SIGNALING EFFECT OF FISCAL REFORMS DURING POLITICAL UNCERTAINTY: A GAME THEORY APPROACH

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Abstract

This paper examines how rules and institutions and monetary-fiscal coordination setup impact welfare outcomes during political instability. Our theoretical model extends the analysis of Alesina and Tabellini (1987), Alesina and Gatti (1995), and Ferre and Manzano (2014) to examine the signaling content of the fiscal authority's decision to engage in a fiscal reform when the policymaker's preferences are private information. In a two-stage signaling game featuring a central banker, a government, and private agents, we examine the fiscal authority's decision to engage in a fiscal reform under a Nash game, a cooperative setup, and a model of Stackelberg leadership. Three main results: 1) rules and commitments contribute to decreasing time inconsistency; 2) the more control the fiscal authority has over monetary policy, the more undesirable welfare outcomes, especially during political instability; 3) central bank independence signals fiscal discipline and produces relatively more desired outcomes during times of political uncertainty. Nevertheless, even with low degrees of central bank independence, proper fiscal "rules" produce close outcomes of an independent central bank even under the dominance of a centralized political authority and can secure close welfare gains in terms of inflation and fiscal outcomes. We propose these theoretical findings for empirical examination in emerging countries with prevailing schemes of fiscal dominance and more dependence on discretionary interventions to secure growth rates and financing gaps. Such setups are argued to contribute to lowering welfare outcomes that could be reduced if proper fiscal rules were used as a substitute for low monetary independence.

Keywords: Monetary-Fiscal Games, Political Uncertainty, Signaling, Fiscal Reforms, Central Bank Independence

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1. INTRODUCTION

Literature mentioned the importance of assessing the outcomes of fiscal-monetary interactions as dynamic players in the macroeconomic system where strategic interactions between political governments and central banks were proven to matter. The level of coordination between these two authorities and their strategic and sequential movements towards each other's economic policies will result in different welfare outcomes. Lack of coordination, whether in the form of different

objectives or even different weights for different objectives result in less desirable welfare outcomes. Nevertheless, different factors interrupting the policy game can influence the welfare outcomes under different coordination schemes.

Within the traditional Tinbergen macroeconomic models, gaming approaches were originally introduced to examine policy outcomes under three basic monetary and fiscal interaction setups: 1) cooperative or fully-coordinated policies pursuing common objectives; 2) simultaneous normal form game or non-cooperative behavior under a Nash equilibrium; and 3) other non-cooperative Stackelberg leader-follower model (Barro & Gordon, 1983; Blinder, 1982; Nordhaus, Schultze, & Fischer, 1994). Emergent literature extended the game analysis and complexities to include aspects such as credibility, political cycles, institutional setups, and rules governing the monetary and fiscal policymaking (Backus & Driffill, 1985; Kirsanova, Stehn, & Vines, 2005; Saulo, Rêgo, & Divino, 2013). However, what has received less attention is the information content of such rules, their analysis is limited to an investment decision or institutional design that shapes the outcomes of the game. This paper attempts to fill this gap by formally introducing the Bayesian analysis of fiscal and monetary rules being strategically used as signaling devices in a politically uncertain environment. We focus on the link between political uncertainty and the signaling content of fiscal reform.

To formalize our argument, we develop a monetary-fiscal game built on the theoretical models in Alesina and Tabellini's (1987) and Dimakou's (2015) frameworks while we further integrate fiscal rules and central bank decisions/ laws as signaling devices. The basic setup consists of a two-stage signaling game featuring a central banker, a government, and private agents. There is a double-sided adverse selection problem; private agents are unable to observe neither the government's commitment to fiscal discipline nor the central bank's degree of conservatism. Each authority minimizes its loss function (which consists of deviations from targeted inflation, output, and government spending) by choosing a policy instrument — public spending for the government and inflation rate for the central bank. Alongside this strategic choice, each authority can choose to signal its type by adopting a fiscal or monetary rule. The signaling content of those rules is analyzed under different schemes, namely a Nash game, a cooperative setup, and a model of Stackelberg leadership.

The parameters we choose for institutional performance are the degree of central bank's independence and fiscal reforms that increase tax efficiency. On the one hand, an independent and conservative central bank in the sense of Dixit and Lambertini (2000), Alesina and Tabillini (1987), and Rogoff (1985) is one that enjoys full control over monetary tools and that is less willing to finance government spending through money creation and seignorage. A conservative central bank is one that sets output and inflation targets lower than the socially optimal one; that is, it gives more weight to inflation stabilization and less weight to output stabilization. Hence, a conservative independent central bank will be inflation averse in the sense that it will be less concerned about generating surprise inflation to increase output and decrease output gaps; and should theoretically result in lower inflation bias and less time consistent inflation.

On the other hand, fiscal reform is a reform that is meant to increase the efficiency of fiscal tools in a way that shall result in a lower fiscal deficit; either through an increase in revenues or a decrease in expenditure bills. In strategic policy games, fiscal reform is identified as one that attempts to decrease the government reliance on seignorage as a source to finance government spending. As Cukierman, Edwards, and Tabellini (1992) note, poor tax structure, political instability, and other factors increase the reliance on seignorage as a source of tax revenue. Hence, the abstract rationale of monetary-fiscal coordination models that we will review is the tax reforms as a means to decrease the dependence on seignorage; that is, raise output without raising inflation. We thus assume that monetary fiscal interaction setups lie between two extremes: that of a centralized authority against one of monetary leadership or a full central bank's independence. Fiscal leadership, as well as Nash setups, lie in between those two extremes. More commitment and less discretionary interventions reflect higher levels of credibility and fewer time-inconsistency problems under any setup.

Results have important implications for developing countries where fiscal dominance and more dependence on discretionary interventions are probably the more prevailing setups to secure growth rates and financing gaps. In such countries, there appears to be a continued setup of fiscal dominance paralleled with lacking efficient institutions and a high reliance on politically motivated discretionary interventions that become apparent during political cycles and spells of political and economic uncertainty. Such setups result in worst welfare outcomes that — according to our game results — could be reduced if proper fiscal rules were used as a substitute for low monetary independence during political uncertainty. Fiscal rules can secure the same welfare gains in terms of both contained inflation and good fiscal performance.

The rest of the paper is organized as follows. Section 2 presents the related literature. Section 3 lays out the theoretical model and discusses the implications of various monetary-fiscal interaction setups. Section 4 discusses the results of the research. Finally, Section 5 concludes.

2. LITERATURE REVIEW

Our paper is related to three strands of the literature: time inconsistency under rules versus discretion, asymmetric information and monetary policy, and monetary-fiscal interactions when fiscal authority is considered an endogenous player in the model.

2.1. The time-inconsistency problem

The Nobel laureates Finn Kydland and Edward Prescott were the first to clearly articulate and examine the time-inconsistency problem within

a broader framework that involves the famous "rules versus discretion" debate[1]. Their classic argument presented in Kydland and Prescott (1977) rests on the notion that policymaking occurs in a dynamic environment where a discretionary policy designed today given the current economic variables will not necessarily be welfare-maximizing if the future expectations of economic agents are taken into consideration and can end up with time-inconsistent monetary policies and eventually higher inflation rates. Public expectations are rational and discretionary measures that are faced by rational expectations of economic agents that impact current responses to economic policies and hence result in a different social wellbeing function with a different outcome of the discretionary measure.

Barro and Gordon (1983), Alesina and Tabillini (1987) argue that time inconsistency is a reason behind the failure of the conventional Philips-Curve tradeoff to be sustained over the long run. In this regard, they found that time inconsistency upsurges when authorities act non-cooperatively and proved the inferiority of Nash equilibria when authorities decide to persistently trade off high inflation for more output. Rogoff (1985) shows that during times of political uncertainty, time inconsistency and inflation biases could be minimized and social welfare outcomes can be improved if policy rules were set *ex-ante*; that is, if the system operated under a higher level of commitment.

In the abovementioned works, among other literature, there is strong advocacy for commitments/rules rather than discretion as solutions to time-inconsistency problems. Later works widened the scope of analysis to incorporate a new variable into the designed games; the reputation or credibility of the monetary authority. The reputation of the monetary authority was found to impact the outcomes of discretionary interventions; both in normal times or during political cycles. For instance, while Barro and Gordon (1983) showed more favorable inflation outcomes under committed regimes, they found that an uncommitted central bank with a good reputation will substitute for the presence of formal rules and keep inflation some place between the commitments low bound and the discretion-high bound. This finding has opened the door for more analysis of the central bank's reputation (credibility) as a variable affecting economic policy outcomes. Backus and Driffill (1983) also re-examined Barro and Gordon's (1983) model while assuming that the public is uncertain about the type of the government and that governments can manipulate their type through manipulating their reputation. Governments can sequentially manipulate their reputation and end up with a dynamically consistent model through a credible policy; providing the second-best equilibrium after a zero-inflation commitment.

Following this argument, Barro (1986) re-examined his famous neoclassical model after relaxing his earlier assumption that policymaker's reputation is infinitely fixed and that the policymaker's behavior is constant. In an environment characterized by political uncertainty, a probability element is introduced to the model where observers would then anticipate the policymaker to be of a specific type and hence build their expectations upon their observations. Mistaking an uncommitted policymaker for a committed one results in lowering expected inflation only for a certain interval after which anticipated inflation shall eventually increase. However, an uncommitted policymaker can improve his reputation through "masquerading" a committed one by persistently keeping low inflation[2]. In a close manner, Alesina (1987) argues that while political cycles decrease the ability of conservative independent central banks to stabilize output, building a good reputation as a result of repeated interaction between the two competing parties or setting common policy rules will result in better discretionary outcomes and will minimize the cycle fluctuations[3].

Barro-Gordon model was experimented on the Iranian economy by Samadi, Marzban, and Owjimehr (2017). They designed a model that considers the discretion in monetary and fiscal policies and the effect of institutional quality. The results of the time consistency of these two policies helped in calculating the inflation bias. As a result, the Iranian economy showed a high degree of inflation bias as it is a developing economy.

Recently Ftiti, Aguir, and Smida (2017) explained in their paper the dynamic relationship between central bank independence (CBI) and inflation through the time inconsistency theory and the theory of expansionary business cycles. The results proved the importance of monetary regimes when analyzing the relationship between CBI and inflation. They found that intermediate and flexible exchange rate regimes allow appropriate control of inflation in the presence of CBI in emerging and developing economies.

2.2. Asymmetric information and the monetary policy

Our paper is closely related to the literature on asymmetric information and monetary policy in Backus and Driffill (1985), Canzoneri (1985), Cukierman and Meltzer (1986), and Barro (1986). In this regard, Vickers (1986) argues that incomplete information during periods of political uncertainty can deliberately produce welfare gains resulting from what he called the signaling content of the designed policies. In a system characterized by incomplete information as a result of political uncertainty, policymakers can enable a signaling behavior to intentionally alter expectations on future inflation and produce changes in welfare outcomes. The desirability of the signaling content varies with the type of policymaker in office compared to other probable policymakers as anticipated by the public. For instance, an expansionary policymaker can benefit from the incomplete information resulting from political uncertainty since it will result in lowering inflation expectations ensuing from public

[1] Finn Kydland and Edward Prescott were awarded Nobel Prize in 2004 for their works on time inconsistency in economic policy models and real business cycles.

[2] Barro's model shows that a system with occasional changes in regimes and identities of the policy makers would result in a series of small negative inflation shocks that are "offset" by a small number of large surprise inflation.

[3] Through examining the effect of uncertainty about electoral outcomes in a model with two parties having different preferences of unemployment and inflation and following a discretionary regime.

expectations of a possibility of having a conservative policy maker in the office. Lower inflation expectations will result in a higher inflationary shock a lower output gap and better welfare outcomes.

In rather recent work, Kuperberg (2013) denotes two factors affecting the credibility of monetary authority and hence the inflation outcomes. First, their understanding of the mechanism of the economy and how public expectations are formulated. If the monetary policy fails to "credibly signal" its commitment to the stated inflation target as a result of ignoring public expectations, a time inconsistency problem emerges. Second, their design and commitment to inflation targets. In his advocacy for the importance of central bank commitment to an inflation target, he defined a "λ" variable to measure "the relative regret that the central bank feels in missing its inflation target versus missing its unemployment target. Larger λ's indicates higher credibility of central banks and hence will result in lower inflation biases as people always expect committed central banks to "cheat less". This identification is remarkable as it captures what previous literature tried to highlight; that signaling a high inflation target will result in welfare outcomes in the form of lower actual inflation and unemployment rates. This result is a reformulation of what Kreps and Wilson (1982) have found; that, oppositely, tight policies will result in lowering output below the natural rate if the public thinks that the government will inflate.

A recent study by Bahmani-Oskooee and Nayeri (2018) assessed the impact of uncertainty on the demand for money in Australia to determine if the effects of policy uncertainty are asymmetric or not. The results showed that significant asymmetric effects of uncertainty were discovered in the long run. Basically, they found that increased uncertainty increases the demand for cash which in this case monetary policy would lose its effectiveness the public holds cash rather than spending.

Istiak and Alam (2019) investigated the possible asymmetric response of inflation expectations to oil price and policy uncertainty shocks. Their analysis confirmed a positive or increasing oil price shock had an asymmetric effect on inflation after the financial crisis. The increased inflation expectation because of positive oil price shocks was much greater than the decreased inflation expectations because of negative oil price shock. In other words, inflation expectations were less anchored post the financial crisis.

In addition, Bhat and Sharma (2020) studied the case of India to determine inflation from a fiscal policy point of view through an asymmetric approach. They found that an increase in fiscal deficit is found to be more inflationary than a decrease in deficit affects inflation. This asymmetric impact is identified through the existence of liquidity constraints, consumption investment downward inflexibility, and downward price stickiness. In addition, the results showed that contractionary monetary policy is more effective than expansionary monetary policy due to the asymmetric influence of monetary policy actions on inflation in India.

2.3. Monetary-fiscal games

Previously reviewed literature generally did not consider the fiscal policy as a dynamic player in the game. It was assumed passive or exogenous. However, when the fiscal policy is introduced as a strategic player in the game, outcomes differ considerably.

When fiscal authority is introduced into the game as a strategic player, results differ from earlier mainstream literature advocating for commitment over discretion. In general, commitments and higher degrees of coordination reduce time-inconsistency problems while oppositely discretionary interventions within Nash setups result in lower output and higher inflation rates compared to other setups, if the two policy authorities are not properly coordinating; that is they do not assign equal weights to their policy objectives, a regime of commitment would not necessarily be welfare improving because the reduction in seignorage will lead to an increase in taxes to finance public spending and hence lower output. Output losses under a non-cooperative setup can be too large to offset the gains from the reduced inflation. The desirability of commitment depends on the level of coordination between monetary and fiscal authorities since the level of coordination ultimately impacts the time inconsistency resulting from policy; either for one authority or both authorities.

Alesina and Tabellini (1987) show that the movement from a discretionary regime to a commitment one is not necessarily (as per Pareto principle) improving under non-cooperative setups. Dixit and Lambertini (2000) similarly show that if the two authorities act non-cooperatively and without commitments to any fiscal or monetary rules, results are the worst, both in terms of inflation and output. While each authority will attempt to minimize its loss function, time inconsistency will be an inevitable outcome of very expansionary fiscal policy as opposed to very contractionary monetary policy. Dixit and Lambertini's (2000) interesting finding is that while good monetary rules decrease time in consistency, discretionary fiscal interventions during shocks limit the operation of these monetary rules. Oppositely, good fiscal rules will not be undermined by discretionary monetary interventions and will still lead to welfare gains that surpass the Nash setup; that is, fiscal leadership under commitment provide the second best outcomes in general.

Finally, another strand of literature introduced new variables to the analysis of monetary-fiscal interactions such as interest rates as a monetary tool and public debt to account for intertemporal dimensions in the monetary-fiscal interactions. Bennett and Loayza's (2000), Kirsanova et al.'s (2005), and Saulo et al.'s (2012) mathematical and empirical findings prove that non-coordinated setups result in higher deficits and higher interest rates during shocks. Coordination, both at the level of designing policy objectives and implementing policies could alleviate policy biases while sequential movements under Stackelberg solutions only decrease the severity of undesirable welfare outcomes of absolute Nash setups. Coordinated policies that are set somewhere between the Nash

equilibria of tight monetary policy and loose fiscal policy, produce optimum welfare outcomes where neither fiscal sustainability nor output or investment capacity.

3. RESEARCH METHODOLOGY

3.1. Basic setup

In this section, we extend the model of Alesina and Tabellini (1987) and its political business cycle adaptation by Ferre and Manzano (2014) to a setting that includes a political decision on engaging in fiscal reform. The basic setup consists of three main players. The private sector consists of firms determining output supply and workers providing labor and setting inflation expectations. The fiscal authority chooses the fiscal policy by setting the level of some distortionary tax and whether to exert effort in enhancing the efficiency of the tax system. The central bank decides on the monetary policy, when applicable.

We define political uncertainty in the scope of this paper as a sudden event that involves a major transformation in the ruling administration or economic system in a way that generates ambiguity about future policy preferences and/or the possible responses of economic agents to the new policies. A priori, an authority that engages in tax reform is presumably of the conservative type in the sense that it prioritizes public good provision over output stabilization. In that sense, the government's decision to engage in the reform should reduce the public's expectations of future inflation. Due to the latter effect, an expansionary government would be willing to engage in reform only to benefit from the positive surprise inflation effect it could induce. In a rational Bayesian equilibrium, the public accounts for the signaling incentives while making inferences about the type of government in office.

3.1.1. The private sector

The private sector consists of a continuum of firms seeking to maximize their profits, net of taxes, and workers. We assume a sticky-price setup where nominal wages are negotiated in the first period and cannot be modified in period 2. The private sector acts competitively rather than strategically in the sense that the best individuals can do is predict inflation correctly. The aggregate output supply is given by:

$$\chi = \pi - \pi^e - \tau \qquad (1)$$

where, π and π^e are the actual and the expected inflation rates, respectively, and τ is the tax rate on output. The term $\pi - \pi^e$ captures the positive effect of unanticipated monetary policy on output (Barro & Gordon, 1983). Nominal wage contracts being set one period in advance, the policymaker has scope to raise output by inducing surprise inflation. Taxes have a distortionary effect on the output which alone can cause the monetary policy to be time-inconsistent (Alesina & Tabellini, 1987).

3.1.2. The government

The fiscal authority (FA) collects taxes and provides public goods. Precisely, a government of type i determines the level of taxes, τ to be imposed on output so as to minimize a convex loss function given by:

$$V_i = \frac{1}{2}\left[\pi_i^2 + \sigma_i(\chi_i - \chi^*)^2 + Y_i(g_i - g^*)^2\right] + c\phi \qquad (2)$$

where, σ_i, $Y_i \geq 0$ denote the weights, relative to inflation, that the policymaker of type i assigns to output stabilization and public spending, respectively. The policymaker thus has three objectives. First, he aims to minimize deviations of inflation from its zero target, i.e., achieve price stability $\pi^* = 0$. In this setup, inflation per se is undesirable, however, a positive level of inflation may be tolerated in exchange for a positive level of public spending and/or boosting output through surprise inflation. The second is to achieve output stabilization by minimizing deviations of output, χ, from its target which is normalized to zero without loss of generality, and the third is public goods provision. Denoting by $g^* > 0$ the ratio of public expenditures over output, the fiscal authority aims at reducing deviations of the level of public good provided from its bliss target $g^* \geq 0$.

Each policymaker is characterized by a type, which is private information. Suppose there are two types — "wet" ($i = W$) with probability p and "dry" ($i = D$) with probability $1 - p$. The type is related to the degree of inflation aversion and the relative interest in output growth over public spending as shown in the following assumption:

Assumption 1: The two types of policymakers, $i \in \{W, D\}$, are such that:

(i) The wet type prioritizes output growth over fiscal consolidation compared to the dry type $\frac{\sigma_W}{y_W} > \frac{\sigma_D}{y_D}$, and

(ii) The dry type is more inflation averse relative to the wet type $a_D > a_W$, where $a_i = \frac{(1/\sigma_i)+(1/Y_i)}{2}$ represents the inflation aversion of the policymaker of type i. It measures the extent to which the policymaker prioritizes the inflation target. Both a higher preference towards output stabilization and a higher weight assigned to the public spending goal translates into a lower value of a_i (Ferré & Manzano, 2014).

It is important to note that, throughout the paper, we consider the gap between the different types' preferences (precisely $a_D - a_W$) to be a proxy for political uncertainty. In an economy with a relatively stable political system, the public knows the priorities of the policymaker in office to be within a certain interval given that the system is well established and that there is a certain political agenda to be followed, any deviations from the specified targets due to personal preferences ought to be small. The smaller this interval the more stable the political system is and the more certainty and credibility there is. However in a political instability context, the political agenda is not clear, policymakers' preferences are not quite bound by the agenda and fall within a large interval.

By eliminating the possibility of issuing public debt[4], the government budget constraint is:

$$g = \phi\tau + \pi_i \quad (3)$$

where, $0 \leq \phi \leq 1$ represents the quality of fiscal institutions. Public spending can be financed either through taxes or seigniorage. Tax revenues, τ, could be raised to make more funds available for public spending purposes. However, in a tax system with high tax evasion rates, bureaucratic inefficiencies, or an inflated bureaucracy, the collected taxes would not be fully directed to the public goods (Cukierman et al., 1992; Huang & Wei, 2006). Alternatively, this could be the case of a corrupt system with either a corrupt bureaucracy overestimating the cost of tax collection, embezzlement of public funds, or appropriation thereof by a ruling elite (Dimakou, 2015). Consequently, a proportion of the collected taxes never reaches the treasury. The parameter ϕ is thus introduced to account for the *efficiency of the tax system*. Precisely, ϕ is the proportion of taxes that is not lost in the tax collection process and $\phi\tau_i$ is the tax base that is available to finance public goods. If $\phi = 1$, there is no tax revenue leakage and $\phi = 0$ represents a case where no tax revenues accrue to the government and hence public goods are financed solely through seigniorage. The cost function for institutional quality is linear, with a constant marginal cost equal to *C*.

Seigniorage is another source of revenues for financing public goods. Generally, we assume that monetary instruments are in the hands of the monetary authority; the central bank perfectly determines inflation with no control errors, thus assuming that money demand is not affected by the fiscal instrument, unlike Dixit and Lambertini (2000)[5]. However, in the case where there is no delegation of monetary policy to an independent central bank, the government also has at its disposal inflation to finance public goods.

3.1.3. The central bank

The central bank represents the monetary authority and is assumed to have direct and perfect control over inflation. The central bank sets the inflation rate, π, so as to minimize the loss function given by:

$$V_B = \frac{1}{2}\left[\pi_i^2 + \sigma_B\chi_i^2 + \gamma_B(g_i - g^*)^2\right] \quad (4)$$

with σ_B, $\gamma_B \geq 0$ denoting the weights the central bank assigns to reducing the output and the public goods gaps relative to inflation. Note that the central bank's objective function comprises the same arguments and targets as the fiscal authority's. The two functions only differ in the weights each authority puts on output stabilization and public spending targets relative to inflation. There are no conflicting objectives but rather conflicting priorities. In particular, it is assumed that (i) $\sigma_B < \sigma_i$ representing a Rogoff-type central bank (Rogoff, 1985) that prioritizes inflation control over output stabilization relative to the FA, and (ii) $\gamma_B \leq \gamma_i$ to capture the idea that the central bank has less interest in the fiscal objectives relative to the FA. A lower V_B indicates more CBI; the less interested the appointed central bank is in using the monetary instrument at its disposal in pursuing fiscal goals, the more independent the central bank is (Ferré & Manzano, 2014).

In what follows, we analyze the government's choice to undertake an institutional reform that enhances the quality of fiscal institutions. We consider the different sequences of moves. First, we analyze the case of a centralized authority setting both the monetary and fiscal policies. Then, we allow for a more independent monetary policy under a non-cooperative Nash game. Third, a fiscal leadership game is considered. Under each setup, we analyze two information structures: the full information scenario and that of asymmetric information where the fiscal authority's preferences are unobservable to the public. In the complete information games, we distinguish between two regimes, namely (i) the commitment regime where the monetary and/or fiscal can credibly commit to a policy and (ii) the case of discretionary policies. Whereas in the asymmetric information scenario where commitment makes no economic sense, we are rather interested in the signaling effect of reforms, i.e., whether policymakers could signal their true preferences through engaging in the reform.

3.1.4. Centralized authority

This subsection studies the case of a single policymaker deciding on either the fiscal and monetary policies, or equivalently where the monetary policy is delegated to a central bank that is fully dependent.

3.2. Complete information: Economic effect of the reform

As standard in the literature, we start our analysis with the commitment regime, also known as the second best, as it serves to separate the direct effect of the reform, absent any surprise inflation motives. Then we introduce discretionary policies to analyze the policymaker's incentives to induce surprise inflation. Under the assumption of full credibility and policy commitment, the policymaker preannounces an inflation rate, and agents fully believe the government will commit to it. The strategic interaction between the policymaker and the public is modeled as a two-period game. In period 1, the single policymaker sets the level of institutional quality ϕ and announces the inflation rate π and the taxes that will be applied in the next period. The public then forms expectations regarding inflation in the next period given the policymaker's choice, wage contracts and prices are set accordingly, and, in period 2, the policymaker simply implements the pre-announced policies.

Since the private sector believes the policymaker will commit to the announced policies, the aggregate supply function reduces to $\chi_i = -\tau_i$. Solving the two first-order conditions associated

[4] This assumption considerably simplifies the analysis at the cost of neglecting the intertemporal allocation of tax burdens and inflation.
[5] This is the main assumption that distinguishes Alesina and Tabellini's (1987) framework from Dixit and Lambertini's (2000) analysis.

with equation (2), the equilibrium for a given level of institutional quality, ϕ, is (where the superscript C refers to the centralized authority or cooperative game and throughout the paper, the bar above policy choices and outcomes refers to the commitment case and the absence thereof means policies are rather discretionary):

$$\begin{aligned} \pi_i^{-C}(\phi) &= \frac{\gamma_i \sigma_i}{\sigma_i(1+\gamma_i)+\phi^2\gamma_i} g^* \\ \tau_i^{-C}(\phi) &= \frac{\phi \bar{\pi}_i}{\sigma_i} \\ \chi_i^{-C} &= -\tau_i^{-C} \\ (g_i^{-C} - g^*) &= -\frac{\bar{\pi}_i}{\gamma_i} \end{aligned} \quad (5)$$

A number of observations can be made. First, as pointed out by Alesina and Tabellini (1987), even at the commitment equilibrium with fully coordinated policies, there is a positive inflation bias due to adding the public spending objective. Both output and public spending are below their bliss targets. If there is no need to provide public goods ($g^* = 0$), all deviations from targets reduce to zero.

Second, as the quality of institutions improves, both inflation and the public good gap decrease. Intuitively, an increase in institutional capacity raises the efficiency of the tax system; it allows for a higher level of public spending for a given tax base. Regular tax channels become relatively more appealing as a source of financing public spending and hence the policymaker's reliance on taxes relative to seigniorage $\left(\left(\frac{\bar{\tau}}{\bar{\pi}}\right)^C = \frac{\phi}{\sigma}\right)$ increases[6]. The reform thus results in lower inflation. The public spending gap is reduced since the tax channel is enhanced, which means less constraints in financing and clearly better outcomes. Third, an improved institutional capacity results in larger taxes when the tax system is initially inefficient. This last result may seem counterintuitive at first sight. A priori, upon enhancing the quality of fiscal institutions in a way that reduces leakage of collected taxes, we would expect less taxes to be imposed. However, due to the increase of relative appeal of taxes vis-à-vis seigniorage, the policymaker can achieve better outcomes by relying more on taxes (especially that inflation per se is undesirable). This effect is particularly strong when the policymaker is initially depending on seigniorage as his main source of revenues (i.e., when $\phi^2 < \frac{\sigma}{\gamma}(1+\gamma)$).

The discretionary regime is, as well known in the literature, the commitment level of inflation, π_i^{-C}, is not time-consistent since the policymaker would always find it optimal to raise inflation unexpectedly. In a rational Bayesian equilibrium, the public accounts for this time-inconsistency problem when setting inflation expectations. The time-consistent policy is then the solution to the policymaker's problem, with the requirement that the expected inflation rate is equal to its equilibrium value. The timing of the game is as follows. In the first stage, the policymaker chooses the level of institutional capacity and the public sets inflation expectations for the next period. In the second stage, given the public's expectations, the centralized government chooses both the fiscal and monetary policies. It should be noted that, throughout the paper, we assume that the institutional quality must be chosen one period ahead. We believe this is a realistic formulation of policymaking for two reasons. First, a tax system, as opposed to policy variables such as taxes and interest rates, is characterized by inertia, and reforming it would require time. Second, in doing so we capture the idea that a tax system acts as a constraint on both the fiscal and monetary policies in subsequent periods. The optimization of equation (2) with respect to τ and π yields:

$$\begin{aligned} \pi^C &= \frac{\gamma_\sigma(1+\phi)}{\sigma_i(1+\gamma_i)+\phi\gamma_i(\phi+\sigma_i)} g^* \\ \tau^C &= \frac{\phi \pi^C}{\sigma(1+\phi)} \\ \chi^C &= -\tau^C \\ g^C - g^* &= -\frac{\pi^C}{\gamma(1+\phi)} \end{aligned} \quad (6)$$

It is easy to see that, compared to the commitment case, discretion results in lower taxes and higher inflation. For $\phi = 0$, the outcome is the same under both regimes and $\bar{V}^C = V^C = VC$. Since the policymaker can now make use of surprise inflation to boost output, inflation gains in appeal relative to taxes. Inflation here, besides being a source of revenues for financing public goods provision, is also a means to reducing the shadow cost of taxes through surprise inflation. The reliance on taxes relative to seigniorage $\left(\frac{\tau}{\pi}\right)^C = \frac{\phi}{\sigma(1+\phi)}$ decreases relative to the commitment case, and as institutional capacity increases, the reliance on taxes increases. Also note that, for a given level of ϕ, discretion results in reduced output and public spending gaps.

Binary choice of the institutional variable better illustrates the different incentives to undertake a fiscal reform, we restrict the analysis to a binary choice of institutional capacity that is ϕ takes only two values: 0 (total leakage of tax revenues) and 1 (a perfectly efficient tax system). This assumption considerably simplifies the analysis. The direct economic effect of the reform (i.e., increasing ϕ from 0 to 1) is summarized in the following lemma.

I. Lemma — Direct economic effect (C) in a centralized authority setup and under complete information, improved institutional quality results in:

(i) Higher taxes and a larger output gap,

(ii) A reduced public spending gap, and

(iii) Higher inflation whenever ($\sigma_i > \gamma_i$) and lower inflation otherwise. The proof is in Appendix A.1.

Starting with an economy with severe institutional inefficiency, $\phi = 0$, there is no incentive to tax, as the collected taxes never reach the treasury to finance public goods. The only source of revenues to finance public spending is seigniorage, so inflation is set proportional to

[6] Note that when $\phi = 0$, this ratio is equal to zero.

the public spending target (that is $\pi^{C0} = \frac{\gamma_i}{1+\gamma_i} g^*$) with the weight being the preference trade-off between inflation and public spending. No taxes will be collected and the output gap will be achieved, at the cost of increased public spending gap and high inflation evidently. Precisely, the public spending gap represents the simple trade-off between the two objectives, inflation and public spending. The more the policymaker prioritizes inflation control over public spending, the larger the public spending gap ($g^{C0} - g^* = -\frac{1}{1+\gamma_i} g^*$).

Should the policymaker decide to engage in the institutional reform, the equilibrium becomes that in equation (6) with 0 sets to 1. Taxes then increase and this has two opposing effects on his incentives to raise inflation. On the one hand, he has less incentives to inflate since his need for revenues from seigniorage decreases as the increased taxes now contribute to financing public spending. On the other hand, the increased taxes have a contractionary effect on output, so the policymaker has incentives to raise inflation to boost the economy through unanticipated inflation. The reform then results in higher inflation whenever the policymaker values growth over the public spending objective, $\sigma_i > \gamma_i$, because then the incentives to inflate will be dominant. The direct effect of the reform is to make taxes more appealing in financing public goods and hence cause a downward deviation of output from its zero target. The public spending gap narrows since the tax channel is enhanced, which results in less constraints in revenues.

In sum, under complete information, the policymaker has incentives to engage in the reform the more he cares about the public spending objective and the less he cares about output stabilization. That is, type i policymaker chooses $\phi = 1$ whenever:

$$V_i^{S1} \leq V_i^{S0} \Leftrightarrow 4c \leq \frac{\gamma_i}{1+\gamma_i}\left(1 + \frac{a_i}{a_i+1}\right) - \frac{1}{(a_i+2)^2} \qquad (7)$$

That is, the type that engages in the reform under complete information is characterized by a high preference for public spending but also relatively high inflation averse, this is only possible if the policymaker places a sufficiently low value on the output target. Assume this condition is met only for the "dry" type, then in a separating equilibrium, the "wet" type abstains from the reform.

3.2.1. Asymmetric information and signaling content of the reform

So far, we have assumed the policymaker's trade-offs between the different goals, as represented by σ_i and γ_i to be common knowledge. When setting taxes and inflation rate, he does not account for any signaling effects; i.e., the public does not update their expectations regarding the policymaker's type upon observing his choice. Consequently, when deciding whether to undertake reform, only the direct economic incentives are relevant. This is a plausible assumption in economies characterized by a relatively high degree of political stability and transparency. However, in the context of an economy undergoing political transition and/or facing high political uncertainty, the public does not know the preferences of the government in office *ex-ante*.

The sequence of events is now as follows. In period 0, nature draws the policymaker's type (σ_i, γ_i) such that $i \in \{D, W\}$), only the policymaker learns his type, the public holds a prior belief that he is wet with probability p and dry with probability $1\text{-}p$. In period 1, the policymaker chooses whether to engage in an institutional reform $\phi \in \{0, 1\}$. The public observes his choice, makes inferences about his type and forms their expectation for period 2 inflation. The policymaker observes π^e and sets the inflation rate and taxes in period 2. There are two types of equilibria for this game. A separating equilibrium occurs if the two types make different choices in the first period, $\phi_w \neq \phi_D$. After observing ϕ_i, the public can infer the type of the policymaker and update their expectation of inflation accordingly. The policymaker then chooses the policy instruments, taking into account that his identity has been revealed. A pooling equilibrium obtains whenever both types of policymakers make the same choice of the reform in the first stage, i.e., $\phi_w \neq \phi_D = \phi$. The public gain no information from observing ϕ_i and hence do not update their prior beliefs, inflation expectation is then given by $\pi^e = p\pi w + (1-p)\pi_D$.

To characterize the Bayesian equilibrium of this game, we solve the model backward. In period 2, for a given choice of institutional capacity and the public's expectations, we solve for the taxes and inflation that would be set by each type of policymaker. In a separating equilibrium, the public can perfectly infer the policymaker's type from his choice of whether to undertake reform, that is $E(\pi|\phi_i) = \pi_i$. The game is then similar to that in the complete information scenario and the resulting equilibrium is given by equation (6); ϕ is equal to 1 for the type that chooses to reform and 0 for the type that abstains (that is why the discretionary policies in equation (6) will have the superscript S denoting the *separating* equilibrium values).

In a pooling equilibrium, however, since no inference can be made upon observing ϕ_i, the policy maker will attempt to minimize its loss function (2) using the two instruments τ and π given that $E(\pi|\phi_i) = p\pi w + (1-p)\pi_D$. The equilibrium[7] is then (the superscript P denotes *pooling*)

$$\pi_i^P(\phi) = \frac{a_{-i}+(1+\phi)}{(a_W+1+\phi)(a_D+\phi)+\phi^2 p(a_W-a_D)} g^*$$

$$\chi_i^P(\phi) - \chi^* = -\frac{\phi}{\sigma_i(1+\phi)}\pi_i \qquad (8)$$

$$g_i^P(\phi) - g^* = -\frac{1}{\gamma_i(1+\phi)}\pi_i$$

where, a_i denotes type i's inflation aversion as explained in *Assumption 1*.

Now it remains to analyze the conditions under which the above equilibria are stable, i.e., to check whether either of the types has an incentive to deviate or mimic the other type's equilibrium

[7] Ferre and Manzano (2014) model is nested as a special case of our framework where $\phi = 1$.

behavior in which case the equilibrium would not be stable since expectations are not rational then given the players' strategies. For instance, the expansionary type may be tempted to mimic the conservative's choice in the first period, i.e., masquerade as a conservative type, if such behavior increases his payoffs in the period 2. The aim of the following analysis is to identify conditions to rule out such behavior and thus identify the set of stable equilibria in order to ultimately identify scenarios in which the reform can be an effective signaling device.

Starting with an economy with severe institutional inefficiency ($\phi = 0$), the policymaker's choice of whether to engage in tax reform (increase ϕ to 1) or abstain (maintain institutional quality at its zero level) amounts to one of four possible equilibria:

1. Separating equilibrium with only the dry type undertaking the reform, $\phi_D = 1$ and $\phi_W = 0$. Upon observing $\phi = 1$, the agents know the policymaker in office to be type D and the inflation expectation becomes $\pi^e = \pi_D^{S1}$, and observing no reform induces $\pi^e = \pi_W^{S0}$ (both can be obtained by setting $\phi = 1$ and 0 respectively in equation (6).

2. Separating equilibrium with only the wet type undertaking the reform $\phi_D = 1$ and $\phi_W = 0$.

3. Pooling equilibrium where both types abstain (pooling on $\phi = 0$. We find that, under the centralized authority setup, pooling has no effect on the equilibrium outcomes relative to the separating equilibrium, i.e., $\pi^{P0} = \pi^{S0}$, $(\chi^{P0} - \chi^*) = (\chi^{S0} - \chi^*)$ and $(g^{P0} - g^*) = (g^{S0} - g^*)$.

4. Pooling equilibrium with both types of policymakers engaging in the reform (pooling on $\phi = 1$). The equilibrium outcomes are then obtained by setting $\phi = 1$ in equation (9) for both types. We are particularly interested here in the difference in inflation rates set by a wet and a dry type at equilibrium when $\phi = 1$:

$$\left(\pi_i^{P1}\right)^C = \frac{a_{-i}+2}{(a_W+2)(a_D+1)-p(a_D-a_W)}g^*$$

Political surprise effect let ΔC denote the difference between the equilibrium inflation rate in a pooling equilibrium if the government in the office turns out to be wet and that resulting from the reform of a dry government, that is:

$$\Delta^C = \pi_W^{P1} - \pi_D^{P1} = \frac{a_D - a_W}{(a_W+2)(a_D+1)-p(a_D-a_W)}g^* \qquad (9)$$

Then the reform is accompanied by higher inflation when it is implemented by a wet type than when it is the dry type that carries it out when the dry type inflation aversion is larger than the wet type $(a_D - a_W) > 0$[8]. Since the public is unable to infer the government's type in a pooling equilibrium, inflation expectations will be set such that $\pi_W^{P1} > \pi^e > \pi_D^{P1}$ since it is a weighted average of both possible inflation rates at equilibrium. This generates a positive surprise inflation effect for the wet type and a negative one for the dry type. We refer to this as the political uncertainty effect and denote it such that:

$$\lambda_i = \pi_i - E(\pi|\phi_i) \qquad (10)$$

measures the magnitude of unanticipated inflation that is due to the policymaker's type being unobservable, when the government in the office turns out to be of type *i*. By a simple mathematical rearrangement, λ_i can be written as:

$$\lambda_i^C = \begin{Bmatrix} (1-p)\Delta^C \; if \; i = W \\ -P\Delta^C \; if \; i = D \end{Bmatrix} \qquad (11)$$

A pooling equilibrium induces a positive policy surprise only for the type whose reform would be accompanied by higher inflation at equilibrium. From equation (9) together with equation (11), it can be seen that two variables are fundamental in determining the magnitude of the policy surprise effect: the probability of a wet type occurring p and the variability of types or what we refer to as the extent of political instability or polarization as measured by $(a_D - a_W)$, the comparative statics of which are shown in the following lemma.

II. Lemma — Both a higher probability of the policymaker in office being of the expansionary type (a larger p) and/or higher uncertainty concerning preferences of policymakers' vis-à-vis the stabilization objective have the effect of reducing the positive political surprise effect from pooling on the reform for the expansionary type and increasing the loss from pooling for the conservative type.

Intuitively, as the public assign a higher probability to the policymaker in office being of the expansionary type, the expected inflation increases. This in turn reduces the gain from surprise inflation for the expansionary type since inflation is not so unanticipated anymore and produces an even larger negative surprise inflation effect for the conservative type as expected inflation becomes too high. An increase in the divergence between the two types' priorities, or what we refer to as an increase in political uncertainty, has the same effect as a higher *p*.

It should be noted that pooling has an unambiguously positive effect on the wet type payoffs from the reform. It reduces his equilibrium levels of inflation, output gap, and public spending gap while having the opposite effect on the dry type welfare. Pooling results in a fall in inflation for the wet type and increased inflation for the dry one, compared to their respective inflation rates in a separating equilibrium. For instance, if the government in the office turns out to be expansionary, expected inflation will be too low, as agents had also accounted for the possibility of a conservative government being in office. This unanticipated inflation permits an increase in taxes as their perverse effect on output is now mitigated. This reduces the need to raise the inflation tax to finance public spending so actual inflation decreases compared to the separating equilibrium case. Output deviations due to the tax increase accompanying the reform can be — at least partly — offset by the pooling effect for the wet type but further

[8] Equivalently, given our context of political uncertainty, this is the case where political uncertainty concerns more interests in growth than preferences towards public goods provision, i.e., $\pi_W^{P1} > \pi_D^{P1}$ whenever $\frac{\sigma_W - \sigma_D}{\sigma_W \sigma_D} > \frac{\gamma_D - \gamma_W}{\gamma_D \gamma_W}$.

enhanced by the negative political surprise for the dry type. While the direct economic effect of the reform is to reduce the public spending gap, pooling comes to further enhance this channel for the wet type since the shadow cost of taxes decreases under the effect of political surprise inflation. This effect works in opposite direction for the dry type.

III. Lemma — Pooling on the tax reform is welfare improving for the wet type but welfare reducing for the dry one whenever $a_D - a_W$ (see Appendix A.1).

An important conclusion can be drawn from the above analysis. The incentive to benefit from political surprise inflation alone can motivate the wet type to undertake the reform, even if he would not do so under complete information. On the other hand, asymmetric information may dissuade the dry type from engaging in the reform even though he would have under complete information.

3.2.2. Incentive constraints and stability of equilibrium

Now it remains to analyze the conditions under which the above equilibria are stable. That is, we check whether either of the types has an incentive to deviate or to mimic the other type's equilibrium behavior. For instance, the expansionary type may be tempted to masquerade as a conservative type, i.e., mimic the conservative choice in the first period in order to increase his payoff from policy surprise inflation in the period 2. The aim of the following analysis is to identify conditions to rule out such behavior and thus identify the set of stable equilibria in order to ultimately identify scenarios in which the reform can be an effective signaling device. We are particularly interested in the equilibria where the dry type engages in the reform: whether it is a separating equilibrium with only the dry type choosing $\phi = 1$ or the pooling equilibrium where both types undertake the reform. The following proposition characterizes and states conditions for the existence of equilibria.

I. Proposition — In a centralized authority setup or given full cooperation between monetary and fiscal policies, political uncertainty is a major determinant of the signaling content of the reform and its economic outcomes such that:

• In economies characterized by high political instability, i.e., when the public's prior beliefs concerning the policymaker's stabilization preferences fall within a large interval (i.e., $(\sigma_W - \sigma_D)$) is large relative to $(\gamma_D - \gamma_W)$, a pooling equilibrium is likely to obtain.

– The reform does not help the public update their beliefs about the policymaker's type. If the policymaker turns out to be of the type that favors fiscal discipline, there is a welfare loss due to the negative political surprise inflation that results from pooling.

– Other factors enhancing the likelihood of a pooling equilibrium are: the public assigning a relatively low probability to the government in office being of the expansionary type, the public spending target being sufficiently low and the fiscal reform not being quite costly.

• Given sufficiently low levels of political uncertainty, a separating equilibrium with the conservative type engaging in the reform while the expansionary type abstains is likely to obtain.

– The act of engaging in the reform signals fiscal discipline and hence low inflation should be expected.

– -Social welfare unambiguously increases due to signaling.

– This is particularly the case when the probability that the government in the office turns out to be of the expansionary type is sufficiently low, the public spending target is relatively high, and the fiscal reform is relatively costly (the proof is in Appendix A.2).

The wet type has no incentives to pool when the gain from pooling is sufficient to offset the loss from undertaking the reform. It is either that the wet type assigns a sufficiently large value to the output objective and does not care much about the public spending objective, in which case the reform makes no economic sense for him, or that pooling itself is not quite rewarding. This is likely to occur: (i) when the public already expect the government in office to be a wet type (large *p*), (ii) when political instability is sufficiently high so that the gain from political surprise inflation is trivial (see *lemma III*), (iii) when the output target is relatively high or (iv) when the reform is costly. The definition of the cost here can be stretched to allow for social and political dimensions. One implication of this assumption would be that, in economies where the opposition is powerful or where questions of justice and equity represent a major concern for society, the reform is a signal of fiscal discipline. Only the policymaker who is interested in public spending would bear the high cost of the reform to reap its economic benefits. This is the case where the informational content of the reform can be exploited by the policymaker to signal his type. In terms of desirability, it is always welfare-improving when the conservative type is able to reveal his identity because then negative surprise inflation can be avoided.

3.3. Non-cooperative game

In this subsection, we will study the case where the monetary policy is delegated to a central bank that is relatively weight-conservative (i.e., $\sigma_B < \sigma_i$). A non-cooperative game is considered. Both the monetary and fiscal authorities set simultaneously and non-cooperatively the policy instrument at their disposal to minimize their own loss function. The FA chooses taxes so as to minimize equation (2) and the central bank sets the inflation rate at the level that minimizes equation (4). The first part considers the symmetric information scenario where the government's type is public information. The second deals with asymmetric information whereby the government's type is only observable to the policymakers. In the former, we distinguish between the cases where both the monetary and fiscal policy regimes are ones of commitment and when they are rather discretionary. The aim of the following discussion is to break down the effect of the tax reform on the policy choices of the two authorities into its two

main components: a direct economic effect and a signaling one. The first refers to the change in inflation, output, and public spending gaps due to the reform enhancing the tax channel. The second reflects the idea that the decision to engage in the reform itself affects the public's inferences about the policymaker's type, inflation expectations, and hence his payoffs from the reform.

3.3.1. Central bank (in)dependence and direct effect

In the commitment Nash game, first, the fiscal authority decides whether to engage in fiscal reform, both the FA and the central bank announce simultaneously their policies, τ and π respectively. Then, both authorities simply implement the policies that were chosen in period 1. The equilibrium choices of taxes and inflation and the corresponding outcomes (where the superscript N represents the Nash equilibrium are given by:

$$\begin{aligned} \pi_i^{-N} &= \frac{\gamma_B \sigma_i}{\sigma_i(1+\gamma_B)+\phi^2\gamma_i} g^* \\ \tau_i^{-N} &= \frac{\phi \pi_i^{-N}}{\sigma_i} \times \frac{\gamma_i}{\gamma_B} \\ \chi_i^{-N} - \chi^* &= -\tau_i^{-N} \\ g_i^{-N} - g^* &= -\frac{\pi_i^{-N}}{\gamma_B} \end{aligned} \tag{12}$$

It is easy to show that a higher institutional quality increases reliance on taxes relative to inflation as a source of financing public goods; $\left(\frac{\tau}{\pi}\right)^C$ increases in ϕ. This result is somewhat similar to the one obtained in the centralized authority case, the intuition behind however is different. In the case of a single policymaker controlling both monetary and fiscal instruments, a tax reform enhances the relative efficiency of taxes in financing the public goods without affecting the efficiency of seigniorage and thus naturally leads to increased reliance on taxes given that the two instruments are to some extent substitutes. However, in a Nash setup, this rather results from the Central bank's reaction; the Central bank ought to reduce inflation after a tax reform since it can now rely on the FA to finance more public spending using the tax revenues (τ and π are rather strategic substitutes). A simple comparative statics exercise allows us to assess the effect of increased institutional quality, ϕ, on the different policy instruments and outcomes as stated in the following lemma. Similar to the centralized authority case, reform in a non-cooperative Nash game and under the commitment regime leads to (i) lower inflation, (ii) higher or lower taxes and hence a larger or smaller output gap, and (iii) an unambiguously reduced public goods gap.

Another similarity between the two setups is the effect of discretion in increasing the dependence on inflation versus taxes in financing public spending. To allow for discretion in the choice of inflation, the fiscal and monetary reaction functions are solved simultaneously taking as given the public's expectations of inflation. The equilibrium choices then become:

$$\begin{aligned} \pi_i^N &= \frac{\gamma_B \sigma_i + \phi \gamma_i \sigma_B}{\sigma_i(1+\gamma_B)+\phi\gamma_i(\phi+\sigma_B)} g^* \\ \tau_i^N &= \frac{\phi \gamma_i}{\gamma_B \sigma_i + \phi \gamma_i \sigma_B} \pi^N \\ (\phi_i - \chi^*)^N &= -\tau_i^N \\ (g_i - g^*)^N &= -\frac{\sigma_i}{\gamma_B \sigma_i + \phi \gamma_i \sigma_B} \pi^N \end{aligned} \tag{13}$$

It can be seen that, for a given level of institutional capacity, the discretion of the central bank results in: (i) $\pi_N^d > \pi_N^c$, (ii) $\tau_N^d \geq \tau_N^c$, (iii) $\chi_N^d \leq \chi_N^c$ and (iv) $g_N^d \leq g_N^c$, with the equality sign-holding only when $\phi = 0$. Under discretion, inflation increases due to the possibility to boost output through unanticipated inflation. Increasing institutional quality further amplifies this channel: given high institutional capacity, the public expects the policymakers to rely more on efficient taxing and less on inflation, so expected inflation falls, this, in turn, increases the benefit from surprise inflation, $\pi_i - \pi^e$. Moreover, the FA has fewer incentives to tax since this increased inflation finances part of the public goods. Those two effects combined result in less reliance on taxes relative to inflation under discretion, i.e., $\left(\frac{\tau}{\pi}\right)^C \geq \left(\frac{\tau}{\pi}\right)^d$ with the equality holding only when $\phi = 0$.

Now consider a binary choice of institutional capacity $\phi \in \{0,1\}$ (see Appendix B.1). In the presence of poor institutional quality, no taxes are imposed. Public goods provision is solely financed by seigniorage, the inflation rate is set proportional to the public spending objective $\left(\pi^{N0} = \frac{\gamma_B}{1+\gamma_B}\right)$ and depends on the central bank's interest in public goods. Should the FA engage in the reform, the direct economic effect depends on the status of the central bank. The reform results in increased inflation in the case of an independent, central bank that values output stabilization over public spending (i.e., $\sigma_B > \gamma_B$) since in that case, the priority of the central bank would be to counter the contractionary effect of increased taxes. When the central bank however is dependent, the strategic substitution effect will be dominant; the central bank reduces inflation since public spending is increasingly financed through taxes. The direct economic effects on output public spending gaps are similar to the centralized authority. That is, the relative appeal of taxes increase, the output gap widens as a result and the public spending gap reduces due to the increased flexibility in financing.

Central bank status and incentives to reform the government thus have incentives to engage in the reform under complete information whenever:

$$V_i^{S1} \leq V_i^{S0} \Leftrightarrow 2c \leq \gamma_i \sigma_i^2 (\gamma_i z + 2\sigma_i \gamma)$$

where,
$z = (\gamma_B^2 + \gamma_i) - (\sigma_B^2 + \sigma_i) + 2\gamma_B(\sigma_B - \gamma_B) + 2(\gamma_i\sigma_B - \gamma_B\sigma_i) + +(\gamma_i\sigma_B^2 - \sigma_i\gamma_B^2)$ and $y = (\gamma_B^2 + \gamma_i)(1+\gamma_B)(1+\sigma_B)$ can be seen from the equation, the larger γ_B relative to σ_B, the less incentives the policymaker has to engage in reform. However a larger preference from the public spending on the part of the policymaker γ_i could offset the negative effect of a high γ_B

IV. Lemma — in a Nash setup, under complete information, the central bank's dependence reduces the government's incentives, both the wet and the dry types, to engage in the reform whereas central bank independence has the opposite effect on both types.

The intuition behind this lemma is as follows. A dependent central bank reduces inflation when taxes increase. This is bad news for the policymaker that wishes to increase public spending because then each dollar increase in taxes will yield less than a dollar increase in public spending because the central bank's reaction would be to reduce inflation (the strategic substitution effect), narrowing the public goods gap becomes a difficult target to achieve. A dry type would still be willing to engage in the reform if he is sufficiently inflation averse so that he values the fall in inflation brought about by the dependent central bank. The wet type, on the other hand, dislikes having a dependent central bank because then the distortionary effect of taxes on output cannot be offset. Under CBI, the same mechanism operates but in the opposite sense. It works as a catalyst for the effect of taxes on public goods provision since increases in taxes will also be accompanied by increases in seigniorage (inflation) and, inflation will counter the contractionary effect of taxes.

3.3.2. Asymmetric information and political uncertainty

First, the FA learns its type and chooses the level of institutional capacity. Then, the public observes this choice and makes inferences about the FA's type and forms expectations about future inflation. Afterward, both the FA and central bank choose their policies simultaneously (at this stage the central bank is aware of the type of the FA in office). We are interested here in the equilibrium where both types choose the same level of institutional capacity and hence no inferences can be made about the type of FA in office upon observing his choice of ϕ in the first period, i.e., we analyze the effect of pooling due to political uncertainty. Taking as given the expected inflation and solving for the equilibrium when the FA in the office turns out to be of type i and for a given level of institutional quality, equilibrium inflation rate when type i is in the office is (where the superscript P indicates pooling):

$$(\pi^{P1})^N = \frac{R_{-i}+2}{(R_W+2)(R_D+1)+\phi^{2P}(R_W-R_D)}\, g^* \qquad (14)$$

where, $R_i(\phi) = \frac{\sigma_i+\phi^2\gamma_i}{\gamma_B\sigma_i+\phi\gamma_i\sigma_B} = 0$ item.

Let $\Delta^N = (\pi_W^{P1} - \pi_D^{P1})^N$ denote the difference between the inflation rates set by the central bank in the presence of a wet and a dry government respectively under a Nash setup and given a pooling equilibrium. This difference measures the magnitude of the political surprise effect. If both types pool on the reform, given in equation (14), this difference can be written as:

$$\Delta^N = \frac{r_D - r_W}{(r_W+2)(r_D+1)-p(r_D-r_W)} \qquad (15)$$

where, $r_i = R_i(1) = \frac{\sigma_i+\gamma_i}{\gamma_B\sigma_i+\phi\gamma_i\sigma_B}$ is a measure of the policymaker's inflation aversion relative to that of the central bank. Recall that $a_i = \frac{(1/\sigma_i)+(1/\gamma_i)}{2}$ represents the absolute inflation aversion, that is, to which extent the policymaker cares about inflation control relative to the output and the public spending objectives. The non-cooperative nature of the game calls for a measure that shows the relative aversion of the two players. An increase in the central bank's preferences towards output or public goods increases the relative inflation aversion of the policymaker, while if a similar increase occurs in the policymaker's preferences, his relative inflation aversion decreases. Equation (15) then shows that the wet type results in higher inflation if he has a low (absolute) inflation aversion and a relatively large inflation aversion as compared to the central bank. Since we know for the wet type that $\frac{\sigma_B}{\sigma_W}$ is quite small, this is only possible when $\frac{\gamma_B}{\gamma_W}$ is quite large, that is, in the presence of a dependent central bank. Similarly, the reform results in higher inflation for the dry type when $\frac{\sigma_B}{\sigma_W}$ is sufficiently large, i.e., when the central bank is independent.

V. Lemma — Policy surprise effect (N). If there are two possible types of fiscal authorities, dry and wet and their preferences are such that the wet type is more interested in output growth over public spending relative to the dry one (i.e., $\frac{\sigma_W}{\gamma_W} \succ \frac{\sigma_D}{\gamma_D}$), then political uncertainty induces:

(i) In the presence of an independent central bank ($\sigma_B \succ \gamma_B$): a positive policy surprise effect for the dry type ($\pi_D - \pi^e \succ 0$) and hence pooling is welfare-improving for this type.

(ii) When the central bank is dependent ($\sigma_B \succ \gamma_B$): a positive policy surprise effect the wet type ($\pi_W - \pi^e \succ 0$) and hence pooling increases his payoffs (the proof is in Appendix B.2).

The first part of the above lemma states that due to uncertainty about the government's preferences, it is the dry type that is more interested in the public good provision that loses in surprise inflation terms due to pooling, this result is similar to the cooperative setup discussed earlier. As the single policymaker raises taxes to finance public spending, this has two effects on his incentives to inflate: on the one hand, he has more incentives to inflate in order to curb the distortionary effect of taxes on output, but on the other, there are less incentives to inflate for the public good provision purpose. If he prioritizes the public spending target (dry type), the latter effect dominates and the increased taxes are accompanied by lower inflation relative to what would prevail if he were of the wet type.

Now in the case of a non-cooperative game, where the central bank also accounts for fiscal considerations to a large extent when setting the inflation rate, a similar result obtains. If the government in office is of the dry type, then the FA has incentives to increase taxes. The central bank then is inclined to increase inflation in order to counter the contractionary effect of taxes but also has incentives to reduce inflation as the need for revenues from seigniorage decreases. If the central bank is relatively more interested in public spending, the incentives to reduce inflation are

stronger. The central bank sets a lower inflation rate when it is dealing with a dry government; i.e., $\pi_W \succ \pi_D$ so that $(\pi_D - \pi^e) < 0$. If the central bank is relatively independent in the sense that he favors growth over fiscal considerations (i.e., γ_B is sufficiently low relative to σ_B), then central bank is rather inclined to increase inflation to curb the negative effect of taxes on output so that $\pi_W \succ \pi_D$, which yields a positive policy surprise effect $(\pi_D - \pi^e) > 0$ for the dry type in a pooling equilibrium.

3.3.3. Incentive compatibility constraints and stable equilibria

Now we can conduct our incentives analysis. Starting from the assumption that the parameters are such that the dry type has incentives to engage in a reform under complete information We are interested in two scenarios:

1. The case of central bank dependence (CBD) $(\pi_W^{P1} - \pi^e \succ 0)$: the Nash signaling game has two possible equilibria:

(i) A separating equilibrium where only the dry type engages in the reform. Since we assume the dry type always has incentives to reform, the incentive compatibility condition of this equilibrium reduces to: $V_W^{S0} \leq (V_W^{P1})^N$

That is, separating on reform results in higher payoffs (smaller loss) for the wet type. This amounts to (the proof is in the Appendix B).

$$V_W^{S1}[1 + (\pi_W^{P1} - \pi^e)] - (\pi_W^{P1} - \pi^e)\frac{\sigma_W^2(\gamma_B^2 - \gamma_W) + \gamma_W^2(\sigma_B^2 - \sigma_W) + 2\gamma_B\gamma_W\sigma_B\sigma_B\sigma_i}{\left(f_W^N(1)\right)^2} + c \leq V_W^{S0}$$

Since the wet type enjoys a positive political surprise in this scenario, $(\pi_W^{P1} - \pi^e) > 0$, it has to be the case that this effect is small, either due to a high prior probability that the government in office is of the wet type or that the political uncertainty itself as measured by $\frac{\gamma_D}{\sigma_D} - \frac{\gamma_W}{\sigma_W}$ is sufficiently low.

(ii) A pooling equilibrium with both types undertaking the reform under relatively high levels of political uncertainty.

2. In the central bank independence scenario $(\pi_W^{P1} - \pi^e \succ 0)$: there are two possible equilibria as well, however, both are more desirable if the government in office is of the dry type:

(i) A separating equilibrium where only the dry type undertakes the reform. This occurs if the wet type initially has no incentives to engage in the reform under complete information. Upon observing $\phi = 1$, the public infers that the government in office is of the dry type and sets inflation expectations accordingly. The dry type reaps the direct economic effect of the reform without any negative political uncertainty effects.

(ii) A pooling equilibrium with both types engaging in the reform. This occurs if the wet type initially has high incentives to engage in the reform (this could also be the case of two dry types with one having an even higher preference for the public spending objective) so that even with the negative policy surprise that occurs to him in a pooling equilibrium, he still values the direct economic effect sufficiently to still be willing to engage in the reform. This is good news for the dry type because then political uncertainty is in his favor; outcomes in terms of inflation, output growth, and public spending are improved relative to the complete information scenario. This is the case where the signaling effect of the reform enhances its direct economic one.

VI. Lemma — In a Nash game between the monetary and fiscal authorities, the signaling effect of the reform:

1) In the CBD case: it either hinders its direct economic effect (in a pooling equilibrium) or is null at best (in a separating equilibrium).

2) In the CBI case: is either null (in a separating equilibrium) or enhances the direct economic effect (in a pooling equilibrium). From the above discussion, we can conclude that, given political uncertainty and a dry type government in office, fiscal reforms work better when coupled with central bank independence.

3.4. Fiscal leadership

In this setup, each authority still chooses its action individually; however, the fiscal policy is set and announced before the monetary one. We first analyze the economic effect of the reform, and break it down into its direct and discretionary components, under complete information. Then, allowing for asymmetric information, its signaling effect will be discussed.

3.4.1. Complete information scenario

Assuming the fiscal policy regime is one of commitment and that the FA moves first, the monetary fiscal interaction can be illustrated through a simple two-period game. In period 1, the FA sets the institutional quality of the tax system ϕ and announces the fiscal policy τ. Upon observing those two choices, the private sector forms expectations regarding period 2 inflation. In period 2, the FA simply implements the fiscal policy previously announced and the central bank chooses π. Given symmetric information, the public can easily infer in period 1 the inflation rate that would prevail.

In period 2 from the FA's announced tax level. This amounts to excluding the surprise inflation effect in this setup, the output gap reduces to $\chi = -\pi$. When monetary policy is chosen in period 2, τ is known. The monetary authority minimizes equation (4) with respect to π, taking τ as given. This yields the monetary reaction function (MRF^F):

$$\pi(\tau) = \frac{\gamma_B}{1+\gamma_B}(g^* - \phi\tau) \qquad (16)$$

This function shows that, as the FA increases taxes, the central bank reacts by reducing inflation. This is because the central bank's incentives to inflate decrease when the government raises revenues from taxes since the need for seigniorage reduces. Also note that this decrease in inflation is

sharper the better the fiscal institutions (i.e., larger ϕ), and the more fiscal considerations are a priority for the central bank (larger γ_B). For a given fiscal policy, having a more dependent central bank then leads to lower inflation. Having a dependent central bank brings the monetary-fiscal interaction closer to the centralized authority game where taxes and inflation are two substitutable instruments in the hands of the policymaker.

Plugging the MRF^F into the fiscal authority's objective, the equilibrium of the fiscal leadership commitment game is:

$$\begin{aligned}
&\pi^{-F}(\phi) = \frac{\gamma_B \sigma_i (1+\gamma_B)}{\phi^2(\gamma_B^2+\gamma_i)+\sigma_i(1+\gamma_B)^2} \\
&\pi^{-F}(\phi) = \frac{\phi(\gamma_B^2+\gamma_i)}{\gamma_B \sigma_i (1+\gamma_B)} \pi^{-F} \\
&\chi^{-F}(\phi) = -\tau^{-F} \\
&(g^{-F} - g^*) = -\frac{1}{\lambda_i \pi^{-F}}
\end{aligned} \tag{17}$$

Comparing the outcomes in the commitment case between the three setups using (5), (12), and (17), we find that:

II. Proposition — In the commitment regime, comparing the outcomes in the centralized authority, fiscal leadership, and non-cooperative Nash game, for a given level of institutional capacity 0, and whenever $\gamma_i > \gamma_B$.

(i) $\tau^C < \tau^F < \tau^N$ and hence $|\chi^C - \chi^*| < |\chi^F - \chi^*| < |\chi^N - \chi^*|$;

(ii) $\pi^C > \pi^F > \pi^N$;

(iii) $|g^C - g^*| < |g^F - g^*| < |g^N - g^*|$

Intuitively, as we move along the monetary-fiscal interaction spectrum from non-cooperative Nash to fiscal leadership to centralized authority, the fiscal authority's control over policy instruments increases. In a Nash game, the FA acts non-cooperatively and has to account for the central bank's reaction function when setting its fiscal policy as both policies together would determine the outcome of the game. In a fiscal leadership setup, both authorities still act non-cooperatively, however, the FA gets a leader advantage since it sets the fiscal policy first and hence has some influence over the central bank's choice of the monetary policy. Finally, in a centralized authority case, the FA controls both fiscal and monetary policies and is free-handed in adjusting taxes and inflation to minimize deviations from its targets. Consequently, in terms of achieving the different objectives, the FA should be able to achieve better outcomes the more control it has over policy instruments (i.e., the less constraints it faces in terms of strategic interaction). If the FA's objective represents the social loss function and the FA is able to pre-commit to monetary and/or a fiscal policy, then the centralized authority setup is unarguably desirable. However, if society is inflation averse relative to the FA, this is not necessarily the case.

Now, considering the effect of varying the institutional capacity o on the policy choices and resulting outcomes, simple derivatives allow us to conclude that the reform under a commitment regime leads to results that are quite similar to the previous setups. That is, in a fiscal leadership game and under the commitment regime, increased institutional capacity results in: (i) lower inflation, (ii) higher taxes, and hence a larger output gap (for $\phi < \frac{\sqrt{\sigma_i}(1+\gamma_B)}{\sqrt{\gamma_B^2+\gamma_i}}$), and (iii) a smaller public spending gap. The reform is thus always welfare-improving in terms of curbing inflation and allowing more public spending. However, when the initial level of institutional capacity is sufficiently low, a tax reform results in higher taxes and an output gap.

If the FA is unable to pre-commit to a fiscal policy, the fiscal policy regime is rather one of discretion and is better described by the following three-stage game. First, the FA chooses institutional quality and the public forms anticipations regarding the next period inflation. Then, the FA moves first and chooses the fiscal policy τ. In stage 3, and after observing the FA's choice, the Central bank sets the monetary policy *a*. In the last stage, the Central bank minimizes equation (4), taking as given both τ and π^e. Solving for the subgame perfect equilibrium in the last stage, the monetary reaction function (MRF^F) is:

$$\pi^F(\tau) = \frac{(\sigma_B - \phi\gamma_B)\tau + \sigma_B \pi^e + \gamma_B}{1 + \sigma_B + \gamma_B} g^* \tag{18}$$

Inflation's reaction to observed taxes (since the FA moves first) is similar to the Nash case: an increase in taxes reduces the central bank's incentives to inflate considering the public spending target but also increases its incentives to inflate to offset the contractionary effect of taxes on output, which effect will dominate depends on the weights the central bank assigns to the two objectives. If the central bank prioritizes output growth (σ_B large), higher taxes will result in an expansionary monetary policy (higher inflation). When the central bank has more interest in fiscal considerations (γ_B), taxes and inflation are strategic substitutes, an increase in taxes leads to a decrease in inflation. Note that institutional capacity further reduces the central bank's incentives to inflate as it enhances the strategic substitution effect. Put differently, in the case of CBD ($\sigma_B < \gamma_B$), the inflation and the taxes are strategic substitutes whereas, under CBI, they are rather strategic complements[9].

In the second stage of the game, the FA anticipates this reaction from the central bank and sets the fiscal policy at a level that induces the monetary reaction that best serves its objectives. For a given level of institutional capacity, the optimal policy mix and the corresponding equilibrium is:

$$\begin{aligned}
&\tau^F(\phi) = \frac{\gamma_i\big(\phi+\sigma_B(1+\phi)\big)-\gamma_B(\sigma_B-\phi\gamma_B)}{f_i^F(\phi)} \\
&\pi^F(\phi) = \frac{\gamma_i\sigma_B\Big(\phi+\sigma_B(1+\phi)+\gamma_B\sigma_i\big(1+\gamma_B(1+\phi)\big)\Big)}{f_i^F(\phi)} \\
&\chi^F(\phi) = -\tau^F \\
&g^f(\phi) - g^* = -\frac{\sigma_B(\sigma_B-\phi\gamma_B)+\sigma_1\big(1+\gamma_B(1+\phi)\big)}{f_i^F(\phi)}
\end{aligned} \tag{19}$$

where,

$f_i^F(\phi) = (\sigma_B - \phi\gamma_B)^2 + \sigma_i(1+\gamma_B)\big(1+\gamma_B(1+\phi)\big) + \gamma_i(\phi+\sigma_B)\big(\phi+\sigma_B(1+\phi)\big)$

[9] It can be easily seen from equation (18) that $\frac{D\pi^F(\tau)}{D_\tau} = \frac{\sigma_B-\gamma_B}{1+\sigma_B+\gamma_B}$.

The economic effect of the reform: the fiscal leadership setup introduces a new set of incentives into the analysis of the FA's choice. First, consider the case where the central bank has very low public spending concerns, we refer to this case as the central bank independence (CBI) scenario. For simplicity, assume $\gamma_B = 0$. An increase in taxes would then be followed by an expansionary monetary policy since the central bank prioritizes stabilization. Anticipating this reaction from the central bank, it has two effects on the behavior of the FA:

- The *"Unleashing effect"*: this refers to the idea that allowing for surprise inflation reduces the shadow cost of taxes since their contractionary effect is now (at least partly) offset by discretionary inflation. The FA's ability to tax is somewhat less constrained. That is, a dollar increase in taxes increases the output gap by $1 - \frac{\sigma_B - \gamma_B}{1+\sigma_B+\gamma_B}$, dollar. This positive effect on taxes is particularly strong if the central bank is quite conservative (*OB* low) so that sharper increases in taxes are necessary to induce the central bank to set high inflation and/or if output stabilization is relatively a priority for the FA (σ_i ; relatively large).
- The *"Strategic substitution effect*": since public goods can now be financed through increased inflation, the need for taxes decreases. If taxes induce an increase in inflation, a dollar increase in taxes allows financing $1 + \frac{\sigma_B - \gamma_B}{1+\sigma_B+\gamma_B}$ dollars of the public goods. This effect is larger the more interested the FA is in public spending.

In sum, a reform results in larger taxes whenever

$$\gamma_i \succ \gamma_B \frac{\sigma_B - \gamma_B}{1 + 2\sigma_B} \qquad (20)$$

This implies that, given CBI, engaging in the reform will be accompanied by an increase in taxes only when the FA has a sufficiently large interest in public spending (i.e., the dry type's reform is likely to result in higher taxes). In this case, since taxes and inflation are strategic complements, the increase in taxes will be followed by a rise in inflation since the central bank here is assumed to be relatively interested in output growth compared to fiscal consolidation.

Now consider the CBD scenario where the appointed central bank takes into account, to a large extent, fiscal considerations when setting inflation. The condition in equation (20) implies that the reform always results in higher taxes. To see this, recall that, under CBD, increases in taxes result in lower inflation since they act as strategic substitutes for financing public spending. The FA anticipates a reduction in inflation for every dollar increase in taxes. The unleashing effect is negative; the FA is more constrained in imposing taxes as their effect here is even more contractionary. The strategic substitution effect works in the opposite direction; the FA needs even more taxes to finance public spending since a dollar increase in taxes results in less than a dollar of public spending. The reform always results in a more contractionary fiscal policy (higher taxes) accompanied by reduced inflation.

3.4.2. Asymmetric information and signaling effect of the reform

The extended game where political uncertainty is introduced goes as follows. At the outset of the game, nature sets a type for the policymaker that is unobservable to the public. The public however holds the prior belief that it is dry with probability p and wet with probability $1-p$. First, the fiscal authority chooses the level of institutional quality (in a binary case, this amounts to choosing whether to engage in a reform). The private sector forms inflation expectations τ^e. Second, the FA moves first and chooses the fiscal policy, the tax level, given the anticipated inflation. Third, the central bank follows and sets the monetary policy. In a separating equilibrium, the equilibrium amounts to that in the discretionary scenario under complete information (19). In a pooling equilibrium, however, the optimal monetary-fiscal policy mix that obtains and the corresponding outcomes are then the fiscal leadership analog of (20) are given in the appendix. We restrict the presentation here to the binary case $\phi \in \{0,1\}$.

VII. Lemma — Policy surprise effect (FL) under a fiscal leadership setup for the monetary-fiscal interaction, political uncertainty induces:

(i) Given an independent central bank $\sigma_B \succ \gamma_B$, a positive policy surprise effect for the dry type under the sufficient condition that the uncertainty regarding the different type preferences vis-à-vis the output target is not too large $\left(\frac{\gamma_D - \gamma_W}{\sigma_W - \sigma_D} \prec \frac{1+2\gamma_B}{1+2\sigma_B}\right)$.

(ii) In the presence of a dependent central bank, a positive policy surprise effect for the wet type whenever uncertainty is more about interests in the output objective $\left(\frac{\gamma_D - \gamma_W}{\sigma_W - \sigma_D} \succ \frac{1+2\gamma_B}{1+2\sigma_B}\right)$. The proof is in Appendix C.1).

Separating and pooling equilibria: Although the incentives analysis using the equilibrium values is too complicated to analyze in the fiscal leadership game, we can still obtain several interesting results concerning the signaling effect of the reform. First, the now-familiar negative pooling effect on the dry type under central bank dependence still obtains. The dry type however experiences a welfare loss whenever he is in office and political uncertainty prevails. The magnitude of the negative policy surprise on his payoffs is stronger the more political instability there is, i.e., the more uncertain the public is about interest in the output objective. A separating equilibrium occurs when political uncertainty is moderately low or when the public already assigns a high probability to the high type being in office because then, through the rational expectations mechanism, the public should infer that it does not pay for the wet type to engage in the reform only to benefit from surprise inflation. So a policymaker engaging in the reform must logically be of the dry type.

The CBI scenario is good news however for the dry type. In this case, in a pooling equilibrium, the reform is accompanied by higher inflation for this type so he actually would benefit from pooling. It is the wet type then that would have no incentives to engage in the reform unless he sufficiently cares about the output target as well (the direct economic effect is relatively important to him) and/or political uncertainty is not too high so his loss from pooling

is not too large. In this scenario, it is likely that a separating equilibrium with only the dry type engaging in the reform. The reform then signals the fiscal discipline of the policymaker and achieves its direct economic effect without any negative inferences effect, even under political instability.

4. RESULTS AND DISCUSSION

The above game resulted in a number of empirical implications that can be summarized in this section and provide a basis for empirical examination.

4.1. Rules versus discretion in a monetary-fiscal game

Generally speaking, reform increases the efficiency of the tax system by allowing to finance a higher level of public spending at a given tax base at a lower inflation rate compared to the non-reform case. Reform under commitment also results in lower inflation since the policymaker is assumed credible and fully committed to the pre-announced policies; hence, no surprise inflations can be induced. A reform also results in a reduced public spending gap; intuitively, the reform results in less constraints for the policymaker in one of the channels of financing public spending — the tax channel – and evidently less constraints should lead to better outcomes. However, reforms are done under commitment clearly result in larger output gaps. In general, while commitment generally results in lower inflation. This is mainly because the only effect of reform under commitment and full information setup is the direct economic effect. No signaling effect in the case of full information.

On the other side, under the discretionary regime, a reform measure will have two effects; the direct economic effect of increased tax efficiency well as a signaling effect resulting from inducing surprise inflation. The basic intuition behind that is that discretionary setups decrease the credibility of the monetary authority and hence create a time consistency problem. Time inconsistency creates surprise inflation since expected inflation by the public will be lower than inflation created by the policymaker. In this case, the reform will result in more tax revenues, smaller public spending gap — compared to the commitment case- as a result of better tax efficiency and obviously smaller output gaps. However, it will result in higher inflation. If society places a high value on public spending and output objectives (which is probably the case for economies undergoing a transition process), discretionary policies might be more desirable by policymakers.

4.2. The effect of political uncertainty on monetary-fiscal choices and outcomes of a reform

The second important setup is one where the policymakers do not reveal their type, which hence creates a problem of asymmetric information. The effect of reform under this setup is decomposed into two components: (1) the economic effect and (2) the surprise inflation effect. Economic effect reflects the idea that, by engaging in the reform, the government has incentives to raise taxes, which are now more efficient in financing the public goods, and hence reduces seigniorage. The surprise inflation effect is attributed to two different sources in our model. It could be either resulting of discretionary interventions or from the signaling effect during episodes of political uncertainty. In times of political instability, uncertainty about future policymakers' preferences will lead to an increase in expected inflation as compared to normal times. Hence, the public draws inferences upon observing the government's choice to reform the tax system. A priori, an authority that engages in tax reform is presumably of the conservative type in the sense that it prioritizes public good provision over output stabilization. In that sense, the government's decision to engage in the reform should reduce the public's expectations of future inflation. Due to the latter effect, an expansionary government would be willing to engage in reform only to benefit from the positive surprise inflation effect it could induce. In a rational Bayesian equilibrium, the public accounts for the signaling incentives while making inferences about the type of government in office. The analysis of the signaling effect under different monetary-fiscal setups reveals the following:

1) Solving the above signaling game for a centralized authority or equivalently full cooperation between the fiscal and monetary authorities, we find that political instability more often than less results in a pooling equilibrium. Any type of government once in office would have incentives to engage in tax reform. More precisely, a conservative/dry government; a government that prioritizes fiscal consolidation implements the reform to enhance the tax channel and thus relax his financing constraints. On the other hand, an expansionary government or a government that prioritizes growth and stabilization has incentives to reform in order to take advantage of the prevailing uncertainty: the public accounts for the government in office to be of the dry type and hence reduce their inflation expectations, which in turn allows boosting output through "political" surprise inflation. In this case, the reform will have no signaling power in the sense that it does not reassure the public about what level of inflation will prevail. Even after observing the government's choice to engage in reform, the public still holds high expectations about inflation and, through a slightly different mechanism, the result of the self-fulfilling anticipation obtains. Inflation is higher than what would prevail under political stability, the output gap is larger and so is the public spending gap.

2) Under non-cooperative setups, such as a Nash or a fiscal leadership game, the same political uncertainty effect is still present; that is, all types of governments would engage in the reform but the motives behind are different and cannot be predicted. This is especially the case when the central bank is dependent. The logic behind this result is that the more dependent the CB is, the more we are close to a case where the monetary policy is directed by the fiscal authority's preferences. However, when the central bank is independent, reform is likely to indicate fiscal discipline. Only a government that would be interested in the economic gains from the reform would have incentives to implement. Intuitively, the opportunistic policy maker (one whose prime concern is the political surprise effect) abstains.

4.3. Commitments and rules can act as substitutes for monetary independence

The above game suggests that central bank independence, and hence credibility, could mitigate the negative effect of political uncertainty on the signaling power of reforms. In economies undergoing political transitions and/or facing high levels of political instability, the vicious circle of high expected inflation and self-fulfilling expectations could be avoided if the appointed CB is independent in the sense that fiscal considerations are not on his agenda. When the CB is fully immune to fiscal budget problems, that is fiscal deficits cannot be financed through inflation and the public debt cannot be financed through CB reserves, fiscal reforms programs can achieve more favorable outcomes in terms of economic growth, contained inflation, and even fiscal performance. This result affirms Fisher's (1988) arguments on the benefits of having an extent of flexibility in monetary policy as long as the central bank enjoys a good reputation or credibility. In this case, rules will not be superior to discretions. Fisher (1988) evidently argued that if the central bank runs in a protected, independent, environment that isolates its operations from political pressures, in this case, central banks' good reputation and credibility will act as efficiently as a monetary rule. However, Fisher's results clearly addressed developed economies with strong central banks, mature financial channels, and efficient political institutions. The case is different for developing countries with immature financial markets and relatively weak fiscal and political institutions.

In this regard, we have also shown through the model that even with very low degrees of central bank independence, high commitment, proper "rules" can pursue the same effect of a highly independent central bank even if the central bank falls under the dominance of a centralized political authority. That is, efficient rules can act as a substitute for low monetary independence during times of political uncertainty and can secure the same welfare gains in terms of both contained inflation and good fiscal performance. Our results are reinforced by Blackburn and Christensen's (1989) argument that a dependent central bank is not as harmful as long as there is a strong institutional framework and prudent rules that limit discretionary interventions; both by politicians or by central bankers. Limiting the scope of discretionary interventions, particularly during spells of political crises, is expected to limit the time inconsistency behavior and discretionary opportunism by policymakers; especially in developing economies with growing relatively weak political institutions.

5. CONCLUSION

This paper provides a framework for analyzing the welfare effects of fiscal reform in an economy during a period of political uncertainty. Different interaction schemes are considered; namely, a centralized authority, a Nash game, and interaction under a fiscal leadership scheme. Several interesting findings emerge from the analysis. In a second-best world where the policymaker can commit to pre-announced targets, a fiscal reform always allows a higher level of public spending while reducing inflation, at the cost of an increased output gap. However, in a discretionary world and, particularly, when information asymmetries are present, the credibility of the policymakers is compromised as time-consistency problems emerge. In the case of uncertainty about future policymakers' preferences will lead to an increase in expected inflation as compared to normal times. Hence, the public draws inferences upon observing the government's choice to reform the tax system. A priori, an authority that engages in tax reform is presumably of the conservative type in the sense that it prioritizes public good provision over output stabilization. In that sense, the government's decision to engage in the reform should reduce the public's expectations of future inflation. Due to the latter effect, an expansionary government would be willing to engage in reform only to benefit from the positive surprise inflation effect it could induce. In a rational Bayesian equilibrium, the public accounts for the signaling incentives while making inferences about the type of government in office. The analysis of the signaling effect under different monetary-fiscal setups reveals two interesting findings.

First, in a centralized authority - or equivalently full cooperation between the fiscal and monetary authorities, political instability is found to result, more often than not, in a pooling equilibrium. Any type of government once in office would have incentives to engage in tax reform. More precisely, a conservative/dry government; a government that prioritizes fiscal consolidation implements the reform to enhance the tax channel and thus relax his financing constraints. On the other hand, an expansionary government or a government that prioritizes growth and stabilization has incentives to reform in order to take advantage of the prevailing uncertainty: the public accounts for the government in office to be of the dry type and hence reduce their inflation expectations, which in turn allows boosting output through "political" surprise inflation. In this case, the reform will have no signaling power in the sense that it does not reassure the public about what level of inflation will prevail. Even after observing the government's choice to engage in reform, the public still holds high expectations about inflation, and the welfare gains from the reform are compromised. Second, under non-cooperative setups (i.e., Nash or fiscal leadership game), the same political uncertainty effect is still present. That is, all types of governments would engage in the reform but the motives behind are different and cannot be predicted. This is especially the case when the central bank is dependent. The logic behind this result is that the more dependent the central bank is, the more we are close to a case where the monetary policy is directed by the fiscal authority's preferences. However, when the central bank is independent, reform is likely to indicate fiscal discipline. Only a government that would be interested in the economic gains from the reform would have incentives to implement. Intuitively, the opportunistic policy maker (one whose prime concern is the political surprise effect) abstains. Third, the more control the government has over the monetary policy in general (the monetary-fiscal interaction setup), the less effective the reform is in signaling fiscal discipline

These findings have interesting implications in terms of the design of institutions in economies undergoing political uncertainty. Central bank independence could mitigate the negative effect of political uncertainty on the signaling power of reforms. In economies undergoing political transitions and/or facing high levels of political instability, the vicious circle of high-expected inflation and political uncertainty could be avoided if the appointed central bank is independent in the sense that fiscal considerations are not on its agenda. When the central bank is fully immune to fiscal budget problems, that is fiscal deficits cannot be financed through inflation and the public debt cannot be financed through central bank reserves, fiscal reforms programs can achieve more favorable outcomes in terms of economic growth, contained inflation and even fiscal performance. In centralized authority setups where central bank independence is not possible, efficient rules can act as a substitute for low monetary independence during times of political uncertainty and can secure the same welfare gains in terms of both contained inflation and good fiscal performance. Limiting the scope of discretionary interventions, particularly during spells of political crises, is expected to limit the time inconsistency behavior and discretionary opportunism by policymakers; especially in developing economies with growing relatively weak political institutions.

Results have important implications for developing countries where fiscal dominance and more dependence on discretionary interventions are probably the more prevailing setups to secure growth rates and financing gaps. In such countries, there appears to be a continued setup of fiscal dominance paralleled with lacking efficient institutions and a high reliance on politically motivated discretionary interventions that become apparent during political cycles and spells of political and economic uncertainty. Such setups result in worst welfare outcomes that — according to our game results — could be reduced if proper fiscal rules were used as a substitute for low monetary independence during political uncertainty. Fiscal rules can secure the same welfare gains in terms of both contained inflation and good fiscal performance.

REFERENCES

1. Alesina, A. (1987). Macroeconomic policy in a two-party system as a repeated game. *The Quarterly Journal of Economics, 102*(3), 651–678. https://doi.org/10.2307/1884222
2. Alesina, A., & Gatti, R. (1995). Independent central banks: Low inflation at no cost? *The American Economic Review, 85*(2), 196–200. Retrieved from https://www.jstor.org/stable/2117918
3. Alesina, A., & Tabellini, G. (1987). Rules and discretion with noncoordinated monetary and fiscal policies. *Economic Inquiry, 25*(4), 619–630. https://doi.org/10.1111/j.1465-7295.1987.tb00764.x
4. Backus, D., & Driffill, J. (1985). Rational expectations and policy credibility following a change in regime. *The Review of Economic Studies, 52*(2), 211–221. https://doi.org/10.2307/2297617
5. Bahmani-Oskooee, M., & Nayeri, M. M. (2018). Policy uncertainty and the demand for money in Australia: An asymmetry analysis. *Australian Economic Papers, 57*(4), 456–469. https://doi.org/10.1111/1467-8454.12127
6. Barro, R. J. (1986). Reputation in a model of monetary policy with incomplete information. *Journal of Monetary Economics, 17*(1), 3–20. https://doi.org/10.1016/0304-3932(86)90003-6
7. Barro, R. J., & Gordon, D. B. (1983). Rules, discretion and reputation in a model of monetary policy. *Journal of Monetary Economics, 12*(1), 101–121. https://doi.org/10.1016/0304-3932(83)90051-X
8. Bennett, H., & Loayza, N. (2000). *Policy biases when the monetary and fiscal authorities have different objectives*. Retrieved from https://si2.bcentral.cl/public/pdf/banca-central/pdf/v4/299_330Bennet.pdf
9. Bhat, J. A., & Sharma, N. K. (2020). Identifying fiscal inflation in India: Some recent evidence from an asymmetric approach. *Journal of Economics, Finance and Administrative Science, 25*(50), 363–393. https://doi.org/10.1108/JEFAS-03-2019-0032
10. Blinder, A. S. (1982). *Issues in the coordination of monetary and fiscal policy* (NBER Working Paper No. 982). https://doi.org/10.3386/w0982
11. Canzoneri, M. B. (1985). Monetary policy games and the role of private information. *The American Economic Review, 75*(5), 1056–1070. Retrieved from https://www.jstor.org/stable/1818645
12. Cukierman, A., & Meltzer, A. H. (1986). A theory of ambiguity, credibility, and inflation under discretion and asymmetric information. *Econometrica, 54*(5), 1099–1128. https://doi.org/10.2307/1912324
13. Cukierman, A., Edwards, S., & Tabellini, G. (1992). Seigniorage and political instability. *The American Economic Review, 82*(3), 537–555. Retrieved from http://www.jstor.org/stable/2117320
14. Dimakou, O. (2015). Bureaucratic corruption and the dynamic interaction between monetary and fiscal policy. *European Journal of Political Economy, 40,* 57–78. https://doi.org/10.1016/j.ejpoleco.2015.07.004
15. Dixit, A., & Lambertini, L. (2000). *Fiscal discretion destroys monetary commitment.* https://doi.org/10.2139/ssrn.232654
16. Ferré, M., & Manzano, C. (2014). Rational partisan theory with fiscal policy and an independent central bank. *Journal of Macroeconomics, 42*, 27–37. https://doi.org/10.1016/j.jmacro.2014.06.003
17. Ftiti, Z., Aguir, A., & Smida, M. (2017). Time-inconsistency and expansionary business cycle theories: What does matter for the central bank independence-inflation relationship? *Economic Modelling, 67*, 215–227. https://doi.org/10.1016/j.econmod.2016.12.013
18. Huang, H., & Wei, S.-J. (2006). Monetary policies for developing countries: The role of institutional quality. *Journal of International Economics, 70*(1), 239–252. https://doi.org/10.1016/j.jinteco.2005.09.001
19. Istiak, K., & Alam, M. R. (2019). Oil prices, policy uncertainty and asymmetries in inflation expectations. *Journal of Economic Studies, 46*(2), 324–334. https://doi.org/10.1108/JES-02-2018-0074
20. Kirsanova, T., Stehn, S. J., & Vines, D. (2005). The interactions between fiscal policy and monetary policy. *Oxford Review of Economic Policy, 21*(4), 532–564. https://doi.org/10.1093/oxrep/gri031
21. Kreps, D. M., & Wilson, R. (1982). Reputation and imperfect information. *Journal of Economic Theory, 27*(2), 253–279. https://doi.org/10.1016/0022-0531(82)90030-8
22. Kuperberg, M. (2013). Teaching time-inconsistency consistently. *The American Economist*, *58*(2), 153–159. https://doi.org/10.1177/056943451305800208

23. Kydland, F. E., & Prescott, E. C. (1977). Rules rather than discretion: The inconsistency of optimal plans. *Journal of Political Economy, 85*(3), 473–491. https://doi.org/10.1086/260580
24. Nordhaus, W. D., Schultze, C. L., & Fischer, S. (1994). Policy games: Coordination and independence in monetary and fiscal policies. *Brookings Papers on Economic Activity, 1994*(2), 139–216. https://doi.org/10.2307/2534656
25. Rogoff, K. (1985). The optimal degree of commitment to an intermediate monetary target. *The Quarterly Journal of Economics, 100*(4), 1169–1189. https://doi.org/10.2307/1885679
26. Samadi, A. H., Marzban, H., & Owjimehr, S. (2017). Inflation bias, time inconsistency of monetary and fiscal policies, and institutional quality. *International Journal of Business and Development Studies, 9*(1), 27–45. Retrieved from https://ijbds.usb.ac.ir/article_3396_5dc9dec08669027248e6a324c64db458.pdf
27. Saulo, H., Rêgo, L. C., & Divino, J. A. (2013). Fiscal and monetary policy interactions: A game theory approach. *Annals of Operations Research, 206*(1), 341–366. https://doi.org/10.1007/s10479-013-1379-3
28. Vickers, J. (1986). Signalling in a model of monetary policy with incomplete information. *Oxford Economic Papers, 38*(3), 443–455. https://doi.org/10.1093/oxfordjournals.oep.a041751

APPENDIX A. CENTRALIZED AUTHORITY

A.1. Breakdown of the effects

In order to get a better understanding of the policymaker's incentives to engage in reform, the following discussion breaks down the effect of the reform into its two main components: a direct economic effect and a signaling one. The first refers to the change in inflation, output, and public spending gaps due to the reform enhancing the tax channel. The second reflects the idea that the decision to engage in the reform itself affects the public's inferences about the policymaker's type, inflation expectations, and hence his payoffs from the reform.

Given a pooling equilibrium where $\phi = 1$, from the first-order conditions of equation (2), the equilibrium inflation in equation (9) can be written as:

$$(\pi^{P1})^C = \underbrace{(\pi^{S0})^C}_{\text{Separating, no reform}} + \underbrace{(\pi^{S1} - \pi^{S0})^C}_{\text{Economic effect in a separating equilibrium}} + \underbrace{(\pi^{P1} - \pi^{S1})^C}_{\text{Pooling effect}} = \frac{\gamma_i}{1+\gamma_i} g^* + \frac{\gamma_i \sigma_i (\sigma_i - \gamma_i)}{f_i^C(0) F_i^C(1)} g^* - \frac{2\gamma_i \sigma_i}{f_i^C(1)} (\pi_i - \pi^e)$$

where, $f_i^C = \sigma_i(1+\gamma_i) + \phi\gamma_i(\phi + \sigma_i)$ is the denominator in the discretionary scenario in the centralized authority setup. As for the effect on the output gap, it can be written as:

$$(\chi^{P1} - \chi^*)^C = \underbrace{(\chi^{S0} - \chi^*)^C}_{\text{Separating, no reform}} + \underbrace{(\chi^{S1} - \chi^{S0})^C}_{\text{Economic effect in a separating equilibrium}} + \underbrace{(\chi^{P1} - \chi^{S1})^C}_{\text{Pooling effect}} = 0 - \frac{\gamma_i}{f_i^C(1)} g^* + \frac{\gamma_i}{f_i^C(1)} (\pi_i - \pi^e)$$

Finally, in terms of the public spending gap:

$$(g^{P1} - g^*)^C = \underbrace{(g^{S0} - g^*)^C}_{\text{Separating, no reform}} + \underbrace{(g^{S1} - g^{S0})^C}_{\text{Economic effect in a separating equilibrium}} + \underbrace{(g^{P1} - g^{S1})^C}_{\text{Pooling effect}} = -\frac{I}{1+\gamma_i} + \frac{\gamma_i \sigma_i (1+\sigma_i)}{f_i^C(0) f_i^C(1)} g^* + \frac{\sigma_i}{f_i^C(1)} (\pi_i - \pi^e)$$

A.2. Incentives constraints and stable equilibria

1. Equilibrium with only the conservative type engaging in the reform:

Two incentive constraints have to be satisfied for this separating equilibrium to be stable. First, the conservative type has no incentive to mimic the expansionary type's behavior and be mistaken for one, i.e.,

$$V_D^{S1} \leq V_D^{P0}$$

which amounts to equation (7) since in the centralized authority case, both pooling and separating equilibrium yield the same outcome when $\phi = 0$ (i.e., $V_D^{P0} = V_D^{S0}$). As previously mentioned, we assume the parameters to be such that this condition is always satisfied for the dry type.

Hence, for the dry type, it is always better to engage in the reform, in particular when the reform allows signaling conservativeness. Second, the expansionary type has no incentives to choose to engage in reform and pool with the conservative type, so that:

$$V_W^{S0} \leq V_W^{P1} \Leftrightarrow p(a_D - a_W) \geq (a_W + 2)\left[a_D + 1 - (a_D + 2)\sqrt{\frac{1}{(a_W+2)\left(\frac{2\gamma_i}{1+\gamma_i} - 4\frac{c}{g^{*2}}\right)}}\right]$$

2. Equilibrium with both types engaging in the reform:

The incentive constraints that should be satisfied are then $V_D^{P1} \leq V_D^{S0}$ and $V_W^{P1} \leq V_W^{S0}$.
Here the wet type's incentive constraint implies that of the dry type. To see this, the loss of type i from engaging in the reform, given a pooling equilibrium (after some mathematical manipulation) can be written as:

$$V_i^{P1} = \frac{\frac{1}{4}(a_i+2)(a_{-i}+2)^2}{[(a_W+2)(a_D+1) - p(a_D - a_W)]^2} g^{*2} + C$$

Since we assume the dry type to be more inflation averse (i.e., $a_D > a_W$), it is always the case that the wet type's loss from the reform is larger than the dry type's in a pooling equilibrium ($V_W^{P1} > V_D^{P1}$)[10]. It is always also the case that the dry type's loss from no reform is larger than the wet's. It is also always the case that $\left(V_D^{S0} > V_W^{S0}\right)$ since we assume that $\gamma_D - \gamma_W$. Combining the two observations, it can be verified that the only incentive constraint that needs to be satisfied for the pooling equilibrium to be stable is that of the wet type. So the stability condition reduces to:

$$p\left(a_D - a_W \leq (a_W + 2)\left[a_D + 1 - (a_D + 2)\sqrt{\frac{1}{(a_W+2)\left(\frac{2\gamma_i}{1+\gamma_i}\right)}}\right]\right)$$

APPENDIX B. NASH GAME

B.1. Economic and pooling effects

It is useful to present a breakdown of the tax reform effect in the Nash setup on the different arguments in the policymakers' objectives: inflation, output, and public spending gap.

$$(\pi^{P1})^N = \underbrace{(\pi^{S0})^N}_{\text{Separating, no reform}} + \underbrace{(\pi^{S1} - \pi^{S0})}_{\text{Economic effect in a separating equilibrium}} + \underbrace{(\pi^{P1} - \pi^{S1})^N}_{\text{Pooling effect}} = \frac{\gamma_B \sigma_i}{f_i^N(0)} g^* + \frac{(\sigma_B - \gamma_B)\gamma_i \sigma_i}{f_i^N(1) f_i^N(1)} g^* - \frac{\gamma_B \sigma_i + \gamma_i \sigma_B}{f_i^N} (\pi_i - \pi^e)$$

As for the effect on the output gap, it can be written as:

$$(\chi^{P1} - \chi^*)^C = \underbrace{(\chi^{S0} - \chi^*)^C}_{\text{Separating, no reform}} + \underbrace{(\chi^{S1} - \chi^{S0})^C}_{\text{Economic effect in a separating equilibrium}} + \underbrace{(\chi^{P1} - \chi^{S1})^C}_{\text{Pooling effect}} = 0 - \frac{\gamma_i}{f_i^C(1)} g^* + \frac{\gamma_i}{f_i^C(1)} (\pi_i - \pi^e)$$

Finally, in terms of the public spending gap:

$$(g^{P1} - g^*)^C = \underbrace{(g^{S0} - g^*)^C}_{\text{Separating, no reform}} + \underbrace{(g^{S1} - g^{S0})^C}_{\text{Economic effect in a separating equilibrium}} + \underbrace{(g^{P1} - g^{S1})^C}_{\text{Pooling effect}} = -\frac{I}{1+\gamma_i} + \frac{\gamma_i \sigma_i (1+\sigma_i)}{f_i^C(0) f_i^C(1)} g^* + \frac{\sigma_i}{f_i^C(1)} (\pi_i - \pi^e)$$

B.2. Central bank status and pooling effect

For a given level of 0, the optimal policy mix and the corresponding outcomes can be written as:

$$\tau_i^P = \tau^S + \frac{\sigma_i + \gamma_B \sigma_i + \phi \gamma_i \sigma_B}{f_i^N(\phi)} (\pi_i - \pi^e)$$
$$\pi_i^P = \pi_i^S - \frac{\gamma_B \sigma_i + \phi \gamma_i \sigma_B}{f_i^N(\phi)} (\pi_i - \pi^e)$$
$$\chi_i^P = \chi_i^S + \frac{\phi \gamma_i}{f_i^N(\phi)} (\pi_i - \pi^e)$$

[10] It should be noted that this result is not contradicting with the idea that pooling is welfare improving for the wet type relative to the separating equilibrium. In other words, even though pooling allows the wet type to improve his economic outcomes, after this improvement he still does worse than the dry type should they both engage in a reform.

where, $f_i^N(\phi) = \sigma_i(1+\gamma_B) + \phi\gamma_i(\phi+\sigma_B)$ The policy surprise effect is $\pi_W - \pi^e = (1-p)(\pi_W - \pi_D)$ for the wet type, and $\pi_D - \pi^e = -P(\pi_W - \pi_D)$ for the dry type. As can be seen from the above, pooling is welfare-improving for one type and welfare-reducing for the other. If $\pi_W \succ \pi_D$ then $\pi_W \succ \pi_D$ and $\pi_D - \pi^e \prec 0$. Using the expression for the inflation rate at equilibrium in (14), we find that $\pi_W - \pi^e \succ 0$ whenever $\chi_2 \succ \chi_1$, that is:

$$\frac{\sigma_2 + \phi^2\gamma_2}{\gamma_B\sigma_2 + \phi\gamma_2\sigma_B} \succ \frac{\sigma_1 + \phi^2\gamma_1}{\gamma_B\sigma_1 + \phi\gamma_1\sigma_B}$$

This condition reduces to:

$$\phi(\sigma_B - \phi\gamma_B)(\sigma_W\gamma_D - \sigma_D\gamma_W) \prec 0$$

Since we assume that the wets and drys are such that $\frac{\sigma_W}{\gamma_W} \succ \frac{\sigma_D}{\gamma_D} \succ$ and $0\,0 \leq \phi \leq 1 < 1$, then $\pi_W \succ \pi_D \Leftrightarrow (\sigma_B - \phi\gamma_B) \prec 0$.

APPENDIX C. FISCAL LEADERSHIP

C.1. Status of central bank and pooling effect

We solve for the equilibrium using backward induction. In the last stage of a fiscal leadership game where both types of policymakers would engage in the reform, i.e., choose , the central bank chooses , given that he observes a type *i* in the office such that:

$$\frac{\partial V_B}{\partial \pi_i} = \pi_i + \sigma_B(\chi_i - \chi^*) + \gamma_B(g_i - g^*) = 0 \tag{22}$$

using the equations for the output and public spending gaps given in equations (1) and (3) respectively, the monetary reaction function MRF^F is:

$$\pi_i(\tau_i) = \frac{(\sigma_B - \gamma_B)\tau_i + \gamma_B g^* - \sigma_B\pi^e}{1+\sigma_B+\gamma_B}$$

Then we plug this inflation rate as a function of τ into equations (1) and (3) to have the three objectives $\pi_i\chi_i - \chi^*$ and $g - g^*$ in terms of τ and the expected inflation π^e, which then allows deriving the FOCs. of the fiscal authority in the previous stage given by:

$$\frac{\partial V_i}{\partial \tau_i} = \frac{\sigma_B - \gamma_B}{1+\sigma_B+\gamma_B}\pi_i - \sigma_i\frac{1+2\gamma_B}{1+\sigma_B+\gamma_B}(\chi_i - \chi^*) + \gamma_i\frac{1+2\sigma_B}{1+\sigma_B+\gamma_B}(g_1 - g^*) = 0 \tag{23}$$

The 4 FOCs, represented by the equations (22) and (23), yield the equilibrium taxes and inflation as a function of the expected inflation. In a separating equilibrium, we set $\pi^e = \pi$.
In a pooling equilibrium, however, we set $\pi^e = p\pi w + (1-p)\pi_D$. From the 2 FOCs given by equation (22), we find that:

$$\Delta F = \pi_W - \pi_D = \frac{\sigma_B - \gamma_B}{1+\sigma_B+\gamma_B}(\tau_W - \tau_D)$$

Let $\eta = \frac{\sigma_B - \gamma_B}{1+\sigma_B+\gamma_B}$. After some algebra, we find that:

$$\tau_W = \frac{fdgw - \eta f_W h_D + \eta h_W h_D + P(f_D g_W - f_W g_D)}{f_D[f_W(1-\eta) + \eta h_W] - p(f_D g_W - f_W g_D)}$$

and

$$\tau_D = \frac{fwgw - \eta f_W h_D + \eta h_W h_D + P(f_D g_W - f_W g_D)}{f_D[f_W(1-\eta) + \eta h_W] - p(f_D g_W - f_W g_D)}$$

so that,

$$\tau_W - \tau_D = \frac{(f_D g_W - f_W g_D)}{f_D[f_W(1-\eta) + \eta h_W] - p(f_D g_W - f_W g_D)}$$

Let $\chi = (f_D g_W - f_W g_D)$, so $\tau_W - \tau_D = \frac{\chi}{f_D[f_W(1-\eta) + \eta h_W] - P_x}$

The magnitude of the surprise inflation is then $\pi_W - \pi_D = \frac{\sigma_B - \gamma_B}{1+\sigma_B+\gamma_B} \times \frac{\chi}{fD[f_W(1-\eta) + \eta h_W] - px}$
where,

$$\chi = \underbrace{(\sigma_B - \gamma_B)}[\underbrace{\gamma_B(1+2\gamma_B)(\sigma_W - \sigma_D) - \sigma_B(1+2\sigma_B)(\gamma_D - \gamma_W)}] \underbrace{-(1+2\gamma_B)(1+2\sigma_B)(\gamma_D\sigma_W - \gamma_W\sigma_D)}$$
$$> 0 \text{ if CBI} > 2\,0 \Leftrightarrow \frac{\sigma_W - \sigma_D}{1+2_\sigma B} > \frac{\gamma_D - \gamma_W}{1+2\gamma_B} \quad \text{always} < 0$$

Under central bank dependence (CBD), where $\sigma_B \prec \gamma_B$, assuming there is relatively more uncertainty regarding stabilization objectives i.e., $\frac{\sigma_W - \sigma_D}{1+2\sigma_B} \succ \frac{\gamma_D - \gamma_W}{1+2\gamma_B}$, then χ is always positive and $T_W > a_D$ in a pooling equilibrium. It is the wet type that benefits from pooling. The dry type then experiences a welfare loss due to political uncertainty. In the case of CBI, χ is positive and hence it is the dry type that benefits from pooling when the uncertainty vis-à-vis the policymaker's interest in output stabilization is sufficiently small relative to the degree of polarization in the political system i.e., $\frac{\gamma_D}{\sigma_D} - \frac{\gamma_W}{\sigma_W}$. In other words, when uncertainty regarding interests in the output target is not too large but the difference between the relative interests in public spending between the two types is.