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Signaling Credibility — Choosing Optimal Debt and International Reserves*

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This paper evaluates the challenges facing developing countries when there is uncertainty about the policy maker type. We consider a country characterized by volatile output, inelastic demand for fiscal outlays, high tax collection costs, and sovereign risk, where future output depends on the type of policymaker in place today. There are two policymakers — type *T* chooses debt and international reserves to smooth tax collection costs; type *S* has higher discount factor, aiming at obtaining current resources for narrow interest groups, and preferring not to undertake costly reforms that may enhance future output. Financial markets do not know the type of policymaker in place and try to infer its type by looking at its financial choices. We show that various adverse shocks (lower output, higher real interest rate, etc.) can induce a switch from equilibrium where each policy maker chooses its preferred policy to another where *T* distorts its policies in order to separate itself from S in the least costly way. This is accomplished by type *T* reducing both international reserves and external debt. Further decline in output would induce type *T* to lower debt, and reserves would fall at a higher rate than otherwise expected.

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Lula's leap; Popular, but no populist

…The victory of a worker born dirt-poor in Brazil's poverty-stricken north-east was celebrated as a victory for poor people everywhere. Yet Lula did not turn out to be a populist like Venezuela's Hugo Chávez. Instead of spending recklessly, reigniting inflation and perhaps defaulting on debt as Argentina has done, Lula clamped down on inflation and saved extra money to pay the debt… Spurred by a devaluation in 1999 and buoyant demand for commodities, exports have boomed, turning a current-account deficit into surplus. Mr Palocci has used the inflow of dollars to pay off foreign creditors, including the IMF. Soon, Brazil will no longer have to worry about a falling real *driving up its debt burden. The risk premium has fallen to a record low of two percentage points.*

Mar 2nd 2006, *The Economist*

1. INTRODUCTION

In the history of sovereign debt, there have been numerous episodes in which countries have rapidly accumulated large debts in short periods, which have led to debt servicing problems later on. A case in point is the experience of many Latin American countries in the late nineteen seventies. Consistent with this pattern, several models have explored the consequences of having governments with high discount factors trying to get as much resources as possible while they are in office. If countries with governments that maximize current resources have weaker growth prospects — for this very reason — than those with governments that have more long-term objectives in mind, then financial markets will treat these different types of countries in different ways. Given the widespread prevalence of short-sighted governments, prudent governments who take the long view may find it difficult to convince investors that they are not of the short-sighted type.

The recent history of Argentina and Brazil provides an intriguing case study. Both countries were challenged by similar macroeconomic maladies in the 1980s — high inflation and fiscal deficiencies. Both had weak federal systems, plagued with common pool problems, where provincial states had the incentive to over borrow, necessitating federal government bail-outs, frequently through excessive monetization. The regime changes of the early 1990s led to rapid disinflation in both countries. Nevertheless, they adopted sharply different exchange rate systems. Argentina chose a currency board, rigidly pegging the peso to the US dollar. In contrast, Brazil put greater emphasis on reducing the bargaining power of provincial states, and on managed flexibility of the exchange rate. These policies, and the external shocks of the 1990s, put them in sharply different positions during the last five years. Argentina ended up defaulting on its internal and external debt and its leaders may be writing another chapter in the populist annals of Latin America (LATAM). Brazil has managed to steer away from default, a remarkable task considering Lula’s political background. As the lead quotation reveals, Lula’s task has been complicated by the need to earn credibility during a time of reemerging populism in LATAM.[1)]

In this paper, we develop a model in which a government, using debt and reserves to smooth tax collection costs, has to be cautious about not being mistaken for one seeking to maximize current resources. Our results can shed light on the new situation that, although not as common as over-borrowing in LATAM, has certainly occurred: the case of a rapidly declining debt, partially financed by recently accumulated international reserves. Our model does not address the fundamental reasons why political leaders may differ in their objectives. Specifically, we don’t attempt to explain their effective discount rates nor their attitudes towards present consumption versus investment in enduring but painful reforms. Taking these things as given, we identify situations that may lead to contrasting choices, akin to the ones observed recently in LATAM and other regions. Our paper focuses on

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[1)] See Miller *et al*. (2003) for an early assessment of the challenges facing the Lula’s administration due to market fears of an untried Left-wing candidate. See Aizenman (2005) for an overview of the divergent paths of Argentina and Brazil in the last fifteen years.

the optimal behavior of a country, overlooking the possibility of gains from regional cooperation in pooling arrangements. See Ogaw (2001) for an interesting analysis dealing with these gains.

We consider a developing country characterized by volatile output, inelastic demand for fiscal outlays, high tax collection costs and sovereign risk. There are two types of policymakers, differing in their preferences. One, dubbed tough (*T*), chooses its debt and international reserves to smooth tax collection costs, maximizing the representative agent expected utility. International Reserves can extend smoothing to bad states of nature where default is likely — provided they are beyond the reach of creditors. Thus, both debt and international reserves play a role in optimally smoothing tax collection costs.

The second type of policymaker, soft (*S*), is interested in obtaining resources for special interest groups while it is in office and acts with a high effective discount rate. Its choice of debt and international reserves is thus tilted towards obtaining current resources for these groups. We assume that the differential discount factors of the two policy makers have repercussions for future output. Since the soft policymaker has a higher discount rate, it will not undertake reforms or investment to the extent that the tough policymaker will. Hence, the future expected output would be lower under the soft policy maker.

When investors have full information about the policy maker type, the soft policy maker ends up with higher debt and lower international reserves, as in Aizenman and Marion (2004). The focus of our paper is on the case where market participants do not know the type of policymaker in place, but try to infer its type by looking at its financial choices.[2)] We identify conditions under which the equilibrium outcome entails two distinct policy regimes. In the first, each policy maker makes the same choices they would when markets have full information, thereby revealing their type to financial

[2)] See Acharya and Diwan (1993) and Fernandez-Ruiz (2000) for models in which countries' financial choices — especially debt buybacks — act as signals in the context of the debt relief packages (mainly the Brady deals) offered to debt-ridden economies in the early nineties.

markets. We refer to this equilibrium as the *undistorted policy regime*. In the second policy regime, the soft policy maker has the incentive to mimic the tough, inducing the tough to distort its policies so as to differentiate itself in the least expensive way. The result is that the tough policy maker opts for lower debt and international reserves while the soft policy maker chooses its undistorted policy choices (i.e. the same choices it would make if investors knew its type). We call this the distorted policy regime and the equilibrium that results is the Least Costly Separating (LCS) Equilibrium.

Adverse shocks, like high international risk free interest rates, or low current output induce the switch from the undistorted regime to the distorted regime. Below a threshold level of current output, further decline in output induces lower debt instead of higher — as would be expected — and reserves fall at a higher rate than otherwise expected. This adjustment may be viewed as a ‘test of fire’ imposed on the tough policy maker in bad times. We also show that the cost of sovereign default is an important determinant of the range of the distorted policy regime. A low enough default penalty induces a switch from the undistorted policy regime to the distorted policy regime for a given level of output. Similarly, a drop in the expected future output that a soft policy maker can achieve induces a shift from the undistorted to the distorted policy regime for certain parameter values.

These results imply that political uncertainty is a key variable impacting the association between output shocks and the patterns of debt and international reserves.

2. THE MODEL

We consider an extension of Aizenman and Marion (2004). The model has three basic ingredients.

i) There are two types of policymakers. The tough (T) — or responsible one — chooses its debt and international reserves to smooth tax collection costs in a setting with volatile output, inelastic demand for fiscal outlays, high tax collection costs and sovereign risk. Debt can accomplish this smoothing only when the country has access to international capital markets — in good states of nature. International Reserves can extend smoothing to bad states of nature — provided they are beyond the reach of creditors. Thus, both debt and international reserves play a role in optimally smoothing tax collection costs.

The soft (*S*) policymaker is interested in obtaining resources for special interest groups with high discount rates. Its choice of debt and international reserves is thus tilted towards obtaining current resources.

ii) We consider the particular case in which current policy choices impact future output. We can envision a simple setting in which this occurs. There are reforms that require a sacrifice today in exchange for higher future output. Since the soft policymaker has higher discount rates, it will not undertake these reforms to the extent that the tough policymaker will. Thus, future output will depend on the type of policymaker in place today.

iii) Financial markets do not know the type of policymaker in place, but try to infer its type by looking at its financial choices.

We consider the two-state case in which second-period output can take only two values: $Y_2 \in \{Y_l, Y_h\}$, with $Y_l = 1 - \delta$, $Y_h = 1 + \delta$, and $\delta > 0$. The tough policymaker induces a distribution for the second-period output in which $Y_2 = Y_h$ with probability 1/2, while the soft policymaker induces a distribution with $\Pr(Y_2 = Y_h) = p < 1/2$. (This can be thought of as the result of a choice of whether or not to exert some costly effort in the first period).

Although financial markets do not know the type of policymaker in place, they assign a prior probability of φ to the policymaker being soft. This implies that they assign a prior probability of $p^M \equiv \varphi p + (1-\varphi)(1/2)$ to the country obtaining a high second-period output.

2.1. The Credit Market

The country can borrow internationally an amount *B* in period 1 at a contractual interest rate *r*, so that it owes (1 + *r*)*B* in period 2. In the second period, the country repays the amount owed, (1 + *r*)*B*, if this is less costly than the default penalty, αY.

So, actual repayment in period 2 equals

$$S_2 = \min\{(1+r)B,\ \alpha Y_2\}. \tag{1}$$

Since maximum repayment cannot exceed αY_h, let us restrict attention to debt values *B* with $(1+r)B \le \alpha Y_h$.

We assume international competitive markets, so that creditors will demand an expected repayment equivalent to the risk-free interest rate r_f : $E(S_2) = (1+r_f)B$; which can be written as

$$\begin{aligned} &[1-\Pr(Y_2=Y_h)]\alpha Y_l + \Pr(Y_2=Y_h)(1+r)B = (1+r_f)B, \quad if\ B > \frac{\alpha Y_l}{(1+r_f)}, \\ &r = r_f, \qquad\qquad if\ B \le \frac{\alpha Y_l}{(1+r_f)}. \end{aligned} \tag{2}$$

This equation implicitly defines the supply of credit. Clearly, this supply depends on the probability that financial markets assign to the country obtaining a high second period-output, $\Pr(Y_2 = Y_h)$. Since $\Pr(Y_2 = Y_h)$ is different depending on the type of policymaker, the supply of credit will also be different depending on the type of policymaker that financial markets believe they are facing.

Let r^t be the (implicitly) defined value of *r* satisfying (2) when $\Pr(Y_2 = Y_h) = 1/2$. Thus, r^t is the interest rate charged to a policymaker believed to be tough.

Similarly, Let r^s be value of *r* satisfying (2) when $\Pr(Y_2 = Y_h) = p < 1/2$: it is the interest rate charged to a policymaker believed to be soft.

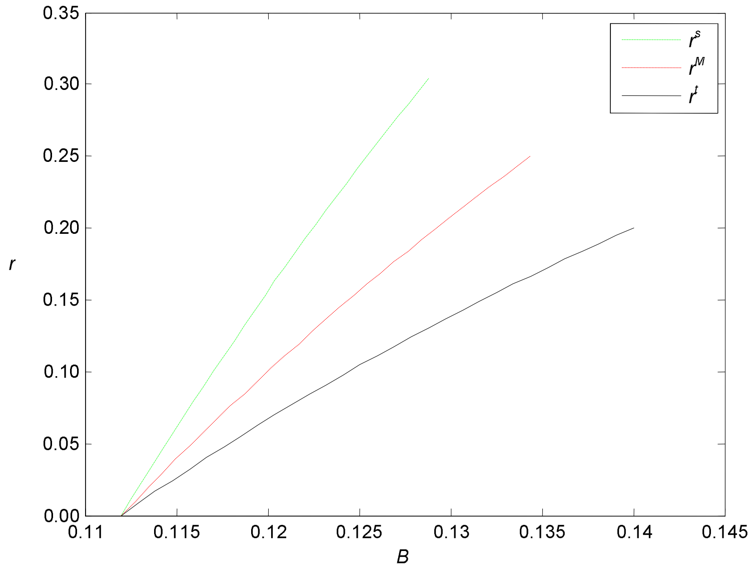
Finally, let us define for future reference r^M as the interest rate charged to a policymaker believed to be soft with the prior probability ϕ. r^M satisfies (2) when $\Pr(Y_2 = Y_h) = P^M$.

Since $p^s < p^M < 1/2$, we will have that, for any given *B*,

$$r^t < r^M < r^s, \qquad if\ B > \frac{\alpha Y_l}{(1+r_f)},$$
$$r^t = r^M = r^s = r_f, \qquad if\ B \le \frac{\alpha Y_l}{(1+r_f)}.$$

When debt is risky, a policymaker perceived to be tough will be charged an interest rate lower than that charged to a policymaker perceived to be soft, while a policymaker whose type is unknown will receive an offer that is a weighted average of the two, determined by the prior: φ. The following figure illustrates this point. It also illustrates the fact that the maximum debt that a country can obtain in period 1 increases with $\Pr(Y_2 = Y_h)$. Thus, the soft policymaker can obtain fewer resources than one with unknown type who, in turn, can obtain less than the tough type.

Figure 1 Supply Curve for Different Markets Beliefs



$r_f = 0;\ \alpha = 0.14;\ \delta = 0.2;\ p = 0.3;\ \phi = 0.5$

2.2. Complete Information

Consider first a setting with complete information: each type of policymaker chooses its preferred policy under the assumption that financial markets know which type it is. Government revenue in the first period is obtained by a combination of taxes, *T*, and borrowing *B*. The revenue is financing government expenditure, *G*, and hoarding international reserves, *R*. The second period government expenditure, *G*, and debt repayment is financed by tax revenue and international reserves. Collecting taxes is associated with deadweight loss, which reduces net output at a rate Γ. This rate depends positively on government net expenditure/GDP ratio, denoted by ξ. Under these assumptions, the representative agent's consumption can be reduced to $Y(1-\xi-\Gamma(\xi))$.[3)]

We assume that financial decisions (sovereign debt and reserves) are made before fiscal decisions. Hence, the creditors lending decisions take place prior to setting the tax rate and the actual fiscal expenditure on fiscal consumption, *G*. The tough policymaker will choose debt (*B*) and reserves (*R*) to maximize

$$V^t(B,\ R,\ r^t) = u\left(Y_1\left(1-\frac{G+R-B}{Y_1}\right)-\Gamma\left(\frac{G+R-B}{Y_1}\right)\right)+$$
$$\frac{0.5}{1+\rho}\left\{\begin{aligned}&u\left(Y_l\left(1-\frac{G+\alpha Y_l-(1+r_f)R}{Y_l}\right)-\Gamma\left(\frac{G+\alpha Y_l-(1+r_f)R}{Y_l}\right)\right)+\\&+u\left(Y_h\left(1-\frac{G+(1+r^t)B-(1+r_f)R}{Y_h}\right)-\Gamma\left(\frac{G+(1+r^t)B-(1+r_f)R}{Y_h}\right)\right)\end{aligned}\right\},$$

3) The deadweight loss may be viewed as tax enforcement and collection costs. In these circumstances, a tax rate *t* paid by the representative consumer yields tax revenue *net* of collection costs of $Y[t-\Gamma]$, where $\Gamma=\Gamma(t); \Gamma'\geq 0, \Gamma''\geq 0$. The fiscal budget constraint linking consumer's tax rate, *t*, with the fiscal revenue needs *net* of tax collection and enforcement costs defines a tax Laffer curve, $t-\Gamma(t)=\xi$, implicitly defining the consumer tax rate as a function of the net fiscal revenue needs, $t=t(\xi)$. Consequently, consumption *C* is a function of the net fiscal needs, $C=Y(1-t)=Y[1-\xi-\Gamma(t(\xi)]$. See Aizenman and Marion (2004) for further details.

where r^t is the interest rate charged to a policymaker believed to be tough, defined by equation (2) when $\Pr(Y_2 = Y_h) = 1/2$.

We assume that the deadweight cost of taxes, $\Gamma(\xi(t)) = 0.5\lambda t^2$, is quadratic in the tax rate.

Debt and reserves allow the government to smooth both consumption and tax collection costs. We will for simplicity consider the case of risk-neutrality, so that the smoothing of tax collection costs will be the only underlying motive behind the use of debt and reserves.

Let (B^t, R^t) be the solution to this problem. It is the full information *benchmark policy* for the tough type. In the next section, when markets are unsure about the type of the policy maker, this benchmark policy is chosen in what will be called the *undistorted policy regime*.

The soft policymaker is interested in maximizing a different objective function. It will choose B and R to maximize the present value of the resources it obtains from capital markets to distribute among special interest groups, using a discount rate $\rho^s > \rho$:

$$\text{Max}(V^s(B,\ R,\ r^s) = [T_m(Y_1) + B - R]$$
$$+\frac{1}{1+\rho^s}\{p[T_m(Y_h) + R(1+r_f) - (1+r^s)B] + (1-p)[T_m(Y_l) + R(1+r_f) - \alpha Y_l]\},$$

where r^s is the interest rate charge to a policymaker believed to be soft ($(\Pr(Y_2 = Y_h) = p < 1/2)$, and $T_m(Y)$ denotes the maximum net tax revenue attainable.[4)]

Let (B^s, R^s) be the solution to this problem. It is the full information *benchmark policy* for the soft type. The fact that $r_f < \rho^s$ implies that

$$R^s = 0,\ B^s = \frac{\alpha[(1-p)Y_l + pY_h]}{1+r_f}.$$

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4) This is the net tax revenue defined by the peak of the tax Laffer curve discussed in the previous footnote.

Under complete information, the soft policymaker holds no reserves and contracts as much debt as possible, to obtain an utility equal to

$$V^s(R^s,\ B^s,\ r^s) = T_m(Y_1) + \frac{\alpha[(1-p)Y_l + pY_h]}{1+r_f}$$

$$= \frac{1}{1+\rho^s}\{p[T_m(Y_h) - \alpha Y_h] + (1-p)[T_m(Y_l) - \alpha Y_l]\}.$$

2.3. Incomplete Information

We now turn our attention to the case in which the policymaker is privately informed about its type. Financial markets hold a prior probability of φ that this type is soft. The policymaker chooses a financial policy (*B*, *R*) and, upon observing this choice, creditors update the prior probability φ, and charge an interest rate according to this updated probability.

When financial markets do not know the type of policymaker, a main concern for the tough policymaker is that it may be mistaken for a soft policymaker. We now address this concern, which will be at the heart of our analysis.

We first compute for future reference the utility the soft policymaker obtains when it mimics the tough policymaker and is treated as such by financial markets. In such a situation the soft policymaker will obtain utility of

$$V^s(B^t,\ R^t,\ r^t) = [T_m(Y_1) + B^t - R^t]$$

$$+ \frac{1}{1+\rho^s}\{p[T_m(Y_h) + R^t(1+r_f) - (1+r^t)B^t]$$

$$+ (1-p)[T_m(Y_l) + R^t(1+r_f) - \alpha Y_l]\}.$$

By mimicking the financial choice of the tough policymaker, the soft policymaker obtains an interest rate, r^t, lower than r^s. This comes at the cost of distorting its otherwise optimal financial policy.

Notice also that the tough policymaker will never want to imitate the soft policymaker: $V^t(B^s,\ R^s,\ r^s) < V^t(B^t,\ R^t,\ r^t)$. This follows from the fact that:

i) given the interest rate r^t, shifting to the soft policy maker's benchmark policies $(B^s,\ R^s)$ decreases its welfare. By construction, $(B^t,\ R^t)$ is welfare maximizing for that interest rate, $V^t(B^s,\ R^s,\ r^s) < V^t(B^t,\ R^t,\ r^t)$.

ii) Given $(B^s,\ R^s)$, an increase in the interest rate from r^t to r^s cannot increase welfare, $V^t(B^s,\ R^s,\ r^s) \leq V^t(B^s,\ R^s, r^t)$.

Let *TSE* be the utility the soft type obtains by following benchmark policy, less the utility it obtains by imitating the tough type and receiving the interest rate r^t:

$$TSE = V^s(B^s, R^s, r^s) - V^s(B^t, R^t, r^t).$$

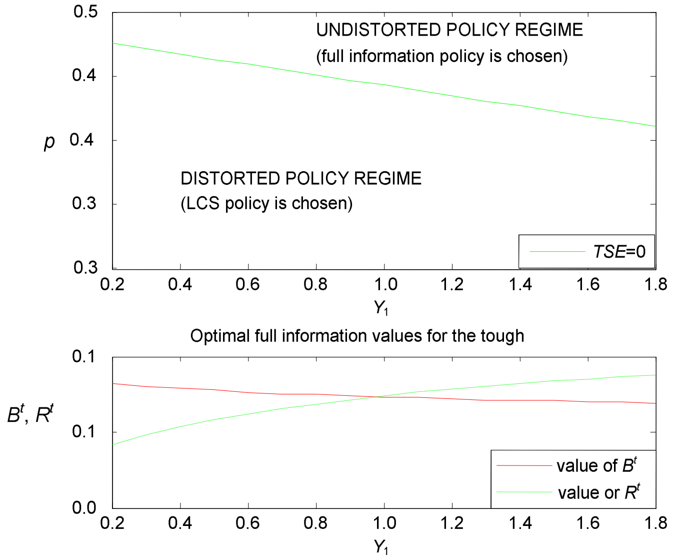
We have now two different scenarios.

i) If *TSE* > 0, the soft policymaker is better-off sticking to its undistorted benchmark policy rather than picking the tough type's benchmark policy. In that case, each policymaker will choose its benchmark policy and financial markets will learn from these choices the type of policymaker they are facing. We will call this the undistorted policy regime.

ii) If *TSE* < 0, then the soft policymaker is better-off imitating the tough policymaker. In this case, a choice of $(B^t,\ R^t)$ would no longer convince the markets that a tough policymaker made such a choice. Thus, the above undistorted choice will no longer be a separating equilibrium. As we will show, the tough policy maker will then distort its choice of debt and reserves to separate itself from the soft policy maker. We will call this the distorted policy regime.

Substituting $V^s(B^s,\ R^s,\ r^s)$ and $V^s(B^t,\ R^t,\ r^t)$, we have that

Figure 2 Equilibrium Zones According to Values of Y_1 and p



$\alpha = 0.14;\ \delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0.01;\ \rho^s = 0.01;\ r_f = 0.0$

$$TSE = \left(\frac{p\alpha(1+\delta) + (1-p)\alpha(1-\delta)}{1+r_f} - \frac{p\alpha(1+\delta) + (1-p)\alpha(1-\delta)}{1+\rho^s} \right)$$

$$- B^t + R^t - \frac{1}{1+\rho^s}\{(1+r_f)R^t - 2p(1+r_f)B^t - \alpha(1-\delta)(1-2p)\}.$$

It is instructive to see how different variables affect the value of *TSE* and thus, which of the two equilibria will prevail. By differentiating *TSE* we find that

i) A reduction in the probability that the soft type obtains a high future output (a lower p) or a reduction in current output (Y_1) will reduce *TSE* and induce a shift to the distorted policy regime for certain parameter values (see figure 2)

$$\frac{\partial TSE}{\partial p} > 0, \ \frac{\partial TSE}{\partial Y_1} > 0. \quad (3)$$

To gain some insight, let us first examine a reduction in p, the probability that the soft government obtains a high output. This reduction leaves (B^t, R^t) unchanged. But it affects *TSE* through two different channels: i) it reduces the utility the soft government obtains by following its complete information policy (B^s, R^s), because it reduces the amount of resources it can borrow, and ii) it increases the cross-subsidization it obtains if it mimics the tough policymaker policy (B^t, R^t). Both effects make it more tempting for the soft government to mimic the tough one.

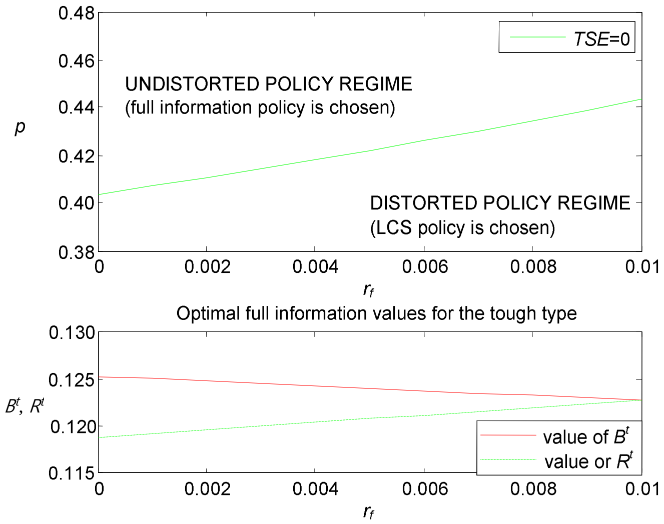
Let us now examine a reduction in Y_1. It affects *TSE* only through its effect on (B^t, R^t). By increasing B^t and reducing R^t, it increases the utility a soft government obtains from imitating a tough one.

Figure 2 illustrates the equilibrium zone we will be in as p and Y_1 change. In the top panel, it shows that either a reduction in p for a given Y_1, or a reduction in Y_1 for a given p, can moves us away from the undistorted policy regime. It also shows in its bottom panel the optimal undistorted policy for the tough government, which explains the effect of Y_1. As Y_1 decreases, the tough type would like to increase debt and reduces reserves. Both movements make it more tempting for the soft government to imitate the tough one.

ii) We now analyze changes in the risk-free interest rate (r_f) and the penalty creditors can inflict (α). These variables have two different effects on *TSE*: i) They influence *TSE* for a given value of (B^t, R^t), and ii) they have an indirect effect in *TSE* through its impact on (B^t, R^t). We have that, for a range of parameters where the first (direct) effect is higher than the second (indirect) effect, an increase in the risk-free interest rate (r_f) or a decrease in the penalty creditors can inflict (α) increases the likelihood that the tough policymaker abandons its undistorted benchmark policy:

$$\frac{\partial TSE}{\partial r_f} < 0 \ \text{ and } \ \frac{\partial TSE}{\partial \alpha} > 0. \quad (4)$$

Figure 3 Equilibrium Zones According to Values of r_f and p



$\alpha = 0.14;\ \delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0.01;\ \rho^s = 0.01;\ Y_1 = 1$

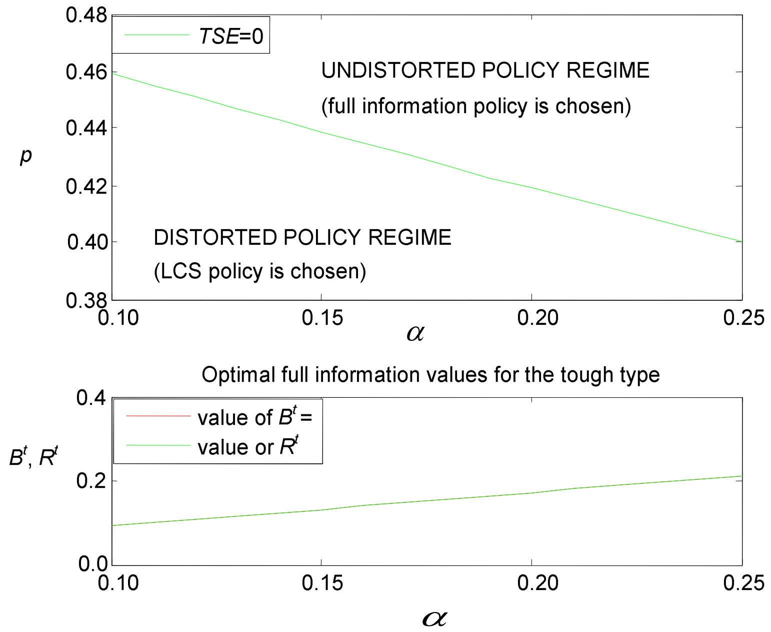
An increase in the risk-free interest rate, r_f, or a reduction in the amount of output creditors can recover for sure, α, both reduce the amount of resources an opportunistic government can get when not trying to imitate the tough policy maker. This reduces *TSE*. However, an increase in r_f also produces a mitigating effect by decreasing B^t and increasing R^t. This effect is usually outweighed by the former effect.

Figure 3 shows in the (r_f, p) space whether or not we will have an undistorted policy equilibrium. It shows in its bottom panel that an increase in r_f induces a tough policymaker to reduce debt and increase reserves, actions that the soft type dislikes. This gives the soft type less incentive to imitate the tough type. The top panel in figure 3 shows that this (indirect) effect is outweighed by the reduction in the amount a soft government can get when pursuing its benchmark policy. Thus, for a range of values for p, we abandon the undistorted policy equilibrium as r_f increases.

Figure 4 shows similar graphs in the (α, p) space.

Equilibrium policies when the benchmark policies are abandoned.

Figure 4 Equilibrium Zones According to Values of α and *p*



$\delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0;\ \rho^s = 0.01;\ Y_1 = 1;\ r_f = 0.0$

We now search for the equilibrium behavior when the benchmark policies do not form an equilibrium (*TSE*<0). It turns out that, under certain conditions, we will have a separating equilibrium in which

i) The soft policy maker chooses its full information policy, $(B^s,\ R^s) = \left(\frac{\alpha[(1-p)Y_l + pY_h]}{1+r_f},\ 0\right)$, and

ii) The tough policymaker does not choose its full information benchmark policy. Instead, it chooses the policy $(B^{tc},\ R^{tc})$ that allows it to separate itself from the soft policy maker in the least costly way. It is the Least Costly Separating (LCS) policy.

More formally, $(B^{tc},\ R^{tc})$ is the solution to the problem

$$\begin{aligned}&\text{Max } V^t(B,\ R,\ r^t)\\&\text{s.t. } V^s(B,\ R,\ r^t) \le V^s(B^s,\ R^s,\ r^s).\end{aligned}$$

We claim that, under certain conditions,

i) The above strategies do provide an equilibrium.
ii) It is the most reasonable equilibrium, and
iii) There are no pooling equilibria.

Before explaining why this is so, let us first comment that the LCS equilibrium differs from the full information benchmark policies only in the policy chosen by the tough type. Here the tough type will choose the LCS policy (B^{tc}, R^{tc}) instead of the full information policy $(B^t,\ R^t)$. Under certain regularity conditions, it turns out that the tough type reduces both debt and reserves to separate itself from the soft type, $B^{tc} < B^t$ and $R^{tc} < R^t$. Figure 5 illustrates this point by plotting the equilibrium value of debt (top panel) and reserves (bottom panel) as a function of r_f both under the undistorted and the LCS policies.

To gain some insight on why this is so, consider the problem from which the LCS policy $(B^{tc},\ R^{tc})$ arises

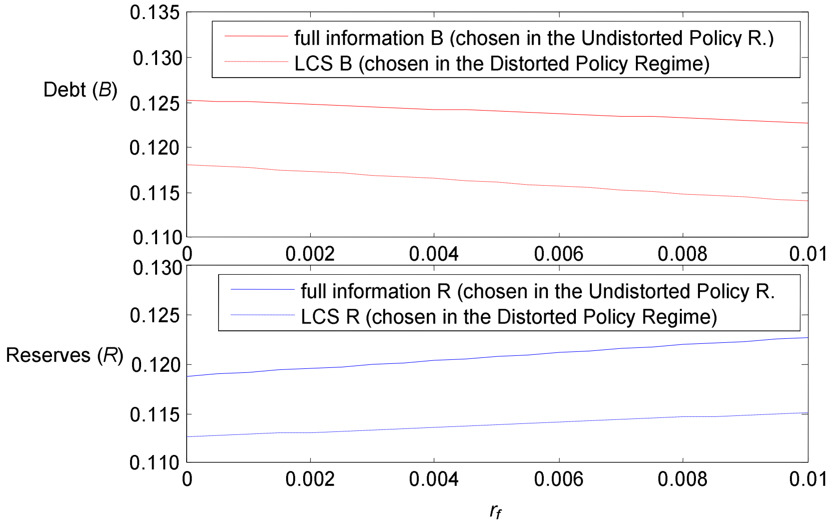
$$\begin{aligned}&\text{Max } V^t(B,\ R,\ r^t)\\&\text{s.t. } V^s(B,\ R,\ r^t) \le V^s(B^s,\ R^s,\ r^s)\ \text{(IC)}.\end{aligned}$$

This problem is equal to the problem giving rise to the complete information policy $(B^t,\ R^t)$, except for (IC), the incentive compatibility constraint. This constraint tells us that the tough policymaker has to choose a policy that the soft policymaker does not find attractive to imitate.

Notice how debt and reserves affect this constraint

i) A decrease in debt relaxes the constraint for two reasons. First, since the soft policymaker has a high discount rate, it prefers to borrow more debt,

Figure 5 Shifting from the Undistorted to the Distorted Policy Regime



$\alpha = 0.14;\ \delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0.01;\ \rho^s = 0.02;\ Y_1 = 1;\ p = 0.3$

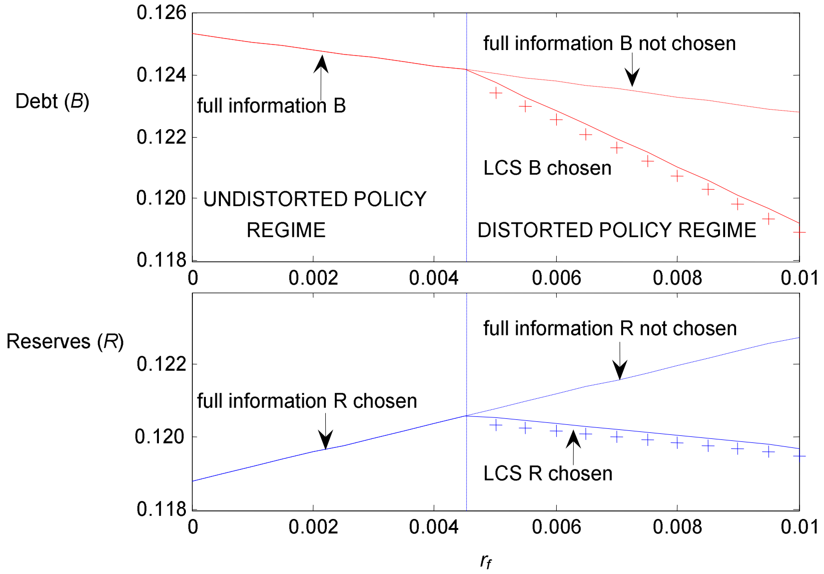
even if this is done at interest rates that reflect its true probability distribution (p) over future output. Second, the soft policymaker receives a cross-subsidization when it is treated as a tough policymaker. This cross-subsidization is higher as debt increases.

ii) An increase in reserves relaxes the constraint. This, again, is because the soft policymaker has a high discount rate, and increasing reserves translate valuable current resources to the future (without increasing cross-subsidization).

So, reductions in debt and increases in reserves can be used to meet the (IC) constraint. One would expect the tough policymaker to optimally resort to both. This is not so because of two facts:

i) A debt reduction has a more powerful effect on the constraint than an increase in reserves. By reducing debt, a soft policymaker not only loses the chance to spend current resources (which also happens by increasing reserves), but also by the mis-pricing implicit in the cross-subsidization (this

Figure 6 Debt and Reserves as a Function of r_f for Different Equilibrium Zones



$$\alpha = 0.14;\ \delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0.01;\ \rho^s = 0.02;\ Y_1 = 1;\ p = 0.42$$

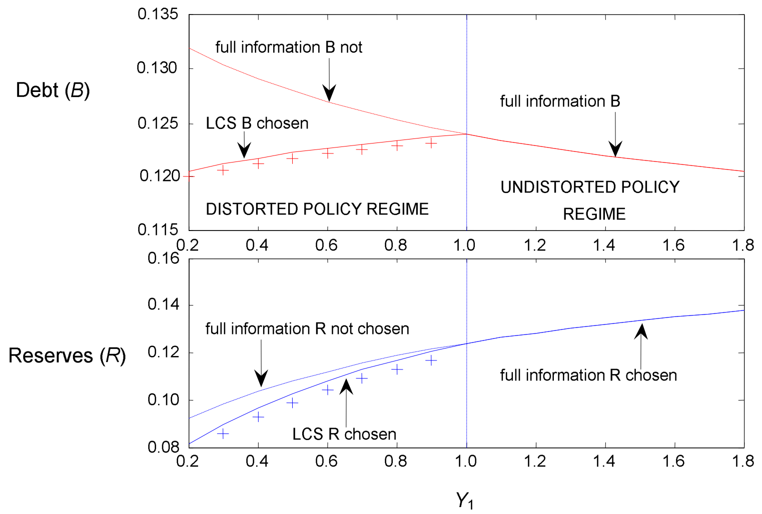
effect is not present when reserves are varied).

ii) Debt and Reserves are complements in the tough policymaker problem. So, as Debt is reduced, it is also less attractive to hold Reserves. This effect is powerful enough so that, in equilibrium (under certain regularity conditions), the tough policymaker reduces both Debt and Reserves to separate himself from the soft policymaker.

We can interpret figure 5 as showing a situation in which doubts appear about the type of policymaker in place. These doubts force him to prove that he is tough, moving him to the distorted policy curves. In this figure the parameter values selected are such that we are in the distorted equilibrium zone for the whole range of values considered for r_f. But, as we have seen above, changes in r_f or in other parameters can be the cause of moving from one type of equilibrium to another.

Figure 6 shows this fact. There, we can see that as r_f increases we move

Figure 7 Debt and Reserves as a Function of Y_1 for Different Equilibrium Zones



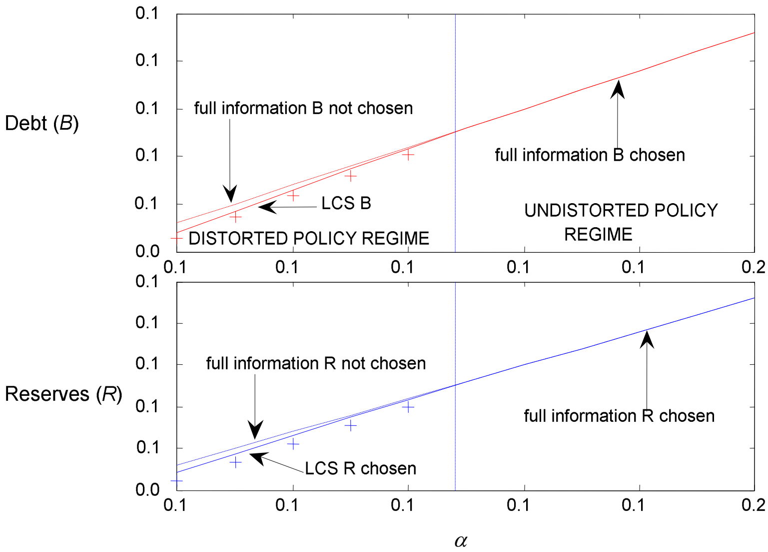
$\alpha = 0.14;\ \delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0;\ \rho^s = 0.01;\ r_f = 0;\ p = 0.443$

from the undistorted policy regime to the distorted regime. This implies that beyond a certain point, further increases in r_f are met with a sharp decrease in debt coupled with a reduction (instead of an increase) in reserves.

Figure 7 performs a similar exercise for current output. It is constructed for parameter values such that the cutoff point between the two zones is precisely a value for current output $Y_1 = 1$: for $Y_1 < 1$ we will be in the distorted equilibrium zone. This implies that, as output falls below $Y_1 = 1$, debt will decrease instead of grow — as would be predicted by the benchmark curve — and reserves will fall at a higher rate than otherwise expected. The intuition for this result is similar to the previous ones: as output falls below $Y_1 = 1$, the (IC) constraint becomes tighter, and the optimal response is to reduce both debt and reserves.

Figure 8 shows a similar pattern for α, which captures how much foreign borrowers can be sure of being repaid. Again, as α decrease we abandon the undistorted policy regime, which implies a reduction in both debt and reserves higher than predicted by the full information policy.

Figure 8 Debt and Reserves as a Function of α for Different Equilibrium Zones



$\delta = 0.2;\ G = 0.06;\ \lambda = 0.7;\ \rho = 0;\ \rho^s = 0.01;\ Y_1 = 1;\ r_f = 0;\ p = 0.44$

Let us now go back to the question of whether this is really an equilibrium. Before proving that this is indeed the case, let us mention first that the crucial point is to be sure that the tough policymaker (weakly) prefers to avoid being perceived as the soft type even though this requires distorting its benchmark policy.

Consider the tough policymaker's alternative of being perceived as soft:

Max $V^t(B,\ R, r^s)$

with $(1-p)\alpha Y_l + p(1+r^s)B = (1+r_f)B$ if $B > \alpha Y_l/(1+r_f)$; $r^s = r_f$ otherwise.

It turns out that the optimal choice for B, B^{ts}, decreases as the probability of obtaining a high output, p, decreases, because this implies an increase in the interest rate charged for any $B > \alpha Y_l/(1+r_f)$. Our assumption regarding the solution to this problem will be a sufficient (not necessary) condition for the tough policymaker to prefer not to be treated as soft.

We will assume that there exists $p^* > 0$ such that $B^{ts}(p^*) = \alpha Y_l / (1+r_f)$ (a condition satisfied in all the simulations performed above). A sufficient (but not necessary) condition for this to occur is that the tax collection marginal cost function $\Gamma'(\xi)$ is bounded.

To see this, notice that, after replacing $(1+r^s)$ from the supply curve into the objective function, the derivative with respect to *B* for $B > \alpha Y_l / (1+r_f)$ will be equal to

$$\frac{dV^t(B, R, r^s(B))}{dB} = \{1 + \Gamma'(\zeta_1)\} - \frac{(1+r_f)}{2p(1+\rho)}\{1 + \Gamma'(\zeta_h)\}.$$

This expression will eventually turn negative as we reduce *p*, provided that $\Gamma'(\zeta_1)$ is bounded.

Assume now that $p < p^M \equiv \varphi p + (1-\varphi)(1/2) < p^*$.

When this is the case, we can show the equilibrium results previously announced

Result 1: *If* $p < p^*$ *then*:

It is an equilibrium for the tough type to choose (B^{tc}, R^{tc}) *and for the soft type to choose*

$$(B^s, R^s) = \left(\frac{\alpha[(1-p)Y_l + pY_h]}{1+r_f}, 0 \right).$$

Proof: Consider the following out-of-equilibrium beliefs:

A policymaker is perceived as being tough if it chooses a pair (B, R) such that $V^s(B, R, r^t) \leq V^s(B^s, R^s, r^s)$, and is perceived as soft otherwise.

i) The soft policymaker has no incentives to deviate to any pair (*B*, *R*) with $V^s(B, R, r^t) \leq V^s(B^s, R^s, r^s)$ because even under the most favorable beliefs — leading to an interest rate r^t — its welfare would decrease. It will never deviate to any pair (B, R) with $V^s(B, R, r^t) > V^s(B^s, R^s, r^s)$ either because, given the out-of-equilibrium beliefs stated above, it would lead to the belief that it is soft, and (B^s, R^s) is the optimal policy choice among the pairs leading to that belief.

ii) Let us now turn our attention to the tough policymaker. It will not deviate to any pair (B, R) with $V^s(B, R, r^t) \leq V^s(B^s, R^s, r^s)$ because the equilibrium pair (B^{tc}, R^{tc}) maximizes its welfare precisely among the pairs (B, R) that satisfy such a condition when the interest rate r^t is charged.

Consider now a deviation in which $V^s(B, R, r^t) > V^s(B^s, R^s, r^s)$. Given the out-of-equilibrium beliefs specified above, it will be perceived as soft. Then, it cannot obtain more than (B^{ts}, R^{ts}), which is the solution to the problem

Max $V^t(B, R, r^s)$

with $(1-p)\alpha Y_l + p(1+r^s)B = (1+r_f)B$ if $B > \alpha Y_l / (1+r_f)$, $r^s = r_f$ otherwise.

Our assumption of $p < p^*$ implies that $B^{ts} = \alpha Y_l / (1+r_f)$. Thus:

a) $V^s(B^{ts}, R^{ts}, r^t) \leq V^s(B^s, R^s, r^s)$ because $V^s(B^{ts}, R^{ts}, r^t) =$ $V^s(B^{ts}, R^{ts}, r^s) < V^s(B^s, R^s, r^s)$; where the equality follows from the fact that when $B^{ts} = \alpha Y_l / (1+r_f)$ there is sure repayment and thus $r^s = r^t = r_f$, and the inequality follows from the fact that (B^s, R^s) is the optimal choice for the soft type when the interest rate r^s is applied.

b) $V^t(B^{ts}, R^{ts}, r^t) \leq V^t(B^{tc}, R^{tc}, r^t)$ since, by a), the policy choice (B^{ts}, R^{ts}) is feasible in the problem defining (B^{tc}, R^{tc}).

c) $V^t(B^{ts}, R^{ts}, r^s) = V^t(B^{ts}, R^{ts}, r^t)$, because, again, there is sure repayment for this debt level: $r^s = r^t = r_f$ when $B \leq \alpha Y_l / (1+r_f)$.

d) from b) and d), it follows that $V^t(B^{ts}, R^{ts}, r^s) \leq V^t(B^{tc}, R^{tc}, r^t)$, and the deviation is not profitable.

Result 2: *If* $p^M \equiv \varphi p + (1-\varphi)(1/2) < p^*$, *then there is no pooling equilibrium.*

Proof:

i) When $p^M < p^*$, the solution to the following problem

Max $V^t(B, R, r^M)$

with $(1-p^M)\alpha Y_l + p^M(1+r^M)B = (1+r_f)B$ if $B > \alpha Y_l/(1+r_f)$; $r^M = r_f$ otherwise,

is given by $B^M = \alpha Y_l/(1+r_f)$. That is, for a low enough value of p^M, the tough policymaker utility is maximized by choosing a debt level low enough to eliminate all cross-subsidization.

ii) Suppose that there is a pooling equilibrium (B^p, R^p) with $B^p > \alpha Y_l/(1+r_f)$. Notice that the interest rate charged in this equilibrium must be r^M as defined above. Then, $V^t(B^p, R^p, r^M) < V^t(B^M, R^M, r^M)$ by revealed preference: $(B^p, R^p) \neq (B^M, R^M)$, where (B^M, R^M) is the optimal choice for the tough policymaker when it faces the interest rate when markets perceive a probability p^M of obtaining a high output .

But, given the choice of $B^M = \alpha Y_l/(1+r_f)$, the loan will be repaid for sure and the interest rate charged will be r_f, no matter how the policymaker is perceived. We will thus have

$$V^t(B^M, R^M, r^M) = V^t(B^M, R^M, r^s).$$

Thus, the tough policymaker will find it profitable to deviate to (B^M, R^M) irrespective of the markets beliefs. So, there are no beliefs that can sustain the supposed equilibrium.

iii) Suppose that there is a pooling equilibrium (B^p, R^p) with $B^p \leq \alpha Y_l/(1+r_f)$. Now the soft policymaker will find it profitable to deviate. This is because

$$V^s(B^p, R^p, r^M) = V^s(B^p, R^p, r^s) < V^s(B^s, R^s, r^s),$$

where the equality comes from the fact that when the debt level

$B^p \leq \alpha Y_l / (1+r_f)$ is chosen, $r^M = r^s = r_f$, and the inequality comes from (B^s, R^s) (which is different from (B^p, R^p)) being the optimal choice for the soft policymaker when facing r^s.

By deviating from the debt level $B^p \leq \alpha Y_l / (1+r_f)$ to (B^s, R^s), the soft policymaker goes back to its choice of maximum debt and zero reserves while renouncing to no cross-subsidization at all.

Result 3: *The least costly separating equilibrium, in which the soft policymaker chooses* (B^s, R^s) *and the tough policymaker chooses* (B^{tc}, R^{tc}), *satisfies the intuitive criterion of Cho and Kreps. There are no other separating equilibria satisfying such criterion.*

i) In any separating equilibrium the soft policymaker chooses (B^s, R^s).

To see why, suppose to the contrary that there is a separating equilibrium in which the soft policymaker chooses $(B^{s1}, R^{s1}) \neq (B^s, R^s)$. By adhering to this equilibrium policy, the soft policymaker will be charged the interest rate r^s, since in any separating equilibrium the true type of each policymaker is revealed. If it instead deviates to its full information policy, it will be charged no more than r^s and obtain no less than $V^s(B^s, R^s, r^s)$. Since (B^s, R^s) maximizes the soft policymaker's welfare when facing r^s, $V^s(B^{s1}, R^{s1}, r^s) < V^s(B^s, R^s, r^s)$, and it will prefer to defect to its full information policy. This contradicts the assumption.

ii) Consider a separating equilibrium in which the soft policymaker chooses (B^s, R^s) and the tough policymaker chooses $(B^{t1}, R^{t1}) \neq (B^{tc}, R^{tc})$.

a) Consider first the case in which $V^s(B^{t1}, R^{t1}, r^t) > V^s(B^s, R^s, r^s)$. Then the soft policymaker will deviate to the policy (B^{t1}, R^{t1}).

b) Consider now the case in which $V^s(B^{t1}, R^{t1}, r^t) \leq V^s(B^s, R^s, r^s)$.

Suppose now that the tough policymaker deviates to (B^{tc}, R^{tc}). We can rule out that the defection was caused by the soft policymaker since (B^{tc}, R^{tc}) satisfies $V^s(B^{tc}, R^{tc}, r^t) \leq V^s(B^s, R^s, r^s)$ by construction. But, we cannot rule out that the defection was caused by the tough type, since $V^t(B^{t1}, R^{t1}, r^t) < V^t(B^{tc}, R^{tc}, r^t)$. To see this, notice that

(B^{tc}, R^{tc}) maximizes the tough policymaker's welfare when it faces the interest rate r^t among the choices (B, R) satisfying $V^s(B, R, r^t) \le V^s(B^s, R^s, r^s)$, a condition which we are now assuming (B^{t1}, R^{t1}) satisfies. Thus, according to the intuitive criterion, we should set to one the probability that the defector is the tough policymaker, which implies that the interest rate r^t will be charged and the defection will indeed take place.

iii) Let us finally see that the least costly separating equilibrium, in which the soft policymaker chooses (B^s, R^s) and the tough policymaker chooses (B^{tc}, R^{tc}), , does survive the Cho-Kreps refinement.

a) Any deviation (B, R) satisfying $V^s(B, R, r^t) \le V^s(B^s, R^s, r^s)$ will not increase the welfare of any type of policymaker, no matter what the markets believe about the defector. This is clear in the case of the soft policymaker. To see that it does not increase the welfare of the tough type, simply notice that (B^{tc}, R^{tc}) maximizes the tough policymaker's welfare when the lowest interest rate is charge among the choices satisfying precisely the condition $V^s(B, R, r^t) \le V^s(B^s, R^s, r^s)$.

b) Consider now a deviation (B, R) satisfying $V^s(B, R, r^t) > V^s(B^s, R^s, r^s)$. Since there exists a posterior probability that makes the soft type gain by deviating to (B, R), the intuitive criterion allows us to set at one the probability that the defector is the soft type. This guarantees that the tough type will not deviate, since, when charged an interest rate r^s, we have seen above that it can do no better than when choosing (B^{tc}, R^{tc}) and being charged the interest rate r^t.

3. CONCLUDING REMARKS

Our study implies that political uncertainty is a key variable impacting the association between output shocks and the patterns of debt and international reserves. Our approach can be extended to allow for output trends, where output shocks would have the interpretation of shocks to the growth rate of the economy. In these circumstances, disappointing economic growth may trigger the regime switch to the separating equilibrium. Our modeling strategy focused on explaining circumstances where the tough regime would distort its policies in order to separate itself from the soft, populist regime. Our model does not attempt to explain how tough and soft regimes come into office nor why their preferences may differ. Better understanding why populism arises in Latin America and other regions remains a challenge.[5)]

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5) Interestingly, shortly after the IMF debt repayment by Brazil described by the lead citation, Argentina following with its own version. While the Brazilian policy led to improvement in Brazil's credit rating, the opposite applies to Argentina. The Economist put it concisely, eluding to the replacement of the IMF by Chávez as the largest Argentina's creditor. *The Economist*, Dec. 20th 2005, put it succinctly:

> "The immediate effect (of Brazil debt repayment) was to rush Néstor Kirchner, Argentina's president, into an identical declaration just two days later. He said his government would repay $9.8 billion to the Fund, before the end of this month. In both cases, the motivations were similar. More telling was the difference in market reaction and policy implications…. Brazil's repayment exploits the robust balance of its international payments: reserves stand at some $67 billion. …Argentina's recent experience with the IMF has been far less happy…. But the benefits to Argentina from its declaration of financial independence are hardly clear-cut. The government was paying an interest rate of 4.2% on its loans from the Fund. It will repay the central bank partly by issuing new debt, which is likely to pay a coupon rate of around 9%.... Thanks to the strength of its recovery, Argentina can just about afford to repay the Fund. Since 2002, exports have increased by around 50% and the central bank's reserves almost tripled, to $27 billion. Even so, markets reacted unfavorably, with both the peso and bond prices falling. That reaction probably had less to do with concerns about lower currency reserves than with the uncertainties Mr Kirchner has now introduced into Argentine economic policy by casting off Mr Lavagna and the IMF in short order…. In place of the IMF, one of Argentina's largest creditors is now Hugo Chávez, Venezuela's socialist president."

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