A Model of Politics and the Central Bank

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Abstract

We present a two-period model examining how the central bank and the elected executive jointly shape economic outcomes, political selection, and accountability of the executive. The central bank is apolitical, minimizing a quadratic per-period loss function in inflation and unemployment, and trading off inflation and unemployment along an expectational Phillips curve. The elected government's quality shifts unemployment for any given level of inflation. After observing first-period unemployment, fully rational voter-households optimally choose between the incumbent, whose quality remains constant, versus a challenger of unknown quality. This simple setup allows us to derive a rich set of conclusions. First, an inflation-averse central bank increases incumbency advantage, or the likelihood that below-average incumbents are reelected. As a result, incumbents prefer more inflation-averse central banks than the social planner, rationalizing the political success of inflation-targeting central banks in practice. Second, in contrast to models without political selection, by increasing incumbency advantage an inflation-averse central bank raises long-term unemployment and can lower unemployment variability. Third, the adverse unemployment effects of inflation-averse central banks are compounded when the incumbent must also exert costly effort.

1 Introduction

This paper starts from the simple observation that in modern economies the elected executive has delegated a substantial portion of macroeconomic policy to an independent central bank. While independent central banks have been instrumental in taming the high inflation of the 1970s and 1980s, new tensions are inevitable as economic outcomes are jointly determined by monetary and fiscal policy, and economic outcomes, in turn, determine voters' choice at the ballot box. It is therefore paramount to understand whether monetary policy affects the political fortunes and incentives of the elected executive, and thereby has so far underappreciated economic consequences.

Recent public debate has made it abundantly clear that monetary policy reacts to politically generated shocks, and that monetary policy is perceived to affect elections. For example, Federal Reserve Chair Jerome Powell recently clarified that the Federal Reserve would respond to economic shocks resulting from the executive just like to any other economic shock within its mandate of employment and price stability.[2] In line with this statement, the Federal Reserve subsequently eased monetary policy in response to trade shocks and to gaps in the political response to Covid-19. At the same time, President Trump clearly expects that monetary policy affects his own chances of being reelected.[3] However, so far there has been little research trying to understand how inflation, employment, and political outcomes are affected by this interdependence between the executive and the central bank.

We present a formal model examining how the central bank and the elected executive

[2] "Challenges for Monetary Policy", a speech by Jerome H. Powell at the Challenges for Monetary Policy symposium, sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, WY, August 23, 2019. The U.S. Federal Reserve's official mandate requires it to promote "maximum employment, stable prices, and moderate long-term interest rates". See e.g. https://www.federalreserve.gov/aboutthefed/section2a.htm

[3] See e.g. Smialek, Jeanna (2019-08-23). "Powell Highlights Fed's Limits. Trump Labels Him an 'Enemy'". The New York Times. Bianchi et al. (2019) provide direct empirical evidence of pressure on the Federal Reserves using high-frequency financial data.

jointly shape economic outcomes, and political selection and accountability of the executive. Overall, we show that a central bank that relatively cares more about inflation than about fighting unemployment has negative impacts on political selection and accountability, as lower quality incumbents are reelected and governments exert less effort to fight unemployment. As a result, average unemployment is higher than it would be under a central bank that conducts a more inflationary policy.

Our two-period model combines a classical model of central banking (Barro and Gordon (1983), Rogoff (1985)) with a simple model of non-partisan political turnover (Ferejohn (1986)). There are three groups of agents: the central bank, the government, and voters. The central bank is apolitical in that it strictly follows a mandate to minimize fluctuations in inflation and unemployment, formally captured through a per-period loss function that is quadratic in both inflation and unemployment.[4] We label a central bank with a high weight on inflation fluctuations *inflation-averse*, whereas a central bank with a low weight on inflation fluctuations is *unemployment-averse*. The central bank trades off higher inflation against unemployment along a standard expectational Phillips curve, where public inflation expectations are formed rationally anticipating the central bank's response. On the monetary policy side, our only departure from the standard model is that shocks to unemployment are not exogenous. Instead they relate to the quality of the government.

We combine this model of monetary policy with the simplest possible setup of electoral control. As in Ferejohn (1986), there are no differences across voters and governments are endowed with a random exogenous quality, drawn from a known prior. At the end of period 1, based on observed economic outcomes, rational voters learn the incumbent government's

[4]We thereby differ from an older literature (Nordhaus (1975), Wooley (1984), Beck (1990), Chappell Jr et al. (1993)), where the interaction between the central bank and the political process is driven either by the executive branch's influence on the central bank or the central banker's concern for the future.

quality and optimally decide whether to retain the incumbent or to draw a new government of unknown quality, rationally anticipating the central bank's response to the unemployment frictions arising from the second-period government. Voters seek to minimize a period-2 social loss function that takes the same form as the central banks' loss function. However, the social weight on inflation versus unemployment fluctuations may be different, consistent with Rogoff (1985)'s proposal to appoint a "conservative central banker" with a stronger distaste of inflation than the public's, and with mandates of inflation-targeting central banks in practice.

We start by showing that the model exhibits *incumbency advantage*, or the tendency of below-average quality incumbents to be reelected. Equilibrium political selection in our model takes the form of a threshold rule, whereby the incumbent is reelected if, based on the economic outcomes, her quality is perceived to be sufficiently high. The threshold reflects voters' trade-off between retaining the incumbent of known quality versus choosing a new government with greater uncertainty. Voters reelect incumbents of below-average quality because they are willing to tolerate the downstream economic consequences of a below-average incumbent, in exchange for the reduction in unemployment and inflation volatility that a challenger of unknown quality would bring.

We next show that *an inflation-averse central bank strengthens incumbency advantage*, or voters' tendency to reelect below-average incumbents. The intuition for this surprising result goes back to classic time-inconsistency. When making their trade-off, voters anticipate that an unemployment-averse central bank will also – and indeed more effectively – smooth unemployment fluctuations arising from the challenger, should voters choose to replace the incumbent. With rational inflation expectations, economic distortions have different effects depending on whether they are anticipated or unanticipated, and voters understand this.

When the incumbent is reelected economic distortions in period 2 are anticipated, and any central bank attempts to counteract them lead to inflation bias but no employment gains. On the contrary, when the challenger is elected economic distortions in period 2 are a surprise, and the central bank can mitigate them by accepting higher-than-expected inflation. A central bank that cares only about inflation and not about unemployment therefore hurts the challenger more than the incumbent.

An immediate consequence of the above finding is that an office-motivated incumbent, or an incumbent who seeks to maximize her reelection chances, *prefers a central banker who is as inflation-averse as possible*. Our model hence provides a new explanation for the political success of inflation-targeting regimes and their sweeping adoption in the 1990s. This prediction and practice stand in contrast with the common narrative that incumbents have incentives to weaken the central bank to generate unexpected inflation, as initially formalized in Nordhaus (1975). If that were the case, an executive who appoints the central banker (as is the case in the U.S., for example) would have an incentive to appoint central bankers with preferences for lowering unemployment instead. The difference between our result and this standard narrative arises because we use a benchmark of fully rational voters who anticipate and understand how the central bank reacts to unemployment shocks.

We next show that political selection alters the link between the central bank and economic outcomes. Political selection on average has a beneficial effect on inflation and unemployment. Since voters replace the worst-performing incumbents, on average period 2 governments are of higher quality, leading to lower unemployment and inflation. However, by exacerbating incumbency advantage, an inflation-averse central bank undermines these positive effects of political selection. With political selection, appointing an inflation-averse central banker hence leads to higher unemployment and a smaller inflation benefit on average.

Through this channel, our model with political selection can rationalize a long-standing puzzle regarding the relationship between central bank independence and unemployment volatility. While the standard model of Rogoff (1985) predicts that an inflation-averse central bank comes at the cost of higher unemployment volatility, empirically this relationship has been elusive (Alesina and Summers (1993), Grilli et al. (1991)). In our model, by increasing the probability that the same incumbent will remain in office, appointing a more inflation-averse central banker can make unemployment less variable over time, provided that the initial level of inflation-aversion is sufficiently low.

In addition, our model generates new economic predictions over the political cycle. Despite an executive's quality being constant, our model generates different unemployment rates across first and second terms served by the same executive. On average, unemployment in our model is lower during the second term, and the difference is more pronounced if the government faces a more unemployment-averse central bank. This finding, however, obscures an interesting heterogeneity. Because voters know the quality of the government in its second term, the central bank becomes ineffective at mitigating unemployment shocks stemming from government's quality. As a result, below average governments perform worse and above average governments perform better in their second term.[5]

Having examined political selection, we next show that having an inflation-averse central bank also affects government's optimal effort provision. In a version of our model where the incumbent chooses costly effort, we show that an inflation-averse central bank has further adverse unemployment effects by discouraging government effort. This result follows because an incumbent expecting to be reelected with high probability under an inflation-averse central

[5]The results on better average performance in the second-term of the government hold when we abstract from government's effort. A second-term government that does not face the incentives provided by elections may not exert as much effort as it did in the first period, which in turn may make economic outcomes worse in the second term of the government. The heterogenous effect, however, still holds.

bank perceives low returns to effort.

In light of the preceding results, it is natural to investigate the classic question of the central banker's optimal inflation-aversion. We find that a social planner in our model would institute a central bank that is less inflation-averse than that chosen by the incumbent government. We also compare the socially optimal central bank inflation aversion to the famous "conservative central banker" prescription of Rogoff (1985) to appoint a central banker who is more inflation-averse than the public. In our model, the optimal inflation-aversion of the central bank relative to this prescription depends on whether the government-related economic frictions are mainly driven by the immutable quality of the government (in which case the central bank should be inflation-averse) or by government effort (in which case the central bank should be unemployment-averse).

Finally, having shown that the political fortunes of the government depend on the central bank, one may wonder whether the central bank might be tempted to stray from its official mandate and use monetary policy to change election outcomes. In particular, worrying about the long-term employment consequences of reelecting a low quality incumbent, the central bank might have an incentive to permit higher unemployment today to change voters' perception of incumbent quality.[6] We show, however, that such worries are unfounded in our model. Despite putting different weights on unemployment and inflation fluctuations, voters' and the central bank's preferences over who should be elected depend only on the central bank's inflation-aversion, and hence coincide. It follows naturally that unemployment and inflation outcomes are unaffected by the length of the central banker's tenure in our model.

Our paper adds to a recent and growing literature on macroeconomics and political

[6]Bill Dudley, the former New York Federal Reserve President, advocated for just such a policy in "The central bank should refuse to play along with an economic disaster in the making" by William Dudley, Bloomberg, August 27, 2019.

economy. Much of this literature has studied the role of fiscal rules (Azzimonti and Yared (2017), Halac and Yared (2014), Halac and Yared (2018), Dovis and Kirpalani (2020)), and has turned towards studying central banking and monetary policy only more recently (Dovis and Kirpalani (2019), Bianchi et al. (2019), Halac and Yared (2019)). We also add to the recent literature on political and economic uncertainty (Pastor and Veronesi (2012), Pastor and Veronesi (2013), Fernández-Villaverde et al. (2015), Baker et al. (2014), Baker et al. (2016)), and to the broader literature studying the interaction of monetary and fiscal policy (Lucas Jr and Stokey (1983), Calvo (1978), Lustig et al. (2008)). Our contribution to this literature is to show that a strict inflation-targeting central bank can amplify political uncertainty.

On the political economy side, our research contributes to literatures studying the interaction between the executive and other branches of government. The executive's interaction with the legislature (e.g. Alesina and Rosenthal (1996), Alesina and Rosenthal (2000)), with the bureaucracy (Fiorina and Noll (1978), Acemoglu and Verdier (2000)), and with state-owned enterprises (Shleifer and Vishny (1994)) have been subject of large literatures. The complementary question of how monetary policy is shaped by the strategic interaction of different decision makers within the central bank has recently received growing attention (Vissing-Jorgensen (2019), Vissing-Jorgensen and Morse (2020)). However, despite the significant and growing relevance of the central bank for macroeconomic policy, little is known so far known how it affects the fundamental concepts of political selection and political accountability of the executive.

2 Model

This section describes our baseline two-period model. The model has three types of agents: the central bank, the government, and the voters. Voters learn about the quality of the first-period government (the incumbent) by observing unemployment, which also reflects the central bank's reaction function. Voters then decide whether to reelected the incumbent for the second term or replace her with a challenger whose quality is unknown and must be drawn from the same prior as the incumbent's.

2.1 Monetary Policy

We start from the classical Barro and Gordon (1983) monetary policy problem.[7] Social welfare each period is represented by a loss function, that is quadratic in both unemployment and inflation:

$$\mathcal{L}_t = \frac{(u_t - \tilde{u})^2}{2} + \theta \frac{(\pi_t - \tilde{\pi})^2}{2}, \tag{1}$$

where $\tilde{u}$ and $\tilde{\pi}$ represent the socially optimal levels of unemployment and inflation and u_t and π_t represent realized unemployment and inflation. The central bank's inflation-aversion, $\tilde{\theta}$, is common knowledge and is the same in both periods.

The central bank sets policy to minimize its own loss function. The central bank's loss function takes the same form as the social loss function but the central bank's weight on inflation deviations, $\tilde{\theta}$, may be different from the social weight, θ:

$$\tilde{\mathcal{L}}_t = \frac{(u_t - \tilde{u})^2}{2} + \tilde{\theta} \frac{(\pi_t - \tilde{\pi})^2}{2}, \tag{2}$$

[7] See Drazen (2000) for a textbook exposition.

The parameter $\tilde{\theta}$ is the central bank's *inflation-aversion*, and it measures how the central banks trades off fluctuations in inflation with fluctuations in unemployment. If $\tilde{\theta}$ is large, we say that the central bank is *inflation-averse* and when $\tilde{\theta}$ is low, we say that the central bank is *unemployment-averse*.

Each period, the central bank's problem is to choose inflation π_t and unemployment u_t to minimize

$$\min_{\pi_t, u_t} \tilde{\mathcal{L}}_t$$

subject to a standard expectational Phillips curve

$$u_t = -\left(\pi_t - \pi_t^e\right) - g_t, \tag{3}$$

and the public's inflation expectations π_t^e being rational. The central bank is assumed to know inflation expectations π_t^e and the unemployment shifter g_t when choosing period t inflation and unemployment. Note that we assume that the central bank minimizes its loss function period by period, instead of minimizing the sum of its losses for periods 1 and 2. We discuss this assumption in Section 5.

The Phillips curve (3) is like in Barro and Gordon (1983), where g_t would represent an exogenous unemployment shock. However, we depart from this standard setup, because we do not take g_t to be exogenous. Instead, we assume that it represents the quality of the current government. That is the quality of the elected government is the sole source of unemployment shocks in our model.[8] In Section 3.4, we present an extension where unemployment is affected by both the government's quality and government effort.

Following the literature, we assume that the pre-existing economic distortions, such as

[8]In the previous version of this paper, we have assumed that there are two types of shocks: one coming from government's quality and one exogenous. None of the central findings were affected.

labor taxes, imply that the socially-optimal unemployment rate $\tilde{u}$ is negative. This means that it is socially desirable to push unemployment below the level that would obtain if there was no surprise inflation. Formally, unless stated otherwise, our subsequent results rely only on the assumption that $\tilde{u} < 0$. However, for intuition it is helpful to think of $\tilde{u}$ as being large in magnitude, which has the intuitive implication that higher unemployment increases the loss for voters and the central bank with probability approaching one.

2.2 Elections

Period 1 starts with the incumbent government in power. The incumbent's quality is denoted by g_I, so $g_1 = g_I$. We assume that the quality of the incumbent is drawn from $\mathcal{N}\left(0, \sigma_g^2\right)$, and is not directly observed by the voters. Instead, at the time of the election voters observe only period 1 unemployment u_1. As the reader will see, whether voters observe inflation π_1 is irrelevant in the model.

The voters' problem at the end of period 1 is to choose whether to reelect the incumbent, in which case $g_2 = g_I$, or to elect a challenger of unknown quality, in which case $g_2 = g_C$. The quality of the incumbent persists for the second period, while the quality of the challenger is drawn from $\mathcal{N}\left(0, \sigma_g^2\right)$. The quality of the incumbent and the challenger, g_I and g_C, are assumed to be uncorrelated.

The voters' period utility function is the negative of the loss function (1). They reelect the incumbent if and only if their expected utility from from doing so is at least as large as the expected utility from electing the unknown challenger. When voting, voters recognize that in the second period the central bank will observe g_2 and choose inflation and unemployment to minimize its loss function (2). After the loss in the second period is realized, the game ends.

3 Equilibrium

This section presents our main results.

3.1 Within-Period Equilibrium

The within-period problem of the central bank is completely standard. Using the fact that voters are rational and that g_I has mean zero, we obtain the period 1 equilibrium values for inflation and unemployment

$$\pi_1 = \tilde{\pi} - \frac{1}{\tilde{\theta}}\tilde{u} - \frac{1}{1+\tilde{\theta}}g_I, \tag{4}$$

$$u_1 = -\frac{\tilde{\theta}}{1+\tilde{\theta}}g_I. \tag{5}$$

In period 2, equilibrium inflation and unemployment are given by

$$\pi_2 = \tilde{\pi} - \frac{1}{\tilde{\theta}}\tilde{u} - \frac{1}{\tilde{\theta}}\mathbb{E}\left(g_2 \left| u_1 \right.\right) - \frac{1}{1+\tilde{\theta}}\left(g_2 - \left(\mathbb{E}\left(g_2 \left| u_1 \right.\right)\right)\right) \tag{6}$$

$$u_2 = -\mathbb{E}\left(g_2 \left| u_1 \right.\right) - \frac{\tilde{\theta}}{1+\tilde{\theta}}\left(g_2 - \mathbb{E}\left(g_2 \left| u_1 \right.\right)\right), \tag{7}$$

where the expectation is taken after the election, once the election outcome is known.

Equations (4), (5), (6), and (7) follow the standard logic of optimal monetary policy (for detailed derivation, see the Appendix). Consider $t = 2$. The central bank is willing to depart from the optimal inflation level $\tilde{\pi}$ in order to move unemployment from the no-intervention equilibrium $-g_2$ towards its optimal level $\tilde{u}$. To the extent that voters know $\tilde{u}$ and anticipate the average g_2, they anticipate the inflationary response of the central bank as well. As a result, the central bank's policy results in *inflation bias* equal to $-\frac{1}{\tilde{\theta}}\tilde{u} - \frac{1}{\tilde{\theta}}\mathbb{E}\left(g_2 \left| u_1 \right.\right)$. Any deviation of g_2 from voters' expectations, however, allows the central bank to affect unemployment via unanticipated inflation. Equation (7) shows that unemployment declines one-for-one with expected government quality, whereas unexpected government quality $(g_2 - \mathbb{E}(g_2 | u_1))$ enters into unemployment with a coefficient smaller than one. In the extreme case of a central bank that cares only about unemployment, i.e. $\tilde{\theta} = 0$, the central bank completely mitigates the impact of unanticipated government quality on unemployment, and unemployment depends only on the anticipated component of government quality. The intuition for $t = 1$ is the same, but equations (4) and (5) use the fact that $\mathbb{E}(g_1) = 0$

Although the intuition that monetary policy is most powerful if it can surprise the public is familiar from the literature, our model links this intuition to the central bank's ability to counteract expected and unexpected political competency of the executive. By generating unexpected inflation, the central bank can mitigate unemployment induced by an unexpectedly bad government, and a more unemployment-averse bank will do that to a larger extent. When voters anticipate a poor quality government, however, they fully anticipate what inflation the central bank will generate in response to government's quality, which in turn renders the central bank powerless against unemployment. Inflation ensues, and this inflation bias is worse the more ununemployment-averse the central bank is.

3.2 Political Turnover

Voters' inference about incumbent quality is a central input into their optimal election decision. From equation (5), voters learn g_I fully after observing period 1 unemployment u_1.[9]

[9]Since voters perfectly infer incumbent's quality from unemployment alone, it is inconsequential whether they observe inflation as well. Observing inflation would also be inconsequential in an extended model in which unemployment in (3) were also affected by an exogenous Phillips curve shock $-\varepsilon_t$. In that case, voters would perfectly infer $g_I + \varepsilon_1$ independent of $\tilde{\theta}$, irrespective of whether inflation is observed.

Armed with this knowledge of g_I, voters reelect the incumbent if and only if the expected social loss from doing so is no larger than if the challenger is elected:

$$\mathbb{E}\left(\mathcal{L}_2 \,|u_1, \text{incumbent}\right) \leq \mathbb{E}\left(\mathcal{L}_2 \,|u_1, \text{challenger}\right).$$

Using (1) and the within-period equilibrium (4) through (7), this condition becomes:

$$\left(\tilde{u} + \mathbb{E}\left(g_I \,|u_1\right)\right)^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2 \mathbb{V}\left(g_I \,|u_1\right) \leq \left(\tilde{u} + \mathbb{E}\left(g_C \,|u_1\right)\right)^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2 \mathbb{V}\left(g_C \,|u_1\right) \quad (8)$$

Condition (8) states that in equilibrium the expected loss has two components. First, the expected loss is higher if the expected quality of the government is poor, as expectations of large unemployment distortions increase the anticipated inflation bias. Second, the expected loss increases with the uncertainty about government quality. This part comes from the concavity of the loss function in unemployment, and the fact that uncertainty about period 2 government quality increases unemployment and inflation uncertainty.

Equation (8) conveys the intuition of voters' election decision between a known incumbent on the one hand, versus the risk of choosing a challenger of unknown quality on the other hand. Since voters learn about the incumbent but not about the challenger in period 1, (8) suggests that voters should be willing to tolerate some below-average quality for the incumbent in exchange for the reduction in the volatility of future unemployment. As the saying goes, "better the devil you know than the devil you don't". This finding is summarized in Proposition 1.

Proposition 1 ***(Political Turnover):*** *There exist $\underline{g} < 0 << \bar{g}$ such that the incumbent is reelected if and only if $g_I \in \left[\underline{g}, \bar{g}\right]$.*

A technical comment is in place. Proposition 1 states that incumbent is voted out of office not only if her quality is too low, $g_I < \underline{g}$, but also if her quality is too high, $g_I > \bar{g}$. The first finding is intuitive. The second, somewhat counterintuitive finding, is an artifact of the quadratic-normal framework we use. However, in the most realistic case where $\tilde{u}$ is very negative, $\bar{g}$ becomes very large, so it is increasingly unlikely that $g_I > \bar{g}$ is realized.[10] Hence, $\underline{g}$ is the key variable summarizing the political equilibrium. Since $\underline{g} < 0$, Proposition 1 implies that the model generates *incumbency advantage* or the tendency of below-average governments to get reelected.

Note that the incumbent's reelection probability is correlated with past macroeconomic performance despite voters being completely prospective, in the sense that they care only about the future economic performance. The correlation between past economic performance and election outcomes arises in our model because future performance depends on the government's quality, and the incumbent's quality is persistent.[11]

3.3 Effect of Central Bank on Political and Economic Outcomes

In this section, we analyze how the inflation aversion of the central bank alters political (Theorem 1) and economic (Theorem 2) outcomes in the presence of political selection.

3.3.1 Political outcomes

Theorem 1 *When the central bank becomes more inflation-averse,*

[10] Alternatively, one could eliminate this counterintuitive finding by assuming either that there is an upper bound on the quality of the government or that the loss function is always increasing in u_t. Departing from the quadratic-normal framework, however, would render the model less tractable.

[11] Voting rules based on macroeconomic performance have been the subject of a rich empirical literature, see e.g. Fair (1978) and Lewis-Beck (1988) and Pastor and Veronesi (2013).

a. *the incumbent is more likely to be reelected:* $\frac{d\Pr\left(g_I \in [\underline{g},\bar{g}]\right)}{d\tilde{\theta}} > 0$;

b. *voters' assessment of incumbent quality becomes less sensitive to unemployment;*

c. *the highest unemployment level that voters are willing to tolerate and still reelect the incumbent increases.*

Theorem 1.a presents our first main result. It says that the incumbent's reelection chances decrease when the central bank cares mostly about smoothing output and little about inflation (i.e. $\tilde{\theta}$ is low). This finding might at first be surprising, but it is a natural result of classic time-inconsistency. Voters understand that an unemployment-averse central bank will attempt to smooth unemployment also if the challenger is elected in period 2. In addition, the central bank will be far more effective at achieving this goal with the challenger in power than the incumbent, simply because the challenger's quality is not incorporated into rational inflation expectations. On the other hand, voters understand that reelecting an incumbent who is known to be of low quality gives rise to inflation bias, that is worse if the central bank has a strong incentive to push unemployment below its natural level. By mitigating unemployment volatility under the challenger and exacerbating the inflation bias under a low quality incumbent, having an unemployment-averse central bank hence tilts voters' trade-off towards the challenger and away from the incumbent.

Theorem 1.b explains how voters' inference changes with the strength of the central bank. In particular, voters blame the incumbent more for high unemployment if the central bank is known to focus on unemployment fluctuations (i.e. $\tilde{\theta}$ is low). The effect comes directly from (5), which implies $g_I = -\frac{1+\theta}{\theta}u_1$. Voters recognize that an unemployment-averse (low $\tilde{\theta}$) central bank mitigates the effect of incumbent quality on unemployment, so small differences in unemployment indicate large differences in incumbent quality. The opposite is true for an inflation-averse central bank. In other words, when voters know that monetary policy decreases the impact of incumbent quality on unemployment, even small increases in unemployment are interpreted as a sign of low quality. In that case, even small changes in unemployment should result in large changes in voters' perceptions.

Theorem 1.c follows from parts a and b. It says that not only is the incumbent more likely to be reelected if the central bank is inflation-averse, but the marginal incumbent is reelected at a higher unemployment rate. This is both because the marginal reelected incumbent is of lower quality and because this lower quality is mitigated less by the central bank.

Theorem 1 has a surprising implication for what kind of central bank different types of political actors prefer if they are solely office-motivated:

Corollary 1 ***(Incumbency Advantage)***

1. *An office-motivated incumbent prefers a central bank that focuses solely on inflation, i.e.,* $\tilde{\theta} = \infty$.

2. *A challenger prefers a central bank that focuses solely on unemployment, i.e.,* $\tilde{\theta} = 0$.

The result that the incumbent in our model prefers an inflation-averse central bank, whereas a challenger prefers an unemployment-averse central bank, might be surprising. It is, however, in line with the sweeping adoption of inflation-targeting central banks since the 1990s, and suggests that governments institutionalizing inflation-targeting may be doing this out of their own self-interest rather than for some higher principle.

Corollary 1 contrasts with the common narrative that incumbents have incentives to unemployment-averse the central bank to generate unexpected inflation and help with re-election, as suggested in Nordhaus (1975). The difference arises because in our model voters understand and anticipate central bank policy in equilibrium, and account for central bank actions when inverting incumbent quality from observed macroeconomic outcomes. In a benchmark of fully rational voters, as considered here, the government hence has an incentive to commit to a inflation-averse central bank that cannot be influenced. If we were to assume that voters are unaware of the central bank's attempts to lower unemployment, the incumbent in our model would have an incentive to exert pressure on the central bank, similarly to Nordhaus (1975). In this case, voters might wrongly interpret lower unemployment as a sign of incumbent quality. However, to the extent that rational voters understand that such covert pressure is possible, they adjust their inference about the incumbent quality, as they do in our model.

Given this discussion, one might wonder why some governments nonetheless appear to pressure their central banks openly to lower unemployment and raise inflation.[12] One potential way to rationalize this behavior within our framework would be if the incumbent government's goal is not to overtly pressure the central bank, but instead to convince voters that she is facing a inflation-averse central bank, thereby improving her reelection chances.

The assumption that incumbents are purely office-motivated simplifies Corollary 1, but is not crucial for the qualitative result. If we were to assume instead that political actors are partly motivated by the loss function, the incumbent would prefer a more inflation-averse central bank than the challenger, as long as both political actors place the same weight on office benefits.

[12]For example, President Trump very openly and frequently criticizes the Fed Chairman Jerome Powell for not doing enough to stimulate the economy.

3.3.2 Economic outcomes

There is a large literature on the effect of the central bank's inflation-aversion for economic outcomes, such as unemployment and inflation. In this section we show that accounting for political selection changes several standard equilibrium relationships between the central bank's inflation-aversion and economic outcomes.

Theorem 2 ***(Economic Outcomes)***

a. *An inflation-averse central bank raises average unemployment but lowers average inflation:* $\frac{\mathbb{E}(u_2+u_1)}{d\tilde{\theta}} > 0$ *and* $\frac{\mathbb{E}(\pi_2+\pi_1)}{d\tilde{\theta}} < 0$

b. *On average, unemployment and inflation are lower in the second period:* $\mathbb{E}\left(u_2 - u_1\right) < 0$ *and* $\mathbb{E}\left(\pi_2 - \pi_1\right) < 0$

c. *An inflation-averse central bank dampens the second-period declines in unemployment and inflation:* $\frac{d\mathbb{E}(u_2-u_1)}{d\tilde{\theta}} > 0$ *and* $\frac{d\mathbb{E}(\pi_2-\pi_1)}{d\tilde{\theta}} > 0$.

d. *Inflation and unemployment variability decline with the central bank's inflation weight* $\tilde{\theta}$ *when* $\tilde{\theta}$ *is small:* $\frac{d\mathbb{V}(u_2-u_1)}{d\tilde{\theta}} < 0$ *and* $\frac{d\mathbb{V}(\pi_2-\pi_1)}{d\tilde{\theta}} < 0$

The first three parts of Theorem 2 describe the levels of unemployment and inflation, while the last part describes their variability. Theorem 2.a states that on average unemployment is higher and inflation is lower with an inflation-averse central bank. As in the standard model without political selection, having a more inflation-averse central bank mitigates the inflation-bias arising from time-inconsistency, lowering average inflation. Different from the standard prediction, however, appointing an inflation-averse central bank does not leave unemployment unchanged, but instead means accepting higher unemployment on average.

Figure 1: **Economic outcomes against central bank inflation aversion**

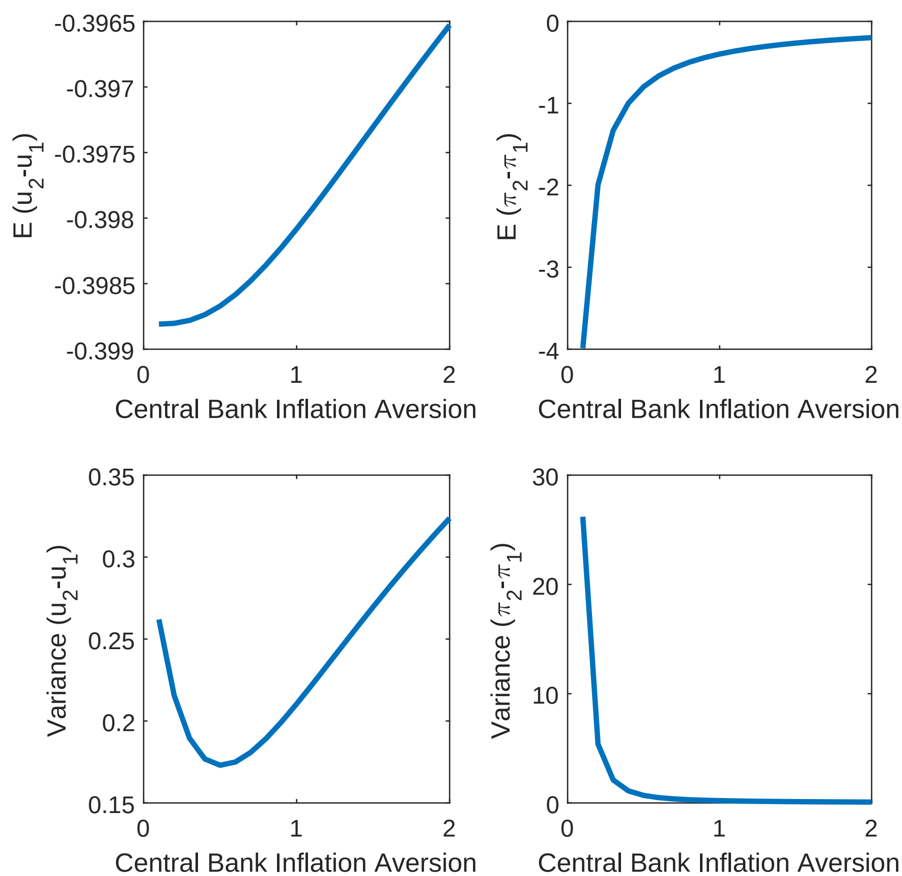

Figure 2: This figure shows the difference between period 2 and period 1 unemployment (left panels) and inflation (right panels) as a function of the central bank inflation weight $\tilde{\theta}$ for $\sigma_g = 1$ and $\tilde{u} = -2$. The upper panels show the average (Theorem 2.c), and the lower panels show the variance (Theorem.2.d).

Theorem 2.b and c shows that the central elements in our model, namely the central bank and political selection, interact and jointly shape economic outcomes. Theorem 2.b shows that on average political selection is beneficial, lowering period 2 unemployment and inflation relative to period 1. Intuitively, voters vote the incumbent out of office if her quality is too low, thereby benefiting both inflation and employment. Theorem 2.c shows that a more inflation-averse central bank leads to worse political selection, and as a result higher average unemployment and inflation, though of course there is variation around these averages. In other words, *an inflation-averse central bank mitigates the beneficial effects of political selection on economic outcomes.* The upper panels of Figure 1 visualize the effect of period 2 political selection on average unemployment and inflation for different values of central bank inflation-aversion.

Looking beyond the average changes in unemployment and inflation, there is interesting heterogeneity, even conditional on the incumbent being reelected. When the incumbent is reelected, her quality remains unchanged. However, because voter-households update their expectations about the incumbent's quality, monetary policy is less able to affect unemployment in period 2, leading to variation in unemployment and inflation across terms even when the same government remains in power. Concretely, note that from (4), (5), (6), and (7), conditional on the incumbent being reelected $u_2 - u_1 = -\frac{1}{1+\tilde{\theta}} g_I$ and $\pi_2 - \pi_1 = -\frac{1}{\tilde{\theta}\left(1+\tilde{\theta}\right)} g_I$. A below-average incumbent (i.e. $g_I < 0$) hence generates worse economic outcomes in the second period than in the first, and the difference is larger when the central bank is unemployment-averse (i.e. $\tilde{\theta}$ small). Hence, we obtain the testable prediction that above average governments perform better and below average governments perform worse in their second terms, conditional on being reelected.[13]

[13] As we will see in the subsequent section, the level of period 2 unemployment is lower for all governments if the government must also exert costly effort. However, effort leaves the heterogeneity across above- and

Theorem 2.d shows that our new effect from political selection can potentially rationalize the otherwise puzzling relationship between central bank inflation aversion and unemployment variability in the data. The lower panels of Figure 1 visualize the variances of the changes in unemployment and inflation for different values of central bank inflation aversion. The downward-sloping relationship in the lower right panel shows that inflation in our model becomes less volatile when appointing an inflation-averse central bank, just as in the model without political selection (Rogoff (1985)). New to our model, the relationship between central bank inflation-aversion and the variability of unemployment is u-shaped, and in particular it is downward-sloping for low values of inflation-aversion. This matters, because in the absence of political selection, the cost from a appointing an inflation-averse central bank is accepting more variable unemployment. In the data unemployment appears, if anything, negatively related with empirical proxies for central bank inflation aversion (Alesina and Summers (1993), Grilli et al. (1991)), which is in contrast with the standard prediction but consistent with the downward-sloping portion of the bottom left panel in Figure 1.

The u-shaped relationship between central bank inflation aversion and unemployment variability in the bottom left panel of Figure 1 reflects opposing effects conditional on the incumbent and the challenger winning the election. The initially downward-sloping relationship between central bank strength $\tilde{\theta}$ and unemployment variability $\mathbb{V}(u_2 - u_1)$ is driven by the states of the world when the incumbent is reelected, in which case we have already seen that an unemployment-averse central bank (i.e. low $\tilde{\theta}$) leads to larger changes in unemployment from period 1 to period 2. Intuitively, because voter-households' update their expectations about the incumbent's quality, any central bank attempt to smooth unemployment is unsustainable, leading to higher unemployment variability when the central bank is

below-average quality incumbents intact.

unemployment-averse (i.e. low $\tilde{\theta}$). As $\tilde{\theta}$ increases, unemployment variability is predominantly driven by states of the world when the challenger is elected. When $\tilde{\theta}$ is high, unemployment variability increases with $\tilde{\theta}$, as further increase in $\tilde{\theta}$ means that a more inflation-averse central bank allows unemployment to vary more in response to the challenger's unanticipated quality.

A comment regarding the condition $\tilde{u} \to -\infty$ needed for Theorem 2 parts a and c is in order. Recall that the normal-quadratic model is most intuitive if we take $\tilde{u}$ to be large and negative, as in this case voters and the central bank prefer lower unemployment with a probability approaching one. We therefore regard this condition as not restrictive in practice.

3.4 Political Accountability

So far we have considered the interaction of monetary policy and political selection, and have shown that an inflation-averse central bank can increase the likelihood of a bad incumbent being reelected. In this section, we assume that in addition to having an immutable quality, the government can also affect unemployment by exerting costly effort. In this case, we show that appointing a inflation-averse central banker has an additional adverse political effect by lowering the incumbent's incentive to exert effort.

We make the following modification to the baseline model. At the beginning of the first period, the office-motivated incumbent chooses how much effort e to exert. Effort is socially desirable as it reduces unemployment in the same way as government quality does, but it comes at a personal cost to the incumbent. Hence, the incumbent's problem is:

$$\max_{e} \left\{ \Pr\left(\text{reelection} \mid e\right) - \frac{1}{2}e^2 \right\}. \tag{9}$$

We assume that the expectational Phillips curve takes the reflects effort:

$$u_1 = -\left(\pi_t - \pi_t^e\right) - g_I - e. \tag{10}$$

We assume that the incumbent chooses e before learning her own quality g_I, and the central bank conducts monetary policy after observing the incumbent's quality and effort. Effort in the second period is analogous, but since it is the final period, the optimal effort is zero, and hence the second period is equivalent to the second period in the baseline model.

Since only the sum of the incumbent's quality and effort enters into the Phillips curve (10), the optimal central bank policy only depends on this sum, and the equilibrium is identical as if the central bank observed only the combined shock $g_I + e$. It follows from our discussion in Section 3 that anticipated effort affects unemployment more than unanticipated effort, as the central bank will mitigate the unemployment impact of unexpected shocks. We continue to assume that rational voters understand the central bank's response to effort and quality. They also form rational expectations about the incumbent's equilibrium effort level, and use this expectation to infer incumbent quality g_I from period 1 unemployment u_1. Because the second period is as in the baseline model, the incumbent is elected if and only if the quality inferred by the voters is in $\left[\underline{g}, \bar{g}\right]$, where the thresholds $\underline{g}$ and $\bar{g}$ are as in Proposition 1.

The equilibrium effort is determined by the incumbent's incentives. The incumbent recognizes how voters use unemployment to infer quality, and decides whether to deviate from the equilibrium effort level to mislead the voters. For example, by increasing effort above the equilibrium level, the incumbent makes voters update positively on her quality. Intuitively, the incumbent finds it optimal to exert more effort when the deviations from the expected effort lead to a large change in the probability of being reelected. From before, we know that $\underline{g}$ is negative and decreases further as the central bank becomes more inflation-averse.[14] This means that as the central bank becomes more inflation-averse, the incumbent is likely to get reelected irrespective of her effort, and the probability of reelection becomes less sensitive to small changes in effort. As a result, the incumbent chooses lower effort in equilibrium. This leads us to the following proposition.

Proposition 2 ***(Optimal Effort):*** *The incumbent government exerts less effort in equilibrium when the central bank is inflation-averse:* $\frac{de^*}{d\tilde{\theta}} < 0$.

Proposition 2 implies that an inflation-averse central bank has a negative impact not only on political selection but also on political accountability. As a result, political accountability further strengthens our main results in Theorem 1 and Theorem 2 that a inflation-averse central bank leads to worse performing governments and higher unemployment on average.

4 Optimal Central Bank

Much of the literature on monetary policy addresses the question of optimal monetary policy. In this section, we revisit this question in our setting with political selection. We compare the socially optimal central bank inflation aversion to both the central bank inflation aversion preferred by the incumbent government, and to the socially optimal central bank inflation aversion in Rogoff (1985)'s benchmark model without political selection.

For the proposition below, we assume only political selection, but abstract from government's effort. We define $\tilde{\theta}^*$ as the $\tilde{\theta}$ that minimizes the ex ante expected loss $\mathbb{E}\left(\mathcal{L}_1 + \mathcal{L}_2\right)$, and $\tilde{\theta}^{*,Rogoff}$ as the $\tilde{\theta}$ that minimizes $\mathbb{E}\left(\mathcal{L}_1 + \mathcal{L}_2\right)$ if g_1 and g_2 are independent $N\left(0, \sigma_g^2\right)$.

[14] The converse holds for $\bar{g}$, which is positive and increases as the central bank becomes more inflation-averse. However, in the empirically relevant case with $\tilde{u}$ large and negative the probability that period 1 unemployment exceeds $\bar{g}$ approaches zero.

Proposition 3 ***(Social Planner)*** *The optimal central banker's inflation-aversion is higher than the public's, and higher than without political selection:*

$$\theta < \tilde{\theta}^{*,Rogoff} < \tilde{\theta}^{*} < \infty.$$

Proposition 3 states that the social planner optimally appoints a central banker who is more inflation-averse than the voter-households, and more inflation-averse than in the absence of political selection. However, the socially-optimal central bank inflation aversion is always finite and therefore smaller than the inflation-aversion preferred by the incumbent (Corollary 1), showing that the incumbent government has incentives to institute a central bank that is excessively inflation-averse.

The intuition for why political turnover makes it optimal to appoint an inflation-averse central bank is as follows. We have seen that an inflation-averse central bank leads to lower-quality incumbents being reelected, pushing towards an unemployment-averse central bank. However, there is a strong countervailing effect. When there is a positive reelection probability, the quality of the period 2 government is known beforehand with some probability, which induces inflation bias in the second period. Having an inflation-averse central bank in the second period reduces this bias. Proposition 3 show that this second effect dominates.

Government effort will typically push down the socially-optimal central bank inflation aversion compared to Proposition 3, further widening the gap with the central bank inflation-aversion preferred by the incumbent government. Because effort lowers the levels of unemployment and inflation and leaves their variability unchanged, it follows from Proposition 2 that a social planner concerned only about government effort should optimally select a central banker with $\tilde{\theta} < \tilde{\theta}^{*,Rogoff}$. Hence, political considerations can raise or lower the optimal central bank inflation aversion, depending on whether the social planner is more concerned about political selection (in which case the central bank should be more inflation-averse) or accountability (in which case the central bank should be more unemployment-averse).

5 Political Incentives of the Central Bank

Up to this point we have assumed that the central bank is apolitical with a technical mandate of minimizing current-period inflation and unemployment fluctuations, similarly to what is mandated in practice. We have shown that even with a purely apolitical mandate, political turnover is affected by the central bank's aversion to inflation versus unemployment fluctuations. These findings raise the question whether a central banker who understands his impact on elections might choose to venture beyond his official apolitical mandate, and try to directly affect election outcomes.

This possibility is not purely theoretical, as illustrated by the controversial statement by former New York Fed chair Bill Dudley that the Federal Reserve "shouldn't enable Donald Trump"[15] A central banker with different preferences than the voters over the inflation-employment tradeoff may prefer voters to be more stringent or lenient in their reelection decisions. For example, if the central banker prefers the incumbent to be voted out of office, he might accept higher unemployment to affect voters' perception of government's quality. If central bankers actively try to affect election outcomes, this could have wide-ranging repercussions. For example, an elected incumbent appointing an inflation-averse central banker might worry that she is appointing a future adversary in the political arena, who could use the tools at his disposal to get her voted out of office. In this section, we show

[15] Bill Dudley, "The Fed Shouldn't Enable Donald Trump", Bloomberg, August 27, 2019.

that such concerns are unfounded in our model.

We model political concerns of the central bank by assuming that, different from Section 2, the central banker cares about economic outcomes in both periods, so he may have an incentive to remove a low quality incumbent to affect future economic outcomes. Formally, suppose that in the first period the central bank chooses u_1 and π_1 to maximize $\tilde{\mathcal{L}}_1 + \mathbb{E}\left[\tilde{\mathcal{L}}_2\right]$. Since $\tilde{\theta} \neq \theta$, the central bank's preferences over who holds power in the second period may differ from voters'. Because the central banker understands how voters map u_1 into g_I, he may have an incentive to choose u_1 differently than the myopic central bank considered in the baseline model in order to change voters' perceived incumbent quality g_I and hence the election outcome. The following Proposition 4 states that in our model the central bank has no incentive to do so.

Proposition 4 *The central bank has no incentive to affect political turnover. When the central bank bank minimizes the sum of period* 1 *and* 2 *expected losses, all results from Section 3 continue to hold.*

Proposition 4 follows from the observation that electing a risky challenger over a low quality incumbent reduces both inflation and unemployment in expectation, at the cost of increasing uncertainty about both variables. Even if the central banker's and voters' preferences were to be diametrically opposite, with the central banker caring only about inflation and voters caring only about unemployment, they would still agree on the optimal reelection decision, or the choice between "devil-you-know" versus the "devil you don't know". Concerns that an inflation-averse central banker might use monetary policy to achieve different political outcomes are hence unfounded in our model.

Another implication of Proposition 4 is that equilibrium monetary policy is the same with a long-lived central banker or a sequence of short-lived central bankers with identical inflation aversion. In the absence of central banker career concerns, the tenure of the central banker does not matter.

6 Conclusion

The interaction of the central bank and politics is clearly a first-order question in a world of high and increasing political uncertainty. We present a fully rational framework of this interaction, building on the classic framework of Barro and Gordon (1983) and Rogoff (1985) on the monetary policy side, and a simple model of non-partisan political turnover (Ferejohn (1986)) on the political economy side.

Our model predicts that, perhaps contrary to received wisdom, having an inflation-averse central bank increases the likelihood that a low quality incumbent government wins reelection, thereby raising the level of unemployment and possibly lowering unemployment variability in the long-term. The intuition goes back to classic time inconsistency of monetary policy, linking it to the central bank's ability to counteract anticipated and unanticipated political competency of the executive. Intuitively, only anticipated economic frictions, such as those from reelecting a below-average quality incumbent, lead to inflation bias, and only unanticipated economic frictions, such as those from electing a challenger of unknown quality, can be mitigated by the central bank. As a result, having a central bank that is highly averse to inflation fluctuations but more willing to tolerate unemployment tilts voters' optimal election decision towards the incumbent and away from the challenger. The adverse political effects of a conservative central bank are compounded when the government must also exert costly effort.

Overall, our framework shows that governments have strong, and not always socially optimal, political incentives to institute an inflation-targeting central bank, and that an inflation-targeting central bank may have so far underappreciated consequences for the macroeconomy by affecting the political fortunes of the elected executive.

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APPENDIX

7 Appendix

7.1 Proofs for Section 3

Proof of Equations (4), (5), (6), and (7). We first solve for the period-2 equilibrium given by equations (6) and (7). The central bank's first-order condition gives the following reaction function to inflation expectations π_2^e and the government shock g_2:

$$\pi_2 = \frac{1}{1+\tilde{\theta}} \left(\pi_2^e + \tilde{\theta}\tilde{\pi} - g_2 - \tilde{u} \right) \tag{11}$$

Imposing that voters' expectations are rational in (11) gives

$$\pi_2^e = \tilde{\pi} - \frac{1}{\tilde{\theta}} \left(\mathbb{E} \left(g_2 \left| u_1 \right. \right) + \tilde{u} \right). \tag{12}$$

Using (12) in (11) we obtain (6), and

$$\pi_2 - \pi_2^e = -\frac{1}{1+\tilde{\theta}} \left(g_2 - \mathbb{E} \left(g_2 \left| u_1 \right. \right) \right). \tag{13}$$

Substituting (13) into the Phillips Curve (3) delivers period-2 equilibrium unemployment (7). The solution for period 1 is analogous to (6) and (7), except that the prior expected incumbent quality equals zero, which delivers (4), and (5). ■

Proof of Proposition 1. The expected loss conditional on having observed period 1 unemployment equals:

$$\begin{aligned}
\mathbb{E} \left(\mathcal{L}_2 \left| u_1 \right. \right) &= \frac{1}{2} \left(\mathbb{V} \left(u_2 \left| u_1 \right. \right) + \left(\mathbb{E} \left(u_2 \left| u_1 \right. \right) - \tilde{u} \right)^2 \right) + \frac{\theta}{2} \left(\mathbb{V} \left(\pi_2 \left| u_1 \right. \right) + \left(\mathbb{E} \left(\pi_2 \left| u_1 \right. \right) - \tilde{\pi} \right)^2 \right), \\
&= \frac{1}{2} \left(\left(\frac{\tilde{\theta}}{1+\tilde{\theta}} \right)^2 \mathbb{V} \left(g_2 \left| u_1 \right. \right) + \left(\mathbb{E} \left(g_2 \left| u_1 \right. \right) + \tilde{u} \right)^2 \right) \\
&\quad + \frac{\theta}{2} \left(\left(\frac{1}{1+\tilde{\theta}} \right)^2 \mathbb{V} \left(g_2 \left| u_1 \right. \right) + \left(\frac{1}{\tilde{\theta}} \right)^2 \left(\mathbb{E} \left(g_2 \left| u_1 \right. \right) + \tilde{u} \right)^2 \right), \\
&= \frac{1}{2} \frac{\tilde{\theta}^2 + \theta}{\left(1+\tilde{\theta} \right)^2} \mathbb{V} \left(g_2 \left| u_1 \right. \right) + \frac{1}{2} \frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2} \left(\mathbb{E} \left(g_2 \left| u_1 \right. \right) + \tilde{u} \right)^2.
\end{aligned} \tag{14}$$

Comparing (14) when $g_2 = g_I$ to (14) when $g_2 = g_C$ results in inequality (8) in the main text.

If the incumbent is reelected then from (5), $\mathbb{E}(g_2 | u_1) = -\frac{1+\tilde{\theta}}{\tilde{\theta}} u_1$ and $\mathbb{V}(g_2 | u_1) = 0$. If the challenger is elected instead, we have $\mathbb{E}(g_2 | u_1) = 0$ and $\mathbb{V}(g_2 | u_1) = \sigma_g^2$. Using (14), we obtain that voters reelect the incumbent if and only if

$$\frac{1}{2} \frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2} (g_I + \tilde{u})^2 \leq \frac{1}{2} \frac{\tilde{\theta}^2 + \theta}{\left(1 + \tilde{\theta}\right)^2} \sigma_g^2 + \frac{1}{2} \frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2} \tilde{u}^2.$$

This implies that the incumbent is reelected if and only if $g_I \in \left[\underline{g}, \bar{g}\right]$, where

$$\underline{g} = -\tilde{u} - \sqrt{\tilde{u}^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2 \sigma_g^2} < 0, \tag{15}$$

$$\bar{g} = -\tilde{u} + \sqrt{\tilde{u}^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2 \sigma_g^2} >> 0. \tag{16}$$

■

Proof of Theorem 1. Define the standardized incumbent quality

$$Z = \frac{g_I}{\sigma_g} \sim N(0, 1).$$

We can then write the political turnover decision in terms of Z: the incumbent is reelected if and only if

$$\underline{Z} \leq Z \leq \bar{Z},$$

where

$$\underline{Z} = -\frac{\tilde{u}}{\sigma_g} - \sqrt{\left(\frac{\tilde{u}}{\sigma_g}\right)^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2}, \tag{17}$$

$$\bar{Z} = -\frac{\tilde{u}}{\sigma_g} + \sqrt{\left(\frac{\tilde{u}}{\sigma_g}\right)^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2}. \tag{18}$$

Using ϕ to denote the probability density function of the standard normal distribution the incumbent's unconditional reelection probability is:

$$\Pr(g_I \in \left[\underline{g}, \bar{g}\right]) = \Pr(Z \in \left[\underline{Z}, \bar{Z}\right]) = \int_{\underline{Z}}^{\bar{Z}} \phi(z) dz. \tag{19}$$

Because $\phi(z) > 0$, to prove part (a) it sufficies to prove that $\bar{Z}$ increases and $\underline{Z}$ decreases in θ, but that follows directly from (17) and (18) and the fact that $\frac{d\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2}{d\tilde{\theta}} > 0$.

To prove part (b), note that from (5), we obtain that $g_I = -\frac{1+\tilde{\theta}}{\tilde{\theta}}u_1$, and the coefficient $\frac{1+\tilde{\theta}}{\tilde{\theta}}$ decreases in $\tilde{\theta}$.

To prove part (c), note that from (5), we obtain that the unemployment at $\underline{g}$ is $\underline{u}_1 = -\frac{\tilde{\theta}}{1+\tilde{\theta}}\underline{g} > 0$, and $\frac{d\underline{u}_1}{d\tilde{\theta}} = -\frac{1}{\left(1+\tilde{\theta}\right)^2}\underline{g} > 0$. ■

Proof of Theorem 2.

We start by proving part b. Using (4), (5), (6), and (7), we obtain second-period inflation and unemployment as functions of g_I and g_C

$$\pi_2\left(g_I, g_C\right) = \begin{cases} \tilde{\pi} - \frac{1}{\tilde{\theta}}\tilde{u} - \frac{1}{\tilde{\theta}}g_I \text{ if } g_I \in \left(\underline{g}, \bar{g}\right) \\ \tilde{\pi} - \frac{1}{\tilde{\theta}}\tilde{u} - \frac{1}{1+\tilde{\theta}}g_C \text{ if } g_I \notin \left(\underline{g}, \bar{g}\right) \end{cases}$$

$$u_2\left(g_I, g_C\right) = \begin{cases} -\, g_I \text{ if } g_I \in \left(\underline{g}, \bar{g}\right) \\ -\frac{\tilde{\theta}}{1+\tilde{\theta}}g_C \text{ if } g_I \notin \left(\underline{g}, \bar{g}\right) \end{cases}$$

Subtracting period 1 inflation and unemployment shows that ex ante, before the realization of g_I and g_C, we have

$$\begin{aligned} \mathbb{E}\left[\pi_2 - \pi_1\right] &= \int\int_{g_I \in \left(\underline{g},\bar{g}\right)} \left[-\frac{1}{\tilde{\theta}}g_I + \frac{1}{1+\tilde{\theta}}g_I\right] \phi_{0,\sigma_g}\left(g_I\right) dg_I \phi_{0,\sigma_g}\left(g_C\right) dg_C \\ &\quad + \int\int_{g_I \notin \left(\underline{g},\bar{g}\right)} \left[-\frac{1}{1+\tilde{\theta}}g_C + \frac{1}{1+\tilde{\theta}}g_I\right] \phi_{0,\sigma_g}\left(g_I\right) dg_I \phi_{0,\sigma_g}\left(g_C\right) dg_C \\ &= -\frac{1}{\tilde{\theta}} \int_{g_I \in \left(\underline{g},\bar{g}\right)} g_I \phi_{0,\sigma_g}\left(g_I\right) dg_I < 0. \end{aligned}$$

$$\begin{aligned} \mathbb{E}\left[u_2 - u_1\right] &= \int\int_{g_I \in \left(\underline{g},\bar{g}\right)} \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}g_I - g_I\right) \phi_{0,\sigma_g}\left(g_I\right) dg_I \phi_{0,\sigma_g}\left(g_C\right) dg_C \\ &\quad + \int\int_{g_I \notin \left(\underline{g},\bar{g}\right)} \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}g_I - \frac{\tilde{\theta}}{1+\tilde{\theta}}g_C\right) \phi_{0,\sigma_g}\left(g_I\right) dg_I \phi_{0,\sigma_g}\left(g_C\right) dg_C \\ &= -\int_{g_I \in \left(\underline{g},\bar{g}\right)} g_I \phi_{0,\sigma_g}\left(g_I\right) dg_I < 0. \end{aligned}$$

Using notation $Z = \frac{g_I}{\sigma_g} \sim N(0,1)$, these become

$$\mathbb{E}\left[\pi_2 - \pi_1\right] = -\frac{\sigma_g^2}{\tilde{\theta}} \int_{Z \in \left(\underline{Z}, \bar{Z}\right)} Z\phi\left(Z\right) dZ = -\frac{\sigma_g^2}{\tilde{\theta}} \left(\phi(\underline{Z}) - \phi(\bar{Z})\right) < 0$$

$$\mathbb{E}\left[u_2 - u_1\right] = -\sigma_g^2 \int_{Z \in \left(\underline{Z}, \bar{Z}\right)} Z\phi\left(Z\right) dZ = -\sigma_g^2 \left(\phi(\underline{Z}) - \phi(\bar{Z})\right) < 0. \tag{20}$$

Both of these terms are negative because $|\underline{Z}| < \left|\bar{Z}\right|$ and therefore $\phi(\underline{Z}) > \phi(\bar{Z})$. This proves Theorem 2.b.

To prove Theorem 2.c, we take the derivative with respect to $\tilde{\theta}$

$$\begin{aligned} \frac{d\mathbb{E}\left[\pi_2 - \pi_1\right]}{d\tilde{\theta}} &= \frac{1}{\tilde{\theta}^2}\sigma_g^2 \int_{Z \in \left(\underline{Z}, \bar{Z}\right)} Z\phi\left(Z\right) dZ + \frac{1}{\tilde{\theta}}\sigma_g^2 \left(-\bar{Z}\phi\left(\bar{Z}\right)\frac{d\bar{Z}}{d\tilde{\theta}} + \underline{Z}\phi\left(\underline{Z}\right)\frac{d\underline{Z}}{d\tilde{\theta}}\right) \quad (21) \\ &= \frac{1}{\tilde{\theta}^2}\sigma_g^2 \int_{Z \in \left(\underline{Z}, \bar{Z}\right)} Z\phi\left(Z\right) dZ + \frac{1}{\tilde{\theta}}\sigma_g^2 \left(\bar{Z}\frac{\phi\left(\bar{Z}\right)}{\phi\left(\underline{Z}\right)} + \underline{Z}\right)\phi\left(\underline{Z}\right)\frac{d\underline{Z}}{d\tilde{\theta}}, \end{aligned}$$

$$\begin{aligned} \frac{d\mathbb{E}\left[u_2 - u_1\right]}{d\tilde{\theta}} &= \sigma_g^2 \left(-\bar{Z}\phi\left(\bar{Z}\right)\frac{d\bar{Z}}{d\tilde{\theta}} + \underline{Z}\phi\left(\underline{Z}\right)\frac{d\underline{Z}}{d\tilde{\theta}}\right) \\ &= \sigma_g^2 \left(\bar{Z}\frac{\phi\left(\bar{Z}\right)}{\phi\left(\underline{Z}\right)} + \underline{Z}\right)\phi\left(\underline{Z}\right)\frac{d\underline{Z}}{d\tilde{\theta}}, \end{aligned}$$

where we use that $\frac{d\underline{Z}}{d\tilde{\theta}} = -\frac{d\bar{Z}}{d\tilde{\theta}} < 0$ (easily seen from (17) and (18)). Since $\int_{Z \in \left(\underline{Z}, \bar{Z}\right)} Z\phi\left(Z\right) dZ > 0$, the sufficient condition for both of these derivatives to be positive is that $\bar{Z}\frac{\phi(\bar{Z})}{\phi(\underline{Z})} + \underline{Z} < 0$. To show that this holds for sufficiently negative $\tilde{u}$, note that

$$\begin{aligned} \frac{\phi(\bar{Z})}{\phi(\underline{Z})} &= exp\left(-\frac{1}{2}\left(\bar{Z}^2 - \underline{Z}^2\right)\right), && (22) \\ &= exp\left(2\frac{\tilde{u}}{\sigma_g}\sqrt{\left(\frac{\tilde{u}}{\sigma_g}\right)^2 + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2}\right), && (23) \\ &\leq exp\left(-2\left(\frac{\tilde{u}}{\sigma_g}\right)^2\right). && (24) \end{aligned}$$

The ratio $\frac{\phi(\bar{Z})}{\phi(\underline{Z})}$ therefore approaches zero at an exponential rate as $\tilde{u} \to -\infty$. We know that

$\underline{Z}$ is negative. To prove that the overall term $\bar{Z}\frac{\phi(\bar{Z})}{\phi(\underline{Z})}+\underline{Z}<0$ as $\tilde{u}\to-\infty$, all that remains to show is therefore that $\frac{\underline{Z}}{\bar{Z}}$ is sufficiently large in magnitude. To bound $\underline{Z}$, we use that the square-root function is concave. Let's restrict our attention to the part of the parameter space where $-\frac{\tilde{u}}{\sigma_g}>1$ so that $\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\frac{\sigma_g}{\tilde{u}}\right)^2<1$. It then follows that

$$\frac{|\underline{Z}|}{\left(-\frac{\tilde{u}}{\sigma_g}\right)}=\sqrt{1+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\frac{\sigma_g}{\tilde{u}}\right)^2}-1\geq\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\frac{\sigma_g}{\tilde{u}}\right)^2\left(\sqrt{2}-1\right).$$

With $-\frac{\tilde{u}}{\sigma_g}>1$ we further have that

$$\frac{|\bar{Z}|}{\left(-\frac{\tilde{u}}{\sigma_g}\right)}=\sqrt{1+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\frac{\sigma_g}{\tilde{u}}\right)^2}+1\leq\sqrt{2}+1.$$

Now, an exponential function grows faster than a linear function, which means that $\forall\tilde{\theta}$ there exists an $x>1$ such that if $\left(\frac{\tilde{u}}{\sigma_g}\right)^2>x$ then

$$exp\left(-2\left(\frac{\tilde{u}}{\sigma_g}\right)^2\right)<\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\frac{\sigma_g}{\tilde{u}}\right)^2\frac{\sqrt{2}-1}{\sqrt{2}+1}.$$

Substituting into

$$\bar{Z}\frac{\phi\left(\bar{Z}\right)}{\phi\left(\underline{Z}\right)}+\underline{Z}=\left(-\frac{\tilde{u}}{\sigma_g}+\sqrt{\left(\frac{\tilde{u}}{\sigma_g}\right)^2+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2}\right)\frac{\phi\left(\bar{Z}\right)}{\phi\left(\underline{Z}\right)}+-\frac{\tilde{u}}{\sigma_g}-\sqrt{\left(\frac{\tilde{u}}{\sigma_g}\right)^2+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2},$$

we obtain that $\bar{Z}\frac{\phi(\bar{Z})}{\phi(\underline{Z})}+\underline{Z}<0$ for $\left(\frac{\tilde{u}}{\sigma_g}\right)^2>x$. This proves Theorem 2.c.

To prove Theorem 2.a note that

$$\mathbb{E}\left[u_1+u_2\right]=\mathbb{E}\left[2u_1+u_2-u_1\right]=\mathbb{E}\left[u_2-u_1\right],$$

and we have already shown that the last expression increases in $\tilde{\theta}$. To prove the the inflation comparative static for Theorem 2.a, we use (4) and (5) and the above to obtain that

$$\mathbb{E}\left[\pi_1+\pi_2\right]=\mathbb{E}\left[2\pi_1+\pi_2-\pi_1\right]=2\tilde{\pi}-2\frac{1}{\tilde{\theta}}\tilde{u}+\mathbb{E}\left[\pi_2-\pi_1\right] \tag{25}$$

It remains to show that $\mathbb{E}\left[\pi_1+\pi_2\right]$ is decreasing in $\tilde{\theta}$. Using (21) and (25), we have

$$\frac{d\mathbb{E}\left[\pi_1+\pi_2\right]}{d\tilde{\theta}}=\frac{1}{\tilde{\theta}^2}\left(2\tilde{u}+\sigma_g^2\int_{Z\in\left(\underline{Z},\bar{Z}\right)}Z\phi\left(Z\right)dZ+\tilde{\theta}\sigma_g^2\left(\bar{Z}\phi\left(\bar{Z}\right)+\underline{Z}\phi\left(\underline{Z}\right)\right)\frac{d\underline{Z}}{d\tilde{\theta}}\right).$$

Clearly, the integral $\sigma_g^2\int_{Z\in\left(\underline{Z},\bar{Z}\right)}Z\phi\left(Z\right)dZ$ is bounded above as $\tilde{u}\to-\infty$, and so is $\tilde{\theta}\sigma_g^2\left(\bar{Z}\phi\left(\bar{Z}\right)+\underline{Z}\phi\left(\underline{Z}\right)\right)$. From (17), $\frac{d\underline{Z}}{d\tilde{\theta}}=\frac{\frac{\tilde{\theta}}{(1+\tilde{\theta})^2}}{\frac{\tilde{u}}{\sigma_g}+\underline{Z}}\to 0$ as $\tilde{u}\to-\infty$. So $\lim\limits_{\tilde{u}\to-\infty}\frac{d\mathbb{E}[\pi_1+\pi_2]}{d\tilde{\theta}}<0$. This proves Theorem 2.a.

To prove Theorem 2.d, note that

$$\begin{aligned}E\left[\left(u_2-u_1\right)^2\right] &= \left(\frac{1}{1+\tilde{\theta}}\right)^2\int_{g_I\in\left(\underline{g},\bar{g}\right)}\left(g_I\right)^2\phi_{0,\sigma_g}\left(g_I\right)dg_I+\\ &\quad+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2\int\int_{g_I\notin\left(\underline{g},\bar{g}\right)}\left(g_C^2+g_I^2\right)\phi_{0,\sigma_g}\left(g_C\right)dg_C\phi_{0,\sigma_g}\left(g_C\right)dg_C,\end{aligned}$$

which can be rewritten as

$$\begin{aligned}E\left[\left(u_2-u_1\right)^2\right] &= \left(\frac{1}{1+\tilde{\theta}}\right)^2\int_{g_I\in\left(\underline{g},\bar{g}\right)}\left(g_I\right)^2\phi_{0,\sigma_g}\left(g_I\right)dg_I\\ &\quad+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2\int_{g_I\notin\left(\underline{g},\bar{g}\right)}\left(\left(g_I\right)^2+\sigma_g^2\right)\phi_{0,\sigma_g}\left(g_I\right)dg_I.\end{aligned}$$

Using this and (20), we obtain

$$\begin{aligned}Var(u_2-u_1) &= \left(\frac{1}{1+\tilde{\theta}}\right)^2\int_{g_I\in\left(\underline{g},\bar{g}\right)}\left(g_I\right)^2\phi_{0,\sigma_g}(g_I)dg_I\\ &\quad+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2\int_{g_I\notin\left(\underline{g},\bar{g}\right)}\left(\left(g_I\right)^2+\sigma_g^2\right)\phi_{0,\sigma_g}(g_I)dg_I\\ &\quad-\left(\int_{g_I\in\left(\underline{g},\bar{g}\right)}g_I\phi_{0,\sigma_g}(g_I)dg_I\right)^2\end{aligned}$$

Using notation $Z = \frac{g_I}{\sigma_g} \sim N(0,1)$, this becomes

$$\begin{aligned}
\mathbb{V}(u_2 - u_1) &= \left(\frac{1}{1+\tilde{\theta}}\right)^2 \sigma_g^2 \int_{Z \in \left(\underline{Z}, \bar{Z}\right)} z^2 \phi(z) dz \\
&\quad + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2 \int_{Z \notin \left(\underline{Z}, \bar{Z}\right)} \left(\sigma_g^2 z^2 + \sigma_g^2\right) \phi(z) dz \\
&\quad - \sigma_g^2 \left(\int_{Z \in \left(\underline{Z}, \bar{Z}\right)} z \phi(z) dz\right)^2 . \qquad (26)
\end{aligned}$$

To make Figure 1, we further transform equation (26). We use that

$$\int_{\underline{Z}}^{\bar{Z}} z^2 \phi(z) dz = \Phi(\bar{Z}) - \Phi(\underline{Z}) + \underline{Z}\phi(\underline{Z}) - \bar{Z}\phi(\bar{Z}),$$

and

$$\int_{\underline{Z}}^{\bar{Z}} z \phi(z) dz = \phi(\underline{Z}) - \phi(\bar{Z}),$$

to get:

$$\begin{aligned}
\mathbb{V}(u_2 - u_1) &= \left(\frac{1}{1+\tilde{\theta}}\right)^2 \sigma_g^2 \left[\Phi(\bar{Z}) - \Phi(\underline{Z}) + \underline{Z}\phi(\underline{Z}) - \bar{Z}\phi(\bar{Z})\right] \\
&\quad + \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2 \sigma_g^2 \left(2 - 2\left(\Phi(\bar{Z}) - \Phi(\underline{Z})\right) - \left(\underline{Z}\phi(\underline{Z}) - \bar{Z}\phi(\bar{Z})\right)\right) \\
&\quad - \sigma_g^2 \left(\phi(\underline{Z}) - \phi(\bar{Z})\right)^2 . \qquad (27)
\end{aligned}$$

We want to show that $\mathbb{V}(u_2 - u_1)$ is decreasing in $\tilde{\theta}$ near $\tilde{\theta} = 0$. What is the derivative of (26) at $\tilde{\theta} = 0$? Note that at $\tilde{\theta} = 0$ we have that $\frac{d\bar{Z}}{d\tilde{\theta}} = \frac{d\underline{Z}}{d\tilde{\theta}} = 0$. Therefore

$$\left.\frac{d\mathbb{V}(u_2 - u_1)}{d\tilde{\theta}}\right|_{\tilde{\theta}=0} = -2\sigma_g^2 \int_{Z \in \left(\underline{Z}, \bar{Z}\right)} z^2 \phi(z) dz < 0,$$

provided that $\tilde{u} < 0$, which ensures that $\bar{Z} > \underline{Z}$. Because $\frac{d\mathbb{V}(u_2-u_1)}{d\tilde{\theta}}$ is continuous, it then follows that there exists a constant c such that $\frac{d\mathbb{V}(u_2-u_1)}{d\tilde{\theta}} < 0$ for $\tilde{\theta} \in (0, c)$.

To prove the corresponding result for inflation, note that

$$\begin{aligned}\pi_2\left(g_I, g_C\right) - \pi_1 &= \begin{cases} -\frac{1}{\tilde{\theta}} g_I + \frac{1}{1+\tilde{\theta}} g_I \text{ if } g_I \in \left(\underline{g}, \bar{g}\right) \\ -\frac{1}{1+\tilde{\theta}} g_C + \frac{1}{1+\tilde{\theta}} g_I \text{ if } g_I \notin \left(\underline{g}, \bar{g}\right) \end{cases} \\ &= \frac{1}{\tilde{\theta}}\left(u_2 - u_1\right).\end{aligned}$$

The proof for $\frac{d\mathbb{V}(\pi_2-\pi_1)}{d\tilde{\theta}}$ then uses that

$$\frac{d\mathbb{V}(\pi_2-\pi_1)}{d\tilde{\theta}} = -\frac{2}{\tilde{\theta}^3}\mathbb{V}(u_2-u_1) + \frac{1}{\tilde{\theta}^2}\frac{d\mathbb{V}(u_2-u_1)}{d\tilde{\theta}},$$

which implies that $\frac{d\mathbb{V}(\pi_2-\pi_1)}{d\tilde{\theta}} < 0$ for $\tilde{\theta} \in (0, c)$. ■

Proof of Proposition 2. The within-period equilibrium is analogous to before, only with g_I replaced by $g_I + e$ and noting that $\mathbb{E}\left(g_I + e\right) = e^e$. We have alredy solved for the within-period equilibrium for period 2 when the expected government quality may be different from zero and we can apply this solution for period 1 with effort. Substituting into the equilibrium (6) and (7) gives:

$$\pi_1 = \tilde{\pi} - \frac{1}{\tilde{\theta}}\left(e^e + \tilde{u}\right) - \frac{1}{1+\tilde{\theta}}\left(g_I + \left(e - e^e\right)\right) \tag{28}$$

$$u_1 = -\frac{\tilde{\theta}}{1+\tilde{\theta}}\left(g_I + \left(e - e^e\right)\right) - e^e. \tag{29}$$

Noting that in equilibrium $e = e^e$ gives Lemma 2 b) and c).

Voters therefore believe that unemployment was generated by

$$u_1 = -\frac{\tilde{\theta}}{1+\tilde{\theta}} g_I - e^e. \tag{30}$$

Voters' posterior of incumbent quality is therefore given by:

$$\mathbb{E}\left(g_I \middle| u_1\right) = -\frac{1+\tilde{\theta}}{\tilde{\theta}}\left(u_1 + e^e\right), \tag{31}$$

$$\mathbb{V}\left(g_I \middle| u_1\right) = 0. \tag{32}$$

Because in equilibrium effort is rationally anticipated, voters fully learn about incumbent quality in equilibrium, proving Lemma 2 a).

To prove Proposition 2, note that the voters choose to reelect the incumbent if and only if

$$\left(\mathbb{E}\left(g_I|\,u_1\right)+\tilde{u}\right)^2 \;\leq\; \left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2\sigma_g^2+\tilde{u}^2, \tag{33}$$

which is equivalent to $\underline{g} \leq \mathbb{E}\left(g_I|\,u_1\right) \leq \bar{g}$, where $\underline{g}$ is still given by (**??**) and $\bar{g}$ is the corresponding positive root given by

$$\bar{g} \;=\; -\tilde{u}+\sqrt{\tilde{u}^2+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2\sigma_g^2} > 0. \tag{34}$$

We can re-write the reelection set in terms of the realized period 1 unemployment rate. The incumbent is reelected if and only if $u_1 \in [\underline{u},\bar{u}]$, where:

$$[\underline{u},\bar{u}] \;=\; -e^e+\frac{\tilde{\theta}}{1+\tilde{\theta}}\tilde{u}\pm\frac{\tilde{\theta}}{1+\tilde{\theta}}\sqrt{\tilde{u}^2+\left(\frac{\tilde{\theta}}{1+\tilde{\theta}}\right)^2\sigma_g^2} \tag{35}$$

We now consider the government's incentive to deviate from e^e. If the government chooses e but expectations are e^e, it knows that voters' expectations are

$$E\left(g_I|\,u_1\right) \;=\; -\frac{1+\tilde{\theta}}{\tilde{\theta}}\left(u_1+e^e\right), \tag{36}$$

$$\;=\; -\frac{1+\tilde{\theta}}{\tilde{\theta}}\left(-\frac{\tilde{\theta}}{1+\tilde{\theta}}\left(g_I+(e-e^e)\right)-e^e+e^e\right), \tag{37}$$

$$\;=\; g_I+(e-e^e) \tag{38}$$

Because expectations are assumed to be rational $e-e^e$ must equal zero in equilibrium, completing the proof for Lemma 3.

To prove Proposition 2, note that from government's perspective, g_I is a random variable with density ϕ_{0,σ_g^2}, so the government chooses e that solves :

$$\max_e \Phi_{0,\left(\sigma_g^2\right)}\left(\bar{g}+e^e-e\right)-\Phi_{0,\sigma_g^2}\left(\underline{g}+e^e-e\right)-\frac{e^2}{2}.$$

Taking the first-order condition with respect to e:

$$\phi_{0,\sigma_g^2}\left(\underline{g}+e^e-e\right)-\phi_{0,\sigma_g^2}\left(\bar{g}+e^e-e\right)-e=0$$

So in equilibrium, $e = e^e \equiv e^*$ satisfies

$$\phi_{0,\sigma_g^2}\left(\underline{g}\right) - \phi_{0,\sigma_g^2}\left(\bar{g}\right) = e^*$$

with the second-order condition

$$\phi'_{0,\sigma_g^2}\left(\bar{g}\right) - \phi'_{0,\sigma_g^2}\left(\underline{g}\right) - 1 < 0.$$

Using the implicit function theorem, we obtain

$$\frac{de^*}{d\tilde{\theta}} = \left(\phi'_{0,\sigma_g^2}\left(\underline{g}\right)\frac{d\underline{g}}{d\tilde{\theta}} - \phi'_{0,\sigma_g^2}\left(\bar{g}\right)\frac{d\bar{g}}{d\tilde{\theta}}\right)$$

Note that $\frac{d\underline{g}}{d\tilde{\theta}} < 0 < \frac{d\bar{g}}{d\tilde{\theta}}$ and $\phi'_{0,\sigma_g^2}\left(\underline{g}\right) > 0 > \phi'_{0,\sigma_g^2}\left(\bar{g}\right)$

$$\frac{d\underline{g}}{d\tilde{\theta}} = -\frac{\frac{\tilde{\theta}}{\left(\tilde{\theta}+1\right)^3}\sigma_g^2}{\sqrt{\tilde{u}^2 + \left(\frac{\tilde{\theta}}{\tilde{\theta}+1}\right)^2\sigma_g^2}} = -\frac{d\bar{g}}{d\tilde{\theta}} < 0,$$

so

$$\frac{de^*}{d\tilde{\theta}} = \left(\phi'_{0,\sigma_g^2}\left(\underline{g}\right) + \phi_{0,\sigma_g^2}\left(\bar{g}\right)\right)\frac{d\underline{g}}{d\tilde{\theta}} < 0,$$

where the last inequality follows from $\frac{d\underline{g}}{d\tilde{\theta}} < 0$ and the fact that $\left|\underline{g}\right| < \left|\bar{g}\right|$. This completes the proof for Proposition 2. ■

Proof of Proposition 3. We now derive results for the optimal central bank inflation weight, $\tilde{\theta}$. We start with the Rogoff case, where shocks across periods are assumed to be uncorrelated. Equation (14) gives that the expected period 1 and 2 loss functions are equal and given by

$$\mathbb{E}\left(\mathcal{L}_1^{Rogoff}\right) = \mathbb{E}\left(\mathcal{L}_2^{Rogoff}\middle| u_1\right) = \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\left(1+\tilde{\theta}\right)^2}\sigma_g^2 + \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2}\tilde{u}^2.$$

The optimal $\theta^{*,Rogoff}$ is given by the first-order condition for $\mathbb{E}\left(\mathcal{L}_1^{Rogoff} + \mathcal{L}_2^{Rogoff}\right)$ with respect to $\tilde{\theta}$, that is:

$$\frac{d\mathbb{E}\left(\mathcal{L}_1^{Rogoff} + \mathcal{L}_2^{Rogoff}\right)}{d\tilde{\theta}} = 2\left(\frac{\tilde{\theta} - \theta}{(1+\tilde{\theta})^3}\sigma_g^2 - \frac{\theta}{\tilde{\theta}^3}\tilde{u}^2\right). \tag{39}$$

When central bank inflation aversion equal to the social inflation aversion ($\tilde{\theta} = \theta$) this derivative is clearly negative, yielding the familiar Rogoff (1985) result that social welfare can be improved by choosing a central banker who is more averse to inflation than the public. As $\tilde{\theta} \to -\infty$, the positive terms in (39) dominate. Together, this shows the existence of an equilibrium with $\theta^{*,Rogoff} > \theta$.

Now we turn to the case with optimal political turnover. Conditional on observing u_1 and the challenger government being elected, the expected period 2 social loss equals to that from Rogoff case:

$$\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right) = \mathbb{E}\left(\mathcal{L}_2^{Rogoff} \middle| u_1\right),$$

Conditional on observing u_1 and the incumbent being reelected, (14) gives us

$$\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{incumbent}\right.\right) = \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2}\left(g_I + \tilde{u}\right)^2.$$

The incumbent is reelected whenever $\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{incumbent}\right.\right) \leq \mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right)$. The expected period 2 loss with optimal political turnover conditional on u_1 equals

$$\mathbb{E}\left(\mathcal{L}_2 \left| u_1\right.\right) = \min\left(\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right), \mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{incumbent}\right.\right)\right).$$

Because the social planner needs to choose the central banker at time 0 before any shocks are realized, the optimal θ^* depends on the expected welfare loss as of period 0. We take the expectation over $Z = \frac{u_1}{\sigma_u}$ to obtain the unconditional expected period 2 loss with optimal government turnover

$$\begin{aligned}
\mathbb{E}\mathcal{L}_2 &= \left(\int_{-\infty}^{\underline{Z}} \phi(z)dz + \int_{\bar{Z}}^{\infty} \phi(z)dz\right)\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right) \\
&\quad + \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2}\int_{\underline{Z}}^{\bar{Z}} \left(\sigma_g z + \tilde{u}\right)^2 \phi(z)dz. \qquad (40)
\end{aligned}$$

Using the Leibniz rule to differentiate integrals, we obtain derivative of $\mathbb{E}\mathcal{L}_2$ with respect to $\tilde{\theta}$

$$\begin{aligned}
\frac{d\mathbb{E}\mathcal{L}_2}{d\tilde{\theta}} &= \left(1 - \left(\Phi(\bar{Z}) - \Phi(\underline{Z})\right)\right)\frac{d\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right)}{d\tilde{\theta}} \\
&\quad - \frac{\theta}{\tilde{\theta}^3}\int_{\underline{Z}}^{\bar{Z}} \left(\sigma_g z + \tilde{u}\right)^2 \phi(z)dz \\
&\quad + \left(\phi\left(\underline{Z}\right) - \phi\left(\bar{Z}\right)\right)\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right) \\
&\quad + \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2}\left(\left(\sigma_g \bar{Z} + \tilde{u}\right)^2 \phi(\bar{Z}) - \left(\sigma_g \underline{Z} + \tilde{u}\right)^2 \phi(\underline{Z})\right). \qquad (41)
\end{aligned}$$

From the definition of the optimal reelection thresholds (17) and (18) we know that the voters are indifferent between the incumbent and the challenger at $Z = \bar{Z}$ and $Z = \underline{Z}$ or

$$\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right) = \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2}\left(\sigma_g \bar{Z} + \tilde{u}\right)^2 = \frac{1}{2}\frac{\tilde{\theta}^2 + \theta}{\tilde{\theta}^2}\left(\sigma_g \underline{Z} + \tilde{u}\right)^2, \tag{42}$$

which implies that the last two terms in (41) cancel. This is an envelope-type result, which obtains because voters are indifferent between reelecting the incumbent and electing a risky challenger at $\underline{Z}$ and $\bar{Z}$.

The derivative (41) then simplifies further

$$\begin{aligned}
\frac{d\mathbb{E}\mathcal{L}_2}{d\tilde{\theta}} &= \left(1 - \left(\Phi(\bar{Z}) - \Phi(\underline{Z})\right)\right) \frac{d\mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right)}{d\tilde{\theta}} \\
&\quad - \frac{\theta}{\tilde{\theta}^3}\int_{\underline{Z}}^{\bar{Z}} \left(\sigma_g z + \tilde{u}\right)^2 \phi(z) dz \\
&= \left(1 - \left(\Phi(\bar{Z}) - \Phi(\underline{Z})\right)\right)\left(\frac{\tilde{\theta} - \theta}{(1+\tilde{\theta})^3}\sigma_g^2 - \frac{\theta}{\tilde{\theta}^3}\tilde{u}^2\right) \\
&\quad - \frac{\theta}{\tilde{\theta}^3}\int_{\underline{Z}}^{\bar{Z}} \left(\sigma_g z + \tilde{u}\right)^2 \phi(z) dz
\end{aligned} \tag{43}$$

The optimal central bank weight θ^* minimizes the expected sum of period 1 and 2 losses and satisfies the first-order condition

$$\begin{aligned}
\frac{d\mathbb{E}\left(\mathcal{L}_1 + \mathcal{L}_2\right)}{d\tilde{\theta}} &= \left(2 - \left(\Phi(\bar{Z}) - \Phi(\underline{Z})\right)\right)\left(\frac{\tilde{\theta} - \theta}{(1+\tilde{\theta})^3}\sigma_g^2 - \frac{\theta}{\tilde{\theta}^3}\tilde{u}^2\right) \\
&\quad - \frac{\theta}{\tilde{\theta}^3}\int_{\underline{Z}}^{\bar{Z}} \left(\sigma_g z + \tilde{u}\right)^2 \phi(z) dz.
\end{aligned} \tag{44}$$

Here, we have used that $\mathbb{E}\mathcal{L}_1 = \mathbb{E}\left(\mathcal{L}_1^{Rogoff}\right) = \mathbb{E}\left(\mathcal{L}_2 \left| u_1, \text{challenger}\right.\right)$. Clearly, at $\tilde{\theta} = \theta$ the first-order condition (44) is negative. As $\tilde{\theta} \to -\infty$, the positive terms in (44) dominate. Together, this shows that an equilibrium exists with $\theta^* > \theta$.

How does θ^* compare to $\theta^{*,Rogoff}$? For this, we take difference of the two comparative statics and scale by σ_g^2 for convenience:

$$\frac{1}{\sigma_g^2}\left(\frac{d\mathbb{E}\left(\mathcal{L}_1+\mathcal{L}_2\right)}{d\tilde{\theta}}-\frac{d\mathbb{E}\left(\mathcal{L}_1^{Rogoff}+\mathcal{L}_2^{Rogoff}\right)}{d\tilde{\theta}}\right) = -\left(\Phi(\bar{Z})\right)-\Phi(\underline{Z})\Big)\left(\frac{\tilde{\theta}-\theta}{\left(1+\tilde{\theta}\right)^3}-\frac{\theta}{\tilde{\theta}^3}\left(\frac{\tilde{u}}{\sigma_g}\right)^2\right) -\frac{\theta}{\tilde{\theta}^3}\int_{\underline{Z}}^{\bar{Z}}\left(\sigma_g z+\tilde{u}\right)^2\phi(z)dz. \tag{45}$$

To prove the existence of an equilibrium with $\theta^* > \theta^{*,Rogoff}$ we only need to show the sign of (45) at $\theta^{*,Rogoff}$. Substituting $\theta^{*,Rogoff}$ defined implicitly via (39) gives

$$\frac{1}{\sigma_g^2}\left(\frac{dE_0\mathcal{L}_2}{d\tilde{\theta}}-\frac{dE_0\mathcal{L}_2^{Rogoff}}{d\tilde{\theta}}\right)\Bigg|_{\tilde{\theta}=\theta^{*,Rogoff}} = -\frac{\theta}{\left(\theta^{*,Rogoff}\right)^3}\int_{\underline{Z}\left(\theta^{*,Rogoff}\right)}^{\bar{Z}\left(\theta^{*,Rogoff}\right)}\left(\sigma_g z+\tilde{u}\right)^2\phi(z)dz < 0. \tag{46}$$

It follows that $\frac{d\mathbb{E}(\mathcal{L}_1+\mathcal{L}_2)}{d\tilde{\theta}}$ intersects zero at $\theta^* > \theta^{*,Rogoff}$.

Intuitively, at $\theta^{*,Rogoff}$ the risk and inflation bias of electing a challenger of unknown quality exactly balance. The optimal θ^* with political turnover reflects an average of the optimal central bank inflation weights conditional on the challenger being elected and the incumbent being reelected. If the incumbent is reelected, the social benefits of having a strong central bank are particularly large, as the central bank is more effective at counteracting inflation bias when the government shock is known in advance. Conditional on the challenger being elected, it is optimal to choose the same central bank as in the Rogoff case. Taken together, this tilts the socially optimal inflation weight towards a stronger central bank when there is political turnover. ■

Proof of Proposition 4. From the fact that neither $\underline{g}$ nor $\bar{g}$ as defined in (15) and (16) depend on θ, we know that the preferences of the voter do not affect the reelection decision. This implies that at the election time, the central bank, whose objective function differs from that of the voters only by the parameter $\tilde{\theta}$, prefers the same candidate as the voters. Hence, the central bank has no incentive to deviate from the period 1 monetary policy that simply minimizes the myopic loss $\tilde{\mathcal{L}}_1$. Because period 2 is the last period, optimal monetary policy in period 2 is also trivially unchanged. ■