence p. In this way, the model can reconcile the reluctance of adopting reforms for fear of losing elections with the evidence that reforms seem to be rewarded,

rather than punished, by voters (e.g., Alesina et al. 1998 and Brender and Drazen, 2008). On the contrary, if the *value* of reforms is random and observed by the incumbent only, then the relationship between r and p may turn negative. In the presence of a high realization for the value of reforms, the incumbent will be willing to choose a larger than expected r although this reduces p below one half. This suggests that the correlation between reforms and reelection is not necessarily informative of the existence of a political cost of reforms and this should be taken into account in the empirical work.

6 Conclusions

The contributions of this paper can be summarized as follows. First, we have formalized in a fully-rational model the popular idea that politicians perceive an electoral cost in adopting costly reforms with future benefits, even when reformist governments are not punished by voters. Second, we have shown how uncertainty is likely to make reforms politically more viable. Third, while uncertainty promotes the adoption of welfare-enhancing reforms, it may also worsen political selection and accountability. As a result, its net welfare effect may be ambiguous. Fourth, we have used the model to study the optimal level of political compensation. Our theory suggests that the optimal reward should trade off the benefit of higher effort with the cost of more underinvestment in reforms. It follows that politicians should be rewarded more when effort is relatively more important than reforms and uncertainty is high. Fifth, we have shown that imposing a term limit promotes reforms, but it is welfare reducing when political ability is sufficiently heterogenous and uncertainty high.

We conclude by mentioning some limitations of our model and suggestions for future work. Although our results have been derived in a two-period model, we expect them to hold qualitatively in an infinite horizon setup. A simple way to show this would be by assuming that the agency game between voters and politicians is repeated and that incumbents have a two-term limit. In this case, since politicians at the second mandate would do more reforms, but put less effort, than a new challenger, the model could explain the so called incumbency advantage (e.g., see Alesina and Rosenthal, 1995). That is, provided that reforms are more important than effort, the equilibrium probability of being reelected would be higher than one half. Alternatively, one could consider a richer time structure and assume that ability follows a first-order moving average process, as in Rogoff (1990).

Another limitation of our approach is that it takes uncertainty as exogenous. In many instances, for example when uncertainty arises from global economic shocks or from a lack of transparency rooted in institutions or cultural traits, this is a reasonable approximation.

Yet, some political reforms may be aimed precisely at lowering uncertainty, either by means of economic stabilization or through improved monitoring and accountability procedures. Allowing policy makers to affect the degree of uncertainty they are exposed to would add feedback effects and seems an interesting direction for future research.

The model could also be extended to include other aspects of reforms, such as their redistributional implications, that are often considered as important. While our goal was to provide an explanation for the political resistance to reform that complements those based on conflicting interests, combining these approaches will certainly produce interesting results. For instance, if politicians could target certain groups to bear the cost of reform, then the model might imply timid reforms whose costs are efficiently shared when uncertainty is low and bold reforms that are disproportionately costly for political losers when uncertainty is high. This would be consistent with the finding that reforms tend to generate winners and losers for political reasons rather than economic necessity (see, for example, Alesina and Drazen, 1991 and Alesina et al. 2006).

Finally, although we have discussed some notable empirical support for our theory, including new evidence on the correlation between economic uncertainty and fiscal policy reforms, a formal test of the model's predictions goes beyond the scope of this paper. For example, some implications that could easily be taken to the data are that technical governments or governments close to a term limit should be more incline to reform, and that more reforms should be adopted at the beginning of legislatures.[26] More generally, we hope that our paper will stimulate new empirical investigations of the underexplored links between instability, elections and the adoption of reforms.

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7 Appendix

7.1 Proof of Proposition 1

Implicit differentiation of (15) with respect to σ_ε^2, σ_θ^2 and γ, and using (17) yields:

$$\frac{\partial r}{\partial \sigma_\varepsilon^2} = \frac{\gamma}{f''(r)}\frac{\partial \overline{g}}{\partial \sigma_\varepsilon^2} = -\frac{\gamma}{f''(r)}\frac{\overline{g}}{2(\sigma_\theta^2+\sigma_\varepsilon^2)} > 0 \tag{35}$$

$$\frac{\partial r}{\partial \sigma_\theta^2} = \frac{\gamma}{f''(r)}\frac{\partial \overline{g}}{\partial \sigma_\theta^2} = -\frac{\gamma}{f''(r)}\frac{\overline{g}}{2(\sigma_\theta^2+\sigma_\varepsilon^2)} > 0 \tag{36}$$

$$\frac{\partial r}{\partial \gamma} = \frac{\overline{g}}{f''(r)} < 0, \tag{37}$$

since marginal returns to reforms are assumed to be decreasing ($f''(r) < 0$).

Differentiation of (16) with respect to σ_ε^2, σ_θ^2 and γ, and using (17) yields:

$$\frac{\partial a}{\partial \sigma_\varepsilon^2} = \frac{\partial a}{\partial \sigma_\theta^2} = -\frac{\kappa\beta\gamma\overline{g}}{2(\sigma_\theta^2+\sigma_\varepsilon^2)} < 0 \tag{38}$$

$$\frac{\partial a}{\partial \gamma} = \kappa\overline{g}\beta > 0. \tag{39}$$

7.2 Proof of Proposition 3

Differencing social welfare (20) w.r.t. σ_ε^2 yields:

$$\frac{\partial W}{\partial \sigma_\varepsilon^2} = \frac{\partial a}{\partial \sigma_\varepsilon^2}\kappa + \left[\beta f'(r) - 1\right]\frac{\partial r}{\partial \sigma_\varepsilon^2} + \frac{\beta}{2}\frac{\partial \delta}{\partial \sigma_\varepsilon^2}.$$

After replacing the term in the bracket with (15), the derivatives $\partial a/\partial\sigma_\varepsilon^2$ and $\partial r/\partial\sigma_\varepsilon^2$ from (38) and (35), and $\partial\delta/\partial\sigma_\varepsilon^2 = -\sigma_\theta^2\overline{g}/\left(\sigma_\theta^2+\sigma_\varepsilon^2\right)$, obtains:

$$\frac{\partial W}{\partial \sigma_\varepsilon^2} = \frac{\beta\overline{g}}{2\left(\sigma_\theta^2+\sigma_\varepsilon^2\right)}\left[-\frac{\overline{g}\gamma^2}{f''(r)} - \sigma_\theta^2 - \kappa^2\gamma\right].$$

This is positive if and only if the term in brackets is positive, i.e.,

$$\frac{\partial W}{\partial \sigma_\varepsilon^2} > 0 \Longleftrightarrow -\frac{\overline{g}\gamma^2}{f''(r)} > \sigma_\theta^2 + \kappa^2\gamma.$$

Differencing social welfare (20) w.r.t. σ_θ^2 yields:

$$\frac{\partial W}{\partial \sigma_\theta^2} = \frac{\partial a}{\partial \sigma_\theta^2}\kappa + \left[\beta f'(r) - 1\right]\frac{\partial r}{\partial \sigma_\theta^2} + \frac{\beta}{2}\frac{\partial \delta}{\partial \sigma_\theta^2}$$

After replacing the term in the bracket with (15), the derivatives $\partial a/\partial \sigma_\theta^2$ and $\partial r/\partial \sigma_\theta^2$ from (38) and (36), and $\partial \delta/\partial \sigma_\theta^2 = \overline{g}\left[2 - \sigma_\theta^2(\sigma_\theta^2 + \sigma_\varepsilon^2)^{-1}\right]$, obtains:

$$\frac{\partial W}{\partial \sigma_\theta^2} = \frac{\beta \overline{g}}{2(\sigma_\theta^2 + \sigma_\varepsilon^2)}\left[-\kappa^2\gamma - \frac{\gamma^2}{f''(r)}\overline{g} + \sigma_\theta^2 + 2\sigma_\varepsilon^2\right]$$

This is positive if and only if the term in brackets is positive, i.e.,

$$\frac{\partial W}{\partial \sigma_\theta^2} > 0 \Longleftrightarrow \sigma_\theta^2 + 2\sigma_\varepsilon^2 - \frac{\gamma^2 \overline{g}}{f''(r)} > \kappa^2\gamma.$$

7.3 Proof of Lemma 1

Recall:

$$MC(\gamma) = -\frac{\partial r}{\partial \gamma}\gamma = -\frac{\overline{g}}{f''(r)}\gamma$$

where we have substituted (37). Differencing $MC(\gamma)$ w.r.t. γ yields:

$$\begin{aligned}\frac{\partial MC(\gamma)}{\partial \gamma} &= \frac{\overline{g}\gamma}{[f''(r)]^2} f'''(r)\frac{\partial r}{\partial \gamma} - \frac{\overline{g}}{f''(r)} \\ &= -\frac{\overline{g}}{f''(r)}\left[1 - \frac{f'''(r)}{f''(r)^2}\overline{g}\gamma\right].\end{aligned}$$

This expression is positive if and only if the term in brackets is positive, i.e.

$$\frac{\partial MC(\gamma)}{\partial \gamma} > 0 \Longleftrightarrow f''(r)^2 > f'''(r)\,\overline{g}\gamma.$$

7.4 Proof of Proposition 4

From:

$$\gamma^* = \frac{-\kappa^2 f''(r)}{\overline{g}}$$

it is immediate to see that γ^* is increasing in κ. To find the effect of uncertainty, note that:

$$\frac{\partial \gamma^*}{\partial \sigma_\varepsilon^2} = \frac{\partial \gamma^*}{\partial \sigma_\theta^2} = \frac{\partial \gamma^*}{\partial \overline{g}}\frac{\partial \overline{g}}{\partial \sigma_x^2} = -\frac{\partial \gamma^*}{\partial \overline{g}}\frac{\overline{g}}{2(\sigma_\theta^2 + \sigma_\varepsilon^2)}$$

for $x = \varepsilon, \theta$. Next, derive γ^* w.r.t. $\overline{g}$:

$$\frac{\partial \gamma^*}{\partial \overline{g}} = \frac{\kappa^2 f''(r) - \kappa^2 f'''(r) \frac{\gamma \overline{g}}{f''(r)}}{\overline{g}^2} < 0,$$

under the condition in Lemma 1, which is assumed to be satisfied at γ^*. Thus, $\partial \gamma^* / \partial \sigma_\varepsilon^2 = \partial \gamma^* / \partial \sigma_\theta^2 > 0$.

Table 1. Economic Volatility and the Number of Reforms
OECD Countries, 1975-2000 - Cross Section

SD	0.946**	1.023**	0.930***	0.929**	0.993***	0.814**
	[0.371]	[0.455]	[0.332]	[0.384]	[0.334]	[0.332]
log(GDP_75)		0.453				
		[2.386]				
DEFICIT			-0.022		0.158	
			[0.163]		[0.140]	
#_CRISIS_DEF				0.022	0.084	0.091
				[0.071]	[0.098]	[0.071]
#_left						0.139**
						[0.063]
#_younggov						-0.136
						[0.063]
parliamentary						-0.162
						[0.694]
R-squared	0.148	0.150	0.149	0.153	0.216	0.489
Observations	20	20	20	20	20	20

Note. Dependent variable: # of Deficit Reform = number of years with the annual change in DEFICIT (= government deficit as a share of GDP) smaller than or equal to -1.17% over the sample period. Regressors are: SD = standard deviation of the output gap over the sample period; log(GDP_75) = log of real GDP per capita in 1975; DEFICIT in period average; #_CRISIS_DEF= number of years with DEFICIT less than or equal to -7.5; #_left = number of years with left-wing governments; #_younggov = number of years with governments in the first two years of office; parliamentary= dummy for parliamentary (as opposed to presidential) systems. Regressions are performed with ordinary least squares. Robust standard errors are reported in brackets. ***, ** and * denote significance at 1, 5 and 10 per cent level.

Table 2. Economic Volatility and the Likelihood of Reforms
OECD Countries, 1975-2000 - Panel

SD_1	0.290*	0.320**	0.346**	0.260***	0.348***	0.320**
	[0.159]	[0.163]	[0.164]	[0.070]	[0.161]	[0.164]
DEFICIT_1	0.153***	0.114**	0.231***	0.300*	0.317***	0.321***
	[0.047]	[0.052]	[0.058]	[0.157]	[0.076]	[0.078]
OUTPUTGAP_1		0.093				
		[0.060]				
log(GDP_1)			-4.288***		-3.934***	-3.925***
			[1.471]		[1.480]	[1.510]
CRISIS_DEF_1				1.502**	1.502**	1.270*
				[0.675]	[0.675]	[0.693]
election_1						-0.238
						[0.334]
left_1						-0.330
						[0.364]
younggov_1						-0.511
						[0.372]
Observations	342	342	342	342	342	342
Countries	19	19	19	19	19	19
Country-FE	Yes	Yes	Yes	Yes	Yes	Yes

Note. Dependent variable is Deficit Reform = dummy taking value 1 if the annual change in DEFICIT is less than or equal to -1.17%, zero otherwise. Covariates are lagged values of: DEFICIT = government deficit as a share of GDP; SD = standard deviation of the output gap over the previous five years; OUTPUTGAP; log(GDP) = log of real GDP per capita; CRISIS_DEF= dummy taking value 1 if DEFICIT is less than or equal to -7.5; election = dummy for legislative and/or executive elections; left = dummy for left-wing governments; younggov = dummy for governments in the first two years of office. Regressions are performed with panel logit with country fixed effects. Standard errors are reported in brackets. ***, ** and * denote significance at 1, 5 and 10 per cent level.

Table 3. Economic Volatility and Reforms
OECD Countries, 1975-2000 - Panel LSDV

SD_1	-0.332**	-0.344**	-0.352**	-0.351**	-0.369***	-0.334**
	[0.148]	[0.152]	[0.146]	[0.148]	[0.145]	[0.149]
DEFICIT_1	0.843***	0.852***	0.775***	0.725***	0.682***	0.687***
	[0.047]	[0.047]	[0.047]	[0.047]	[0.047]	[0.047]
OUTPUTGAP_1		-0.024				
		[0.048]				
log(GDP_1)			0.0001***		0.0001***	0.0001***
			[0.00005]		[0.00005]	[0.00005]
CRISIS_DEF_1				-1.317***	-1.151***	-1.099***
				[0.434]	[0.428]	[0.431]
election_1						0.269
						[0.263]
left_1						0.353
						[0.286]
younggov_1						0.518*
						[0.290]
R-squared	0.743	0.745	0.732	0.743	0.739	0.742
Observations	346	346	346	346	346	346
Countries	20	20	20	20	20	20

Note. Dependent variable is DEFICIT = government deficit as a share of GDP. Regressors are lagged values of: DEFICIT; SD = standard deviation of the output gap over the previous five years; output gap; log(GDP) = log of real GDP per capita; CRISIS_DEF = dummy taking value 1 if DEFICIT is less than or equal to -7.5; election = dummy for legislative and/or executive elections; left = dummy for left-wing governments; younggov = dummy for governments in the first two years of office. Regressions are performed with least squares (LSDV) with country fixed effects. Standard errors, in brackets, are corrected for heteroskedasticity and consistency with Kiviet (1995) procedure. ***, ** and * denote significance at 1, 5 and 10 per cent level.