Heterogeneity of Central Bankers and Inflationary Pressure[τ]

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Abstract

This paper investigates the role of the degree of heterogeneity of central bankers' preferences in the output-inflation tradeoff. It builds a game theoretic model of monetary policy with inflation targets not set by the monetary authority and with uncertainty about the preferences of the central banker. Under reasonable assumptions, the model shows that in countries with greater dispersion in the distribution of central bankers' preferences, as it is the case in a number of developing nations, monetary policy has to be tougher to convince society of the central banker's commitment to controlling inflation. The model also shows that inflation targets have a role in anchoring expectations even when the central banker highly values output expansions. The paper also presents empirical evidence supporting the model's results.

JEL Classification: E52, E58, C72
Key words: Inflation targeting, credibility, Central Bank heterogeneity, exogenous targets.

1. Introduction

Since March 1990, when New Zealand became the first country to formally adopt an inflation targeting regime, 24 additional countries have embraced this new approach to monetary policy.[1] Conquering highly industrialized countries such as the United Kingdom and Sweden, transition

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[1] As of 2003, when Turkey adopted inflation targeting. The inflation targeting countries and the respective year of adoption of the regime are: Australia (1994), Brazil (1999), Canada (1991), Chile (1990), Colombia (1999), the Czech Republic (1998), Finland (1993), Hungary (2002), Iceland (2001), Indonesia (2000), Israel (1992), Korea (1998), Mexico (1999), New Zealand (1990), Norway (2001), Peru (1994), The Philippines (2002), Poland (1999), South Africa (2000), Spain (1994), Sweden (1993), Switzerland (2000), Thailand (2000), Turkey (2003) and the United Kingdom (1992). See Hayashi (2003) and Kahn and Klara (1998).

economies such as Poland and Hungary, and developing countries such as Brazil and Thailand, the expansion of the inflation targeting monetary regime has been impressive.

One fundamental characteristic of this monetary regime is that inflation targets are announced in advance to society. Therefore, inflation expectations based on the announcements and credibility about the central banker's ability and willingness to deliver the publicized inflation rate play a crucial role in the workings of the system.

It has been standard in the theoretic literature to assume that inflation targets are set by the monetary authority. However, analyzing inflation targeting (IT) countries' monetary institutions, one can easily check that in most cases the central banker does not have the autonomy to set the inflation targets. Indeed, according to Mishkin and Schmidt-Hebbel (2001)'s Table 2, only 5 out of 19 IT countries allow their central bankers to independently choose the inflation targets.[2] In the United Kingdom, for instance, the target is set by the Chancellor of the Exchequer. In Poland, the target is set by the Monetary Policy Council, which consists of the President of the National Bank of Poland and nine other members appointed in equal numbers by the President of the Republic, the Sejm and the Senate of the Parliament. In Brazil, it is also the Monetary Policy Council (CMN), comprised of the Finance Minister, the Minister of Budget and Planning and the Central Bank's governor, which decides on inflation targets.

In some of these cases, the monetary authority has exerted the greatest influence in the process of deciding the target. However, there is evidence that the other parties also play a role in the process, especially in times of political turmoil. The mere existence of an institutional framework that enforces mutual understanding among potentially conflicting members of the

[2] In fact, that study appoints Poland as a country in which the Central Bank sets the target independently, which is not formally the case according to Horská, 2001. Therefore, the study appoints 6 rather than 5 countries with Central Bank's goal autonomy. Moreover, only 7 out of the 25 countries listed in footnote 1 allow their central bankers to independently set the inflation targets.

government implies that the standard assumption that central bankers set inflation targets may leave behind important dynamics in monetary policy models. In order to better understand the monetary equilibrium when the central banker does not set inflation targets, the present study extends the models of Vickers (1986) and Cukierman and Liviatan (1991) by introducing exogenously determined inflation targets and not requiring that any type of central banker achieve the exact target. These assumptions allow us to analyze the importance of inflation targets and credibility to the formation of inflation expectations when society has imperfect information about the central banker's characteristics.

The most important result of the model is that, under reasonable assumptions about the discount factor ($\delta \geq 1/2$), a higher dispersion in central bankers' preferences causes a strong-type central banker to be tougher on its delivered inflation rates so as to signal his type to society. In other words, in countries where different types of central bankers have very distinct preferences for monetary policy, disinflation policies will be costlier. If one believes that developing countries tend to be more heterogeneous, then the model explains why strong central bankers in those countries need to adopt very tight monetary policies in order to maintain credibility, as it seems to be the case, for instance, in recent Brazilian monetary policy history.

The model also shows that the exogenous inflation targets and target ranges have a role in anchoring expectations even when the central banker has greater preference for output expansion. Expectations will typically be higher than the center of the target, but the upper target range has an important role to build on credibility.

The role of inflation expectations in short-run output variations has been widely studied since the seminal works of Kydland and Prescott (1977) and Barro and Gordon (1983a,b). With the advent of the economics of information, several models have analyzed the effects of

asymmetric information on the outcome of the monetary policy game played between the central bank and society.

Canzoneri (1985) presents an infinite repeated game between society and a central bank. At each period *t*, society first sets inflation expectations, and the central banker next chooses inflation. However, realized real inflation in period *t* is affected by a stochastic component to money demand $\delta_t = e_t + \varepsilon_t$. The model focuses on *imperfect* asymmetric information on δ_t: the central banker observes e_t before choosing inflation but society only observes δ_t at the end of the period. Because society does not distinguish between e_t and ε_t, the central banker can create unexpected inflation and attribute it to the unexpected shock ε_t. The solution to the model follows Green and Porter (1984) and finds a trigger strategy equilibrium in which society sets an inflation threshold so that, if realized inflation is below that threshold society expects the Pareto-superior low inflation, but if realized inflation is above that threshold society expects the higher Nash inflation for a punishment period. The model explains periods of high inflation and low employment (stagflation) triggered by the stochastic component of money demand, rather than by the traditional time inconsistency incentives.

Backus and Driffill (1985) focus on *incomplete* asymmetric information about the type of the central banker, who could be *wet* or *hard-nosed*. A *wet* central banker cares both about controlling inflation and employment whereas a *hard-nosed* central banker only cares about controlling inflation. The paper considers a finite horizon game between society –who sets inflation expectations– and the central banker –who chooses inflation– and finds a mixed-strategy partially-pooling equilibrium in which the *wet* central banker mimics the *hard-nosed* one with positive probability. In their models inflation may be lower than expected in the initial periods of the game and higher in the final period.

Vickers (1986) presents a more general game where all types of central banker care both about low inflation and high employment, but they have different relative preferences for inflation and unemployment. The paper focuses on a signaling, separating equilibrium in which the central banker who most values employment (*wet*) is not able mimic the central banker who most values low inflation (*dry*). The game consists of two periods and in equilibrium there will be a recession in the first period if the central banker is *dry* and there will expansion if he is *wet.* Moreover, there will be no surprises in the last period, as all relevant information becomes public in equilibrium. In that paper, as well as in Backus and Driffill (1985), the central banker cannot commit to an announced target. Therefore, there are no explicit inflation targets.

Cukierman and Liviatan (1991) extend Vickers's model by letting the central banker announce inflation targets before society sets its inflation expectations, in a two period setup. In their model, a *strong* central banker will always achieve the exact announced inflation target, whereas a *weak* one may deviate from the announced target. Walsh (2001) and Bugarin and Carvalho (2005) analyze the monetary equilibria of an extension of Cukierman and Liviatan's setup to an infinite game where a central banker has a fixed two-period nonrenewable term of office.

Cukierman and Liviatan (1991), Walsh (2001) and Bugarin and Carvalho (2005) allow for announcements of inflation targets, with the assumptions that the announcement is a *strategic* variable chosen by the central banker and that the *strong* central banker always delivers on his announced target.

In light of that, the novelty of this paper is to consider exogenous inflation targets in a game theoretic set-up to explicitly analyze the role of credibility in inflation targets and the role of heterogeneity in the inflation-output tradeoff. Another novelty is the use of Cho and Kreps (1987) intuitive equilibrium refinement in monetary policy games.

The paper is organized as follows. Section 2 builds the theoretical model of credibility of an inflation-targeting monetary policy and finds its equilibria. Section 3 discusses the model's implications. Section 4 applies the model to analyze the recent Brazilian monetary policy history. Section 5 presents empirical evidence that conforms to the models' predictions. Finally, the last section concludes the paper.

2. A model of credibility and inflation expectations formation with exogenous inflation targets

Let us first set a central banker's standard utility function at time *t* as:[3]

$$v\left(\pi_t, \overline{\pi}_t, \pi_t^e\right) = -\frac{1}{2}\left(\pi_t - \overline{\pi}_t\right)^2 + \lambda\left(\pi_t - \pi_t^e\right) \qquad (1)$$

where π_t is the inflation rate at time *t* set by the central banker, $\overline{\pi}_t$ is the inflation target for time *t* that is exogenously set by the government, and π_t^e is market inflation expectation for time *t.*

The parameter $\lambda \geq 0$ reflects the importance the central banker attributes to output expansion above trend levels, which is simplified in this model as the (positive) inflationary surprise, relative to the importance he attributes to reaching the inflation target.

The first term on the right represents the (possibly political) cost the central banker incurs by not achieving the target. In inflation targeting regimes the farther away realized inflation is from the target, the stronger the social reaction to central banker's policies. In certain countries

[3] This is the simplest way to introduce the traditional trade-off between inflation and growth and follows the seminal articles by Vickers (1986) and Cukierman and Liviatan (1991). For a more detailed derivation of such a reduced form see, for example, Walsh (2000).

this could even lead to appointing a new central banker.[4] Inflation targeting countries usually adopt target bands that are symmetric around the center of the target. Assuming a cost function that is quadratic in the deviation of inflation from the target might be a suitable simplification to the common inflation targeting design.

With only one type of central banker and targets exogenously set, the model will predict an inflation bias. First order conditions yield $\pi_t = \overline{\pi}_t + \lambda$, which means that the central banker will always inflate above target levels. Assuming that expectations are rational, in this one-period game agents will anticipate the inflationary bias and thus no inflation surprises will arise, as $\pi_t^e = \overline{\pi}_t + \lambda = \pi_t$.

Let us now allow for two possible types of central bankers, μ and λ, $\mu \geq \lambda$, who differ as to the relative importance each one privately attributes to output growth with respect to inflation stabilization. Therefore, a central banker that attributes weight λ to output expansion cares relatively more about reaching the exogenous target than the central banker that attributes weight μ, who cares relatively more about generating inflationary surprise. The λ-type central banker of is said to be *strong*, whereas the μ-type is said to be *weak*.

In a one period game, inflation set by the strong type is $\pi_t^S = \overline{\pi}_t + \lambda$, whereas the weak type's is $\pi_t^W = \overline{\pi}_t + \mu$. If society believes that the incumbent is of a strong type with probability ρ, inflation expectations will be a weighted average of inflation rates chosen by the strong and the weak type: $\pi_t^e = \rho\pi_t^S + (1-\rho)\pi_t^W = \overline{\pi}_t + \rho\lambda + (1-\rho)\mu$.

This simple analysis allows us to draw the following preliminary conclusions. If central bankers cannot pre-commit to an inflation target, and if this target is exogenously set, then

[4] See New Zealand's institutional framework in Walsh (1995).

inflation expectations will be biased upwards from the target. Realized inflation will also exceed the target, even if the central banker is of a strong type. Of course, the weaker the central banker is, the higher the deviation of realized inflation from targets. However, as expected inflation is an average of inflation rates optimally chosen by a weak and a strong central banker, realized inflation under a strong type will be lower than the one expected by society.

Note that inflation targets, in spite of not being fulfilled, have a very important role in this model. As realized inflation is directly related to them, targets guide inflation expectations, thus working as a nominal anchor to the economy. This is the main feature of the inflation targeting regime.

Plugging in realized and expected inflation into strong- and weak-type central bankers' utilities yields respectively $v_t^S = -\frac{1}{2}\lambda^2 - \lambda(1-\rho)(\mu-\lambda)$ and $v_t^W = -\frac{1}{2}\mu^2 + \rho(\mu-\lambda)\mu$. Notice that both types gain with higher credibility in the central banker, which is modeled here as the parameter ρ, i.e., the higher ρ, the more society believes that the central banker is strong. Indeed, if society attributes a higher probability that the central banker is strong, a strong type benefits from the reduction in society's "pessimism", and the model predicts lower inflation expectations and weaker recession. Moreover, the weak-type central banker benefits from higher inflationary surprise.

Let us now allow for a two-period game between society and the central banker. Let the central banker be chosen at random at the beginning of period 1, according to the distribution (ρ, $1-\rho$), for a two-period term. A time invariant inflation target is concomitantly set by the Executive branch or the Congress for periods 1 and 2: $\bar{\pi}_1 = \bar{\pi}_2 = \bar{\pi}$. As before, the central banker may be either weak or strong, and this is his private information. Society will thus form expectations based on its belief on the type of the central banker. After expectations have been

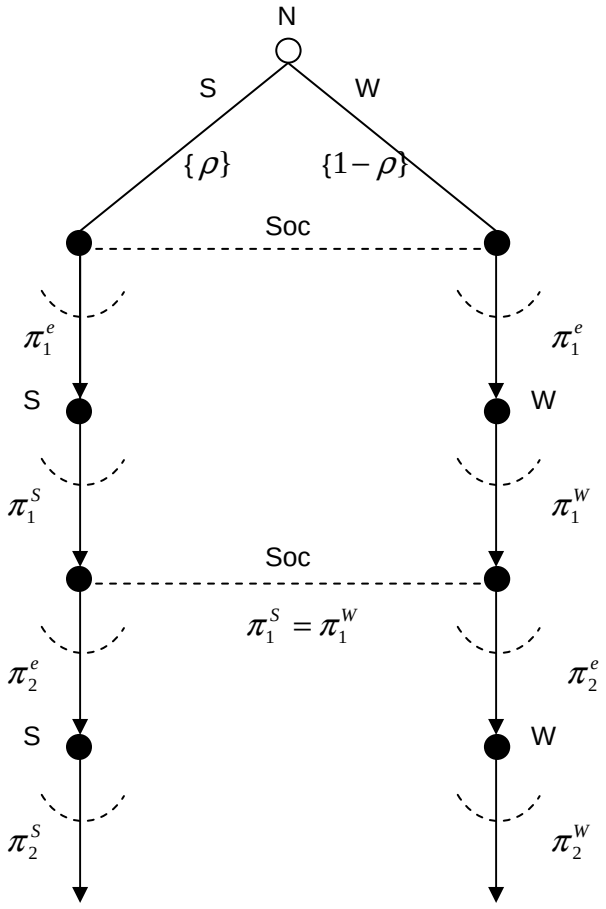
formed, the central banker sets the inflation rate for period 1. By observing realized inflation, society updates its belief about the type of the central banker and forms inflation expectations for period 2. After expectations have been formed, the central banker sets inflation for the second period and the game finishes. Society's payoff is a direct measure of the accuracy of its inflation expectations.

Figure 1 depicts the extensive form of the game. The stochastic determination of the central banker's type (S: strong, W: weak) is modeled by the use of nature (N) in the top decision node. The dotted straight lines represent information sets for society (Soc). The top dotted straight line indicates that society does not know the central banker's type when setting inflation expectations in period 1. The one on the bottom indicates that if both central bankers' types choose the same inflation in period 1 in equilibrium, society cannot identify their types. The curved dotted lines indicate that the central banker (respectively society) has infinitely many possible choices for inflation (respectively, for inflation expectations), only one of which is represented in the game tree.

2.1 – Separating Equilibrium

In the separating perfect Bayesian equilibrium, the weak central banker will reveal his type to society at the end of the first period. Therefore, he will choose to inflate at its optimal rate in every period. Inflation surprises will thus occur only in the first period of the game. In this equilibrium, realized inflation in periods 1 and 2 under a weak type central banker will be $\pi_1^W = \pi_2^W = \overline{\pi} + \mu$.

Figure 1: The extensive form game



$$\begin{pmatrix} -\left(\pi_1^S-\pi_1^e\right)^2-\delta\left(\pi_2^S-\pi_2^e\right)^2 \\ -\frac{1}{2}\left(\pi_1^S-\overline{\pi}\right)^2+\lambda\left(\pi_1^S-\pi_1^e\right)+ \\ +\delta\left[-\frac{1}{2}\left(\pi_2^S-\overline{\pi}\right)^2+\lambda\left(\pi_2^S-\pi_2^e\right)\right] \end{pmatrix} \quad \begin{pmatrix} -\left(\pi_1^W-\pi_1^e\right)^2-\delta\left(\pi_2^W-\pi_2^e\right)^2 \\ -\frac{1}{2}\left(\pi_1^W-\overline{\pi}\right)^2+\mu\left(\pi_1^W-\pi_1^e\right)+ \\ +\delta\left[-\frac{1}{2}\left(\pi_2^W-\overline{\pi}\right)^2+\mu\left(\pi_2^W-\pi_2^e\right)\right] \end{pmatrix}$$

On the other hand, a strong central banker may have incentives to deviate from its optimal complete information rate if this is necessary to induce the weak central banker not to mimic his

chosen inflation. Let π_1^S be the inflation chosen by the strong central banker in period 1. Then, the consistent beliefs society holds in period 2, π_2^e, are the following: if the realized inflation in period 1 is lower or equal to π_1^S, then the central banker is strong; if it is above π_1^S, then the central banker is weak. Moreover, society's expected inflation in period 1 is $\pi_1^e = \rho\pi_1^S + (1-\rho)(\bar{\pi} + \mu)$.

In order for the weak central banker not to mimic *S*'s choice, it must be the case that choosing his preferred inflation rate $\pi_1^W = \bar{\pi} + \mu$ and revealing his type to society yields a higher utility than choosing π_1^S, inducing society to believe he is strong, and gaining from the inflationary surprise at period 2. This will be the case if and only if the following condition holds:

$$\pi_1^S \leq \bar{\pi} + \mu - (2\delta\mu(\mu - \lambda))^{\frac{1}{2}} \tag{2}$$

Furthermore, any deviation from his optimal complete information policy is costly to the strong central banker. Therefore, he must be better off choosing π_1^S than if he chooses the higher inflation $\bar{\pi} + \lambda$ and lets society conclude that he is a weak central banker. This will be the case if and only if the condition below is satisfied.

$$\pi_1^S \geq \bar{\pi} + \lambda - (2\delta\lambda(\mu - \lambda))^{\frac{1}{2}} \tag{3}$$

It is straightforward to check that $\bar{\pi} + \lambda - (2\delta\lambda(\mu - \lambda))^{\frac{1}{2}} \leq \bar{\pi} + \mu - (2\delta\mu(\mu - \lambda))^{\frac{1}{2}}$. Therefore there is a range of values for π_1^S compatible with a separating perfect Bayesian

equilibrium. Note now that $\bar{\pi}+\lambda \leq \bar{\pi}+\mu-(2\delta\mu(\mu-\lambda))^{\frac{1}{2}}$ if and only if $\frac{\lambda}{\mu} \leq 1-2\delta$. Therefore, if $\frac{\lambda}{\mu} \leq 1-2\delta$, then only the inflation rates $\pi_1^S \in \left[\bar{\pi}+\lambda-(2\delta\lambda(\mu-\lambda))^{\frac{1}{2}}, \bar{\pi}+\lambda\right]$ belong to a perfect Bayesian equilibrium.[5] However, only the optimal inflation $\pi_1^S = \bar{\pi}+\lambda$ satisfies the intuitive criterion.[6] This corresponds to the case where the strong type can signal his type without any costly deviation from his complete information choice.

On the other hand, if $\frac{\lambda}{\mu} > 1-2\delta$, then $\bar{\pi}+\mu-(2\delta\mu(\mu-\lambda))^{\frac{1}{2}} < \bar{\pi}+\lambda$ and any perfect Bayesian equilibrium will require an inflation rate below the strong type's preferred policy. In that case, every inflation rate $\pi_1^S \in \left[\bar{\pi}+\lambda-(2\delta\lambda(\mu-\lambda))^{\frac{1}{2}}, \bar{\pi}+\mu-(2\delta\mu(\mu-\lambda))^{\frac{1}{2}}\right]$ belongs to a perfect Bayesian equilibrium. However, only the choice $\pi_1^S = \bar{\pi}+\mu-(2\delta\mu(\mu-\lambda))^{\frac{1}{2}}$ satisfies the intuitive criterion[7].

Note that $\bar{\pi} > \bar{\pi}+\mu-(2\delta\mu(\mu-\lambda))^{\frac{1}{2}} = \pi_1^S$ if and only if $\frac{\lambda}{\mu} < \frac{2\delta-1}{2\delta}$. Therefore, if $\frac{\lambda}{\mu} > \frac{2\delta-1}{2\delta}$, then $\pi_1^S > \bar{\pi}$, i.e., the inflation level chosen by a strong central banker, although below his preferred level $(\bar{\pi}+\lambda)$, will still be above the target. On the other hand, if $\frac{\lambda}{\mu} < \frac{2\delta-1}{2\delta}$,

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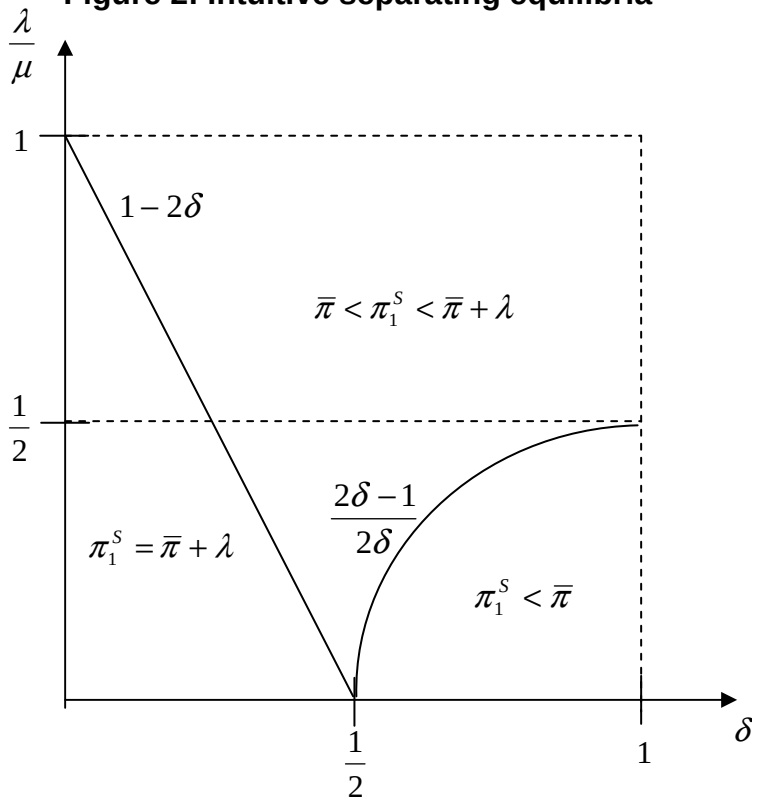
[5] Since for any $\pi_1^S \in \left(\bar{\pi}+\lambda, \bar{\pi}+\mu-(2\delta\mu(\mu-\lambda))^{\frac{1}{2}}\right]$ the strong central banker would prefer to choose his optimal complete information inflation $\bar{\pi}+\lambda$ which would also signal his type.

[6] Consider any other choice in the interval $\left[\bar{\pi}+\lambda-(2\delta\lambda(\mu-\lambda))^{\frac{1}{2}}, \bar{\pi}+\lambda\right)$. Then, choosing an inflation level closer to the right hand side of the interval, and convincing society that he is strong, increases the strong central banker's utility. On the other hand, the weak central banker still prefers not to mimic the strong type's policy. For a detailed exposition on the intuitive criterion see Cho & Kreps (1987).

[7] The argument is the same presented in the previous footnote.

then $\pi_1^S < \bar{\pi}$, i.e., in order to signal his type the strong central banker will keep inflation below the target $\bar{\pi}$. Figure 2 summarizes the present analysis.

Figure 2: Intuitive separating equilibria



Note that one can interpret the size of the ratio $\frac{\lambda}{\mu}$ as the level of homogeneity of a society. Indeed, if λ is very close to μ, so that the quotient is close to one, there is not much divergence in the way different types of central bankers value output relatively to achieving the inflation target. This corresponds to the upper right corner of the figure when the discount factor δ is high enough (bigger than 0.5). Conversely, if μ is much bigger than λ, then different types of central bankers diverge strongly and society is heterogeneous. This last case corresponds to the lower right corner of Figure 2.

If one believes that developing economies tend to be more heterogeneous due to the strong political struggle between different sectors of society, then the present model suggests that a strong central banker needs to adopt a much more conservative monetary policy in developing countries, in order to convince society that he really is strong.

2.2 – Pooling Equilibrium

In the pooling equilibrium the weak central banker will mimic the strong type in the first period of the game. As society will observe a first-period rate of inflation that does not allow it to infer which type of central banker is in office, expectations for the second period will be a weighted average of likely inflation rates: $\pi_2^e = \rho\pi_2^S + (1-\rho)\pi_2^W = \bar{\pi} + \rho\lambda + (1-\rho)\mu$. Let π_1^P be inflation chosen by both types of central bankers in period 1. Then, society will anticipate that actual inflation rate and set: $\pi_1^e = \pi_1^S = \pi_1^W = \pi_1^P$. The consistent beliefs in period 2 are as follows: if the realized inflation in period 1 is lower than or equal to π_1^P, then there is no updating in beliefs, i.e., society still believes that the central banker is strong with the same probability ρ; if it is above π_1^P, then society concludes the central banker is weak. Given these beliefs, there cannot be a pooling equilibrium with $\pi_1^P > \bar{\pi} + \lambda$, as the strong central banker would prefer to choose $\pi_1^S = \bar{\pi} + \lambda$. Therefore, it must be the case that $\pi_1^P \leq \bar{\pi} + \lambda$.

In a pooling equilibrium, the strong central banker will choose π_1^P as long as this gives him a higher utility than selecting his preferred policy $\bar{\pi} + \lambda$ and allowing society to believe that he is weak. This will be the case if and only if the condition below is satisfied:

$$\pi_1^P \geq \bar{\pi} + \lambda - \left(2\delta\lambda\rho(\mu - \lambda)\right)^{\frac{1}{2}} \qquad (4)$$

Similarly, the weak type central banker will choose not to deviate from the pooling equilibrium if the utility he attains in mimicking the strong type in the first period is higher than the utility he would derive if he inflated at his optimal discretionary rate in the first period, and thus revealed its type. This will be the case if and only if the condition below is satisfied:

$$\pi_1^P \geq \overline{\pi} + \mu - (2\delta\mu\rho(\mu - \lambda))^{\frac{1}{2}} \tag{5}$$

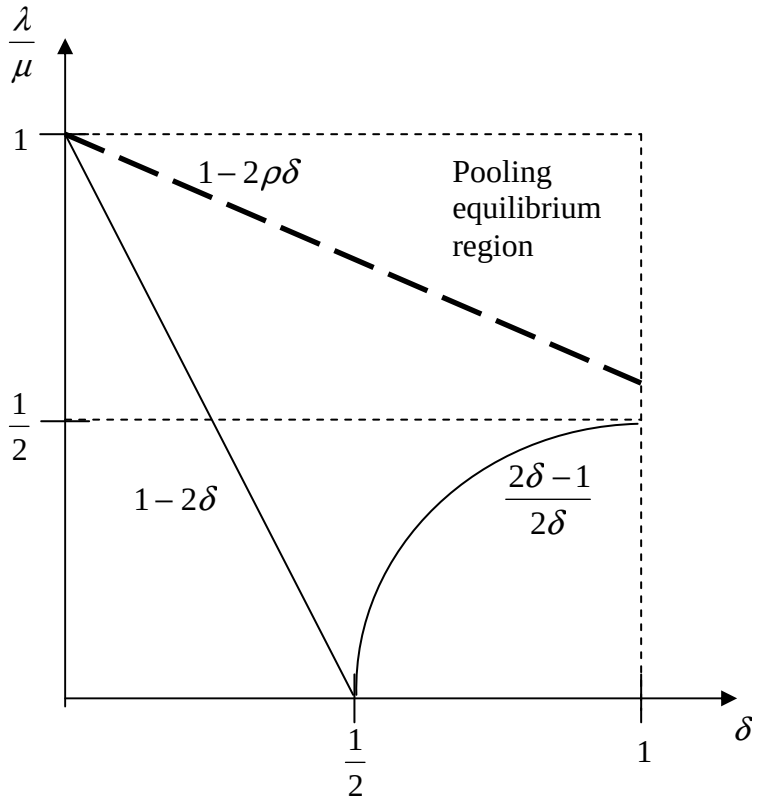
It is immediate to check that $\overline{\pi} + \lambda - (2\delta\lambda\rho(\mu - \lambda))^{\frac{1}{2}} \leq \overline{\pi} + \mu - (2\delta\mu\rho(\mu - \lambda))^{\frac{1}{2}}$. Therefore, both conditions (4) and (5) will be satisfied if and only if $\pi_1^P \geq \overline{\pi} + \mu - (2\delta\mu\rho(\mu - \lambda))^{\frac{1}{2}}$. Furthermore, one must have $\pi_1^P \leq \overline{\pi} + \lambda$. But $\overline{\pi} + \lambda \geq \overline{\pi} + \mu - (2\delta\mu\rho(\mu - \lambda))^{\frac{1}{2}}$ if and only if $\frac{\lambda}{\mu} \geq 1 - 2\delta\rho$.

Thus, if $\frac{\lambda}{\mu} < 1 - 2\delta\rho$ there will be no pooling equilibrium. On the other hand, if $\frac{\lambda}{\mu} \geq 1 - 2\delta\rho$, then any inflation level $\pi_1^P \in \left[\overline{\pi} + \mu - (2\delta\mu\rho(\mu - \lambda))^{\frac{1}{2}}, \overline{\pi} + \lambda\right]$ corresponds to a perfect Bayesian pooling equilibrium.

Pooling will be more likely to occur if the difference between the weak and the strong types is not pronounced (μ close to λ, which, according to the previous discussion, corresponds to a more homogeneous society), the weak type significantly values the future (δ very high, close to 1), and credibility is high (society expects the central banker is of type λ with high probability,

i.e., ρ is high). Figure 3 adds to Figure 2 the bold dotted line $\frac{\lambda}{\mu} = 1 - 2\rho\delta$ (with ρ<1/4); the region above that dotted line corresponds to the model's pooling equilibria.

Figure 3: Pooling equilibrium region



3. Model implications

This model makes explicit the role of "social stability" for the type of equilibrium that results. In a stable society the possible types of central bankers will not differ significantly among each other. As such, the $\frac{\lambda}{\mu}$ ratio will be close to 1, which induces either a pooling equilibrium or a separating equilibrium with low deviation from society's expectations, i.e., low recession cost

when a strong central banker wants to signal his type. The latter corresponds to the equilibria in the upper right corner of Figure 2. On the other hand, in unstable countries, which exhibit a high turnover of very distinct political parties in power, there will be higher heterogeneity of central bankers' types. This heterogeneity will induce a separating equilibrium in which the strong central banker needs to impose high recession costs to society in order to signal his type. This corresponds to the equilibria in the lower right corner of Figure 2.

That discussion brings about the issue of independence of the monetary authority and staggered terms for the Executive incumbent and the Central Bank's governor. Central Bank autonomy *per se* does not induce a reduction in heterogeneity of central bankers' types. However, with a fragile institutional framework, the perspective of a change in political parties in power may enact an undesirable update of society's priors on the type of the next central banker. As the model showed, if society attributes a higher chance for the next central banker to be weak, inflation expectations will be higher, and should the real central banker be strong, there will be important recession costs to the economy. If the terms of the Central Bank and the Executive branch do not coincide, then the change of party in the Executive will not induce an immediate change in the Central Bank governor's type; therefore, monetary policy and society's beliefs will be more stable during the transition to a new government.

Another important implication of the model is that forecasters recognize that the Central Bank will not reach the center of the target ($\bar{\pi}$) in the low deviation separating equilibria (upper right corner in Figure 2), even if the central banker attributes a higher relative importance to the variance of inflation around the targets. Therefore, credibility in this model should be interpreted as the likelihood that the central banker is strong in controlling inflation and not as the ability of the central banker to reach the center of the inflation target. In that regard, as we have shown, the higher the credibility of the central banker, the lower are inflation expectations.

If the center of inflation targets is usually not attained, then why should the government set an inflation target? As we have shown, the target directly affects central banker's optimal choice of inflation. As such, it signals the future path of inflation to society. Therefore, this model confirms the "signaling" role of the inflation-targeting regime.

If the authority that sets the target wishes, for instance, to reduce equilibrium inflation, it shall act strategically by setting a low target. In order to induce an average inflation of $\hat{\pi}_2$ in period 2, for instance, it should set a target $\bar{\pi} = \hat{\pi}_2 - (\rho\lambda + (1-\rho)\mu)$.

In addition, as there is usually a political cost associated with not achieving the targets, the authority that sets the targets shall reduce this cost by defining an inflation target range around the center $\bar{\pi}$. If the target range is $(\bar{\pi} - \varepsilon, \bar{\pi} + \varepsilon)$, such that $\varepsilon \in [\lambda, \mu)$, then the target band will always be attained in the first period of the pooling equilibrium by any type of central banker and will always be achieved in the other equilibria should the central banker be strong. Note that if the political cost associated with the failure in achieving the targets is sufficiently high or if ex-ante credibility of the Central Bank is low, it may be optimal for the authority setting the targets to choose a wider range. Notwithstanding, this enlargement of the range could come with some utility loss because of the lack of accuracy of the monetary policy.

4. An application to Brazilian presidential elections

Carvalho and Bugarin (2006) compare the formation rule of inflation expectations in three Latin American countries: Brazil, Chile and Mexico. The study finds that in the particular case of Brazil, for some time in 2002 and 2003, inflation targets ceased to be an anchor to inflation forecasts. The misalignment of inflation forecasts may have stemmed from a number of sources, domestic and external. However, as external shocks were common to the two other countries

investigated, it seems plausible to argue that domestic imbalances played a more important role for the weakening of credibility in inflation targets in Brazil.

The strong misalignment of inflation forecasts coincided with the victory of a left-wing candidate, Luis Inacio Lula da Silva, in the country's presidential elections. As the Central Bank of Brazil has not been granted formal autonomy, and a new central banker was to be appointed by the new president, there appeared to be high uncertainty regarding the future conduct of macroeconomic policy and, in particular, of the recently implemented inflation targeting regime.

The behavior of inflation forecasts was a signal of what was yet to come. In the first quarters of 2003, there was evidence that the inertial component of inflation in Brazil had actually increased. Monetary policy was further tightened to assure the convergence of consumer price inflation to the targets. The tightening of monetary policy resulted in stagnation of the real output growth in 2003. It was only after June 2003 that inflation forecasts were again aligned to the targets, and the country resumed its growth path.

Brazilian society has shown a diversity of opinions about how domestic monetary policy should be conducted. There is indeed an important debate on inflation control versus growth. In Brazilian politics, this debate opposes "orthodoxists" to "developmentists". In the language of the present model, it appears that the Brazilian society expected significant differences in the conduct of monetary policy by different types of potential central bankers (large value for $\lambda-\mu$). The new government meant a new central banker and society expected it to be *weak* with high probability (small value for ρ) due to the fact that a left wing president was elected, in spite of president Lula's continued assurance that he would maintain the same monetary policy as its predecessor. Although monetary policy proved that the appointed central banker was tough on inflation, due both to the huge difference between possible weak and strong central banker preferences in Brazil

(the size of $\lambda-\mu$) and the low probability of a strong central banker (small ρ), the incumbent was forced into an excessively tight monetary policy in order to signal his type in a separating equilibrium. As a consequence, the country witnessed stagnation in the first year of president Lula's term. By the second year, however, the reputation of the central bank was well established, as his type was revealed to society, and the country experienced a high growth rate of about 5% of GDP.

5. Empirical Evidence

In this section we test whether some of the model's implications have empirical support. More explicitly, we test whether the degree of heterogeneity of central bankers' preferences affect inflation-output choices.

Heterogeneity of central bankers' preferences within a certain society is a variable that cannot be explicitly observed. We thus need to make a few assumptions. We hypothesize that the set of central bankers' preference distributions is representative of that of the entire society. Society's preferences are not an observable variable either. However, partisan composition in Congress, which is directly observable, could be thought of as the materialization of citizens' preferences for some policies, including the output-inflation tradeoff.

Heterogeneity of partisan preferences could be measured in a number of different ways. We chose a very straightforward one: a Herfindahl-Hirschman political Index (HHI) for the number of seats occupied by each party in the House of Representatives. The HHI is defined as the sum of the squares of the market shares of each individual firm in the industry, and has traditionally been used to measure the degree of competition in the industry.

To our purposes, for each country *j* in the chosen sample we calculate the HHI for every election date *t* as follows:

$$HHI_{j,t} = \sum_{i=1}^{N} s_{i,j,t}^2$$

In the previous expression, s_i is the share of seats occupied by party i, $i = [1,2,...,N]$, in the House of Representatives. A higher HHI can thus be interpreted as greater homogeneity in society's preference, whereas a low HHI represents greater heterogeneity in society.

The sample of countries is composed of Brazil, Mexico, Israel, UK, USA, Australia, and New Zealand. We consider party composition upon elections that took place in each of these countries within the 1980-2006 period.

We ran POLS regressions of the HHI on leads of yearly consumer price inflation and output gap, calculated using the HP-filter to detrend the output series. We used controllers in the regressions. For the lead of the output gap, we controlled for possible inertia by including the lag of the output gap or the GDP growth of the very country and of the world. For the lead of inflation, we controlled for inertia through the lag of the output gap.

A note here is in order. We avoided the use of lags of inflation as controlling variables because in many of the countries investigated, inflation may have been determinant to election results. The same is likely not true for the lag of the output gap for at least two reasons: 1) the output gap in a certain date can only be calculated with a large delay, as data on GDP growth is not as frequent and contemporaneous as data on inflation; and 2) in several of these countries, there is high uncertainty regarding the accuracy of GDP data. In addition, we did not run regressions on the first lead of the output gap because of the most likely interference of prior-to-election scenario on decisions that directly affect that variable.

Regression results are reported in Table 1. From all regressions, we find evidence that more heterogeneous societies imply more constrained GDP growth and higher inflation. The output-inflation tradeoff is thus more favorable in societies that have achieved higher homogeneity in their political preferences.

Table 1: The Effect of Partisan Composition in the House of Representatives in the Output-Inflation Tradeoff

Second lead of GDP	Coef.	*t*	P>|t|	[95% Conf.	Interval]
HHI	4.70	2.26	0.029	0.50	8.90
1st lag of GDP	-0.20	-1.3	0.202	-0.52	0.11
1st lag of World GDP	-0.51	-1.36	0.182	-1.28	0.25
Constant	3.16	2.41	0.02	0.52	5.79

N of obs	46
F(3, 42)	4.24
Prob > F	0.011
R-squared	0.233
Adj R2	0.178
Root MSE	1.836

Second lead of output gap	Coef.	*t*	P>|t|	[95% Conf.	Interval]
HHI	1.86	0.6	0.552	-4.40	8.13
1st lag of output gap	0.14	0.96	0.344	-0.15	0.42
1st lag of world output gap	-0.14	-2.75	0.009	-0.24	-0.04
Constant	-1.44	-1.08	0.288	-4.15	1.27

N of obs	46
F(3, 42)	2.76
Prob > F	0.054
R-squared	0.165
Adj R2	0.105
Root MSE	2.757

First lead of inflation	Coef.	*t*	P>|t|	[95% Conf.	Interval]
HHI	-481.69	-2.5	0.016	-869.75	-93.62
1st lag of output gap	27.27	2.78	0.008	7.54	47.00
Constant	252.14	3.13	0.003	90.17	414.11

N of obs	49
F(2, 46)	7.58
Prob > F	0.001
R-squared	0.248
Adj R2	0.215
Root MSE	190.460

Second lead of inflation	Coef.	*t*	P>|t|	[95% Conf.	Interval]
hhi	-1288.15	-2.92	0.006	-2177.31	-398.99
1st lag of output gap	58.74	2.86	0.006	17.37	100.10
Constant	658.63	3.49	0.001	278.37	1038.88

N of obs	46
F(2, 43)	8.93
Prob > F	0.001
R-squared	0.294
Adj R2	0.261
Root MSE	397.670

Source: IMF, Wikipedia

6. Conclusion

This paper extended a theoretical model of credibility to investigate the role of uncertainty regarding the type of a central banker on optimal monetary policy and formation of inflation expectations, in an environment where inflation targets are exogenously set by a government agency that is not the Central Bank.

The model shows that "social stability" has important implications for monetary policy. Under reasonable values of the discount factor ($\delta \geq 1/2$), in more heterogeneous societies, monetary policy has to be more restrictive so as to build on credibility. On the other hand, in more homogeneous societies, the very presence of an inflationary bias will not be grounds for such a restrictive monetary policy. If one believes that developing countries tend to be more heterogeneous, then the model explains why strong central bankers in those countries need to adopt very tight monetary policies in order to maintain credibility, as it seems to be the case in the recent Brazilian monetary policy history.

The model also shows that even when the center of a target range is hardly ever achieved, this center target has an important role in guiding inflation expectations. Therefore, the authority that sets the target has a strategic opportunity to choose target ranges that take into account the positive inflation bias that may exist even under a central banker that attributes a high relative weight to inflation stabilization.

Empirical evidence from a cross-section of countries conforms to the model's prediction that more heterogeneous societies imply more constrained GDP growth and higher inflation. The output-inflation tradeoff was found to be more favorable in societies that have achieved higher homogeneity in their political preferences.

References

Backus, D. and J. Driffill, 1985, Inflation and Reputation, *The American Economic Review* 75, 530–8.

Barro, R. and D. Gordon, 1983a, Rules, Discretion and Reputation in a Model of Monetary Policy, *Journal of Monetary Economics* 12, 101-21.

Barro, R. and D. Gordon, 1983b, A Positive Theory of Monetary Policy in a Natural Rate Model, *Journal of Political Economy* 91, 589-610.

Bugarin, M. and F. Carvalho, 2005, Comment on "Market Discipline and Monetary Policy" by Carl Walsh, *Oxford Economic Papers* 57, 732-739.

Canzoneri, M., 1985, Monetary Policy and the Role of Private Information, *The American Economic Review* 75, 1056–70.

Carvalho, F. and M. Bugarin, 2006, Inflation Expectations in Latin America, *Economía: Journal of the Latin American and Caribbean Economic Association*, 6, 101–45.

Cho, I.-K. and D. Kreps, 1987, Signaling Games and Stable Equilibria, *Quarterly Journal of Economics* 102, 179-221.

Cukierman, A. and N. Liviatan, 1991, Optimal Accommodation by Strong Policymakers Under Incomplete Information, *Journal of Monetary Economics* 27, 99-127

Green, E. and R. Porter, 1984, Non-cooperative Collusion under Imperfect Price Information, *Econometrica* 52, 78–100.

Hayashi, T., 2003, Inflation Targeting and Exchange Rate Policy in Asia, *Japan Bank for International Cooperation Review* 8, 231-258.

Horská, H., 2001, *Inflation Targeting in Poland*, Kiel Institute of World Economics, Prague, monograph. 25p.

Kahn, G. A. and P. Klara, 1998, Conducting Monetary Policy with Inflation Targets, Federal Reserve Bank of Kansas City, *Economic Review*, Third Quarter, 5–32.

Kydland, F. and E. Prescott, 1977, Rules Rather than Discretion: The Inconsistency of Optimal Plans, *Journal of Political Economy* 85, 473-91.

Mishkin, F. and K. Schmidt-Hebbel, 2001, *One Decade of Inflation Targeting in the World: What Do We Know and What Do We Need to Know?* Central Bank of Chile Working Papers, 101.

Vickers, J., 1986, Signaling in a Model of Monetary Policy with Incomplete Information, *Oxford Economic Papers* 38, 443-55.

Walsh, C. E., 1995, Is New Zealand's Reserve Bank Act of 1989 an optimal Central Bank contract? *Journal of Money, Credit and Banking* 27(4-Part 1), 1179-91.

Walsh, C.E., 2000, Market Discipline and Monetary Policy, *Oxford Economic Papers* 52, 249-71.

Woodford, M.E., 2003, *Interest and Prices* (Princeton University Press, Princeton).