THE INSTITUTIONAL DESIGN OF MONETARY POLICY

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I declare that this my own work.

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Abstract

The aim of this thesis is to provide a general framework for the analysis and interpretation of the determinants that help to define monetary stability goals. The main issue is that money supply, and therefore inflation are not exogenous; rather, they depend on interactions between monetary institutions and other economic agents (including governments, commercial banks, trade unions, etc.), as determined by the institutional rules and by the socioeconomic structure. This approach requires identifying factors that help to define the greater (or lesser) desirability of long-term inflation control goals.

In this regard, certain fundamental determinants characterizing the political, social, and economic context of decisions on monetary policy should be further analysed. Factors such as social sensitivity to the costs and benefits of inflation, the degree of political instability, the existence of asymmetrical information between the policymaker and the public influence the ability to be constrained by a rule or an institution.

This work is therefore an attempt to carry out a theoretical and empirical analysis of the implications of these determinants for both the institutional design and the inflation rate. This is a very important issue, certain countries have often borrowed their institutional designs from others, but without achieving the same results in terms of control over inflation.

More specifically, this thesis consists of four parts:

1. Monetary Policy in the presence of Imperfect Observability of the Objectives of Central Bankers.

2. On the Determinants of Central Bank Independence in open economies.

3. Political institutions and Central Bank Independence revisited.

4. Political Stabilization by an independent Central Bank.

Index

Introduction

Ever since they were first created, the primary goal of the "institutions" in charge of money governance has been to protect the value of currency, both internal and external. In the gold standard era (1879-1914), this goal was pursued through an endeavour to ensure the convertibility of bank notes into gold at pre-set exchange rates. The purchasing power of a currency vs. commodities, i.e. the price index, was only pursued indirectly by the monetary authority because gold was seen as the true nominal anchor. However, if no fluctuations of gold's value vs. commodities were recorded, maintaining a fixed parity between bank notes and gold equalled price stability.

Following a gradual decline of the gold standard during the first half of the twentieth century, as well as the introduction of a system founded on both the non-convertibility of bank notes and the note-issuing monopoly of Central Banks, the goal of monetary policy was expressly reconsidered with respect to price stability. Thereafter, the value of the notes issued by Central Banks was nothing but the reverse of the price level of a given bundle of goods; therefore the monetary authority undertook to achieve a given price level, or inflation target.

In their pursuit of the goal to keep the value of their currencies unchanged, Central Banks were always subject to major pressures with respect to their relations with governments and with commercial banks. Such pressures were caused by the existence of possible incentives to use monetary policy for purposes other than controlling inflation.

According to Cukierman (1992), four main causes can be identified for a pro-inflationary attitude of monetary institutions: employment-related reasons, fiscal

reasons, and reasons connected with the balance of payments and with financial stability, respectively. While the first two reasons concern a policymaker that is only in charge of monetary policy, for the other two the policymaker is responsible for setting the exchange rate and defining the banking surveillance policy, respectively. All decisions by a monetary policymaker are therefore the result of comparisons between the benefits of a generally stable price level and the cost connected with the achievement of such stability.

The aim of this thesis is to provide a general framework for the analysis and interpretation of the determinants that help define monetary stability goals. The main issue is that money supply, and therefore inflation, are not exogenous; rather, they depend on interactions between the monetary institutions and the other economic agents (including governments, commercial banks, trade unions, etc.), as determined by the institutional rules and by the socioeconomic structure. This approach requires identifying factors that help define the greater or lesser desirability of long-term inflation control goals.

A fair relation between Central Banks and governments is, perhaps, the most important institutional determinant from the political viewpoint. During the past two centuries, multiple factors have had a significant impact on relations between the government and the Central Bank. These have included the prevalence of certain political conditions, such as war or peace, the dominant political and economic doctrines, and the exchange rate regime in force. These factors have contributed, in different circumstances, to a higher or lower degree of independence of the Central Bank from the political power (Capie et al., 1994).

A debate has developed over time, in parallel with the issue of the independence of the Central Bank, on the choice between rules and discretion in implementation of monetary policy. This debate originated in nineteenth-century England, where two

schools of thought, the Currency School and the Banking School, engaged in a heated argument that involved several scholars, as well as British policymakers and businessmen of the time (Ciocca, 1983). The debate on rules and discretion further developed between the late 1950s and the early 1970s in the famous controversy between Keynesians and Monetarists.

Both debates started from a perceived failure of the system to achieve the desired goal, *i.e.* monetary stability (Capie et al., 1994). The nineteenth-century monetary debate originated from discussions and analyses of the causes and effects of the suspension of note/gold convertibility in the United Kingdom in the 1797-1821 period, as well as from its relation with the inflation rates recorded at that time; and it later developed with analysis of the causes underlying the monetary disturbances that characterized the 1820-1831 period.

Similarly, the debate between Keynesians and Monetarists developed with the continuous and widespread worsening of the inflationary experience to which developed economies were exposed from the early 1970s onwards (Capie et al., 1994).

In both cases, the supporters of the Currency School and of Monetarism essentially emphasized the monetary causes of inflation. Since both schools of thought claimed that the reason for the failure of monetary stability was the failure of money supply management, *i.e.* excessive growth rates of the relevant monetary aggregates – bank notes in the nineteenth century and some specific monetary aggregates (M) in the twentieth – the obvious proposed solution was to introduce appropriate controls, *i.e.* rules governing increase of the money supply (Toniolo, 1988).

On the other hand, the Banking School and the Keynesians focused on non-monetary shocks on the supply side, including negative yields of crops and wars for the Banking School, and oil shocks for the Keynesians. Moreover, according to both schools, a monetary authority is only necessary if it can act on its own discretion, in that they

both stressed that it is impossible to come up with a non-varying definition of the money stock. This rationale denies not so much the possibility of identifying the object of monetary control, as the possibility of exercising such control under pre-set rules (Ciocca, 1983).

The economic literature on incentive issues and on monetary policy credibility in the 1980s and 1990s reconsidered the debate on whether rules or discretion should be applied in the implementation of monetary policy. According to this literature, rules act as a commitment mechanism that prevents the monetary authority from issuing money surprises to obtain revenues from the inflation rate or benefits in terms of increases in employment.[1] The most severe financial crisis of the post-war era, due to the bankruptcy of the Lehman Brothers investment bank in 2007, revamped this debate and showed that rules should be more flexible so that the monetary policy can react to a broader variety of variables, besides price stability, in certain circumstances (Alesina and Stella, 2010; and Fisher, 2010). Indeed, the debate between rules and discretion in this literature is complementary to the relation between the government and the Central Bank.

In this regard, certain fundamental determinants characterizing the political, social, and economic context of decisions on monetary policy should be analysed further. Factors such as social sensitivity to the costs and benefits of inflation, the degree of political instability, the existence of asymmetrical information between the policymaker and the public influence the ability to be constrained by a rule or an institution.

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[1] This strand of literature, which started with the works of Kydland and Prescott (1977) and Barro and Gordon (1983a, 1983b), focused almost entirely on the "time inconsistency" features of discretionary monetary policies and claimed that these policies imply a positive inflationary bias. Indeed, if the objective function of the policymaker is characterized by specific incentives and goals, the attempt to use monetary policy to pursue such goals is likely to generate higher inflation rates, with no permanent benefits on the other macroeconomic variables. Later, different solutions were suggested in the literature to address the issue of the time inconsistency of monetary policy. See Drazen (2000) Persson and Tabellini (2000) and Alesina and Stella (2010) for a survey.

This work is therefore an attempt to carry out a theoretical and empirical analysis of the implications of these determinants for both the institutional design and the inflation rate. This is a very important issue, in that certain countries have often borrowed their institutional designs from others, but without achieving the same results in terms of control over inflation.

More specifically, this thesis consists of four parts. Part one is a theoretical contribution on the determinants that may influence the willingness of a "society" to be bound by the design of a given monetary institution. The goal is to demonstrate that the existence of a non-homogeneous private sector, vs. the observability of the parameter reflecting the relative preferences of the Central Banker, can deeply influence the Banker in the evaluation of the short-term benefits – or costs – of inflation, as opposed to long-term consequences on its reputation.

Part two contains an empirical analysis, based on a sample of approximately 60 countries, of the degree of independence of the Central Bank and of certain institutional determinants. This part conducts an empirical investigation of the conditions under which certain "societies" have selected certain institutional designs to manage their monetary policy. In particular, the analysis considers the impact of different variables on the degree of independence of the Central Bank and, therefore, on the ability of a country to abide by a commitment. The main variables are: imperfect observability of the goals of the Central Bank, the political stability of a country, the degree of openness of the economy, the synchronization of economic cycles in the different countries, and past inflation.

Part three also contains an empirical analysis. This is based on a sample of 24 OECD countries, and is carried out for the 1980-2005 period. The political and institutional systems of individual countries are also crucial for determining the degree of independence of the central bank. Research in this field is limited to a few studies. The

aim of this part is to investigate this issue. Three types of innovation are introduced with respect to past studies: the first concerns the timeframe of the analysis, which was carried out until 2005; the second is that political and institutional variables are examined alongside economic ones; the third concerns the statistical method adopted to select the variables for the empirical analysis.

Part four is an extension of the Gabillon and Martimort model (2004), which studies how the independence of the institution in charge of monetary policy may stabilize inflationary fluctuations due to political uncertainty when the economy is characterized by lobbies that seek to promote their own interests to the detriment of the general interests of society.

Chapter I:
Monetary policy in the presence of imperfect observability of the objectives of central bankers

1.1. Introduction

As shown by the literature on the institutional designs of monetary policy, there are various arguments in favour of delegating monetary policy to agents independent of the government, within an institutional framework which not only guarantees that independence but also imposes precise objectives and constraints on the operations of a Central Banker. The advantages of delegation to an independent banker more inflation-averse than the government, or 'society', arise from the desire to prevent the stagflation problems usually associated with time inconsistency and the prevalence of a 'discretion equilibrium'. However, this approach has been criticised in light of considerations concerning the distribution of the benefits and costs of inflation within a society made up of heterogeneous agents. For example, from the positive point of view, Adam Posen (1995) argues that what matters in the long run in the struggle against inflation is the presence of a strong financial sector with an interest in price stability and willing and able to induce the monetary policy authorities to pursue that objective. From this standpoint, the independence of the Central Bank and its inflation-control targets are unconnected with the interests of society as a whole, and the convenience of a particular institutional arrangement derives not from normative considerations but from the political influence of a particular interest group. This point of view has been analysed further in the literature that connects the design of

monetary institutions with the field of political economics (see Persson and Tabellini, 2000; Drazen, 2000; Alesina and Gatti, 1995).

Yet the view of institutions as produced by "special interests politics" is not necessarily antithetical to the credibility-based approach (Kydland and Prescott, 1977; Barro and Gordon, 1983a, b; Rogoff, 1985a; Lohmann, 1992). It is possible in fact to hypothesise that even in the presence of heterogeneous agents (debtors versus creditors, financial system versus firms' system, agents whose wages are fixed by long-period contacts versus agents whose remuneration is fixed in flexible markets), the time-inconsistency problem and its solution of strategic delegation (commitment) continues to play a significant role in the design of monetary policy institutions.

This paper analyses a simple time inconsistency model in which institutional reforms – *i.e.* the process of strategic delegation to an independent Banker constrained in its decisions to monetary stability goals – come about in the presence of agents heterogeneous in their ability, or willingness, to invest resources in order to observe and understand those reforms. In the presence of agents not all of which are able to observe and understand the effects of reform of the monetary institutions on the behaviour of the Central Banker in terms of its decisions, monetary policy is implemented in the presence of the Banker's partial private information, with respect to private agents, about monetary policy objectives.

The aim of the paper is therefore to analyse the effect of the imperfect observability of Central Bank preferences by the private sector on the decisions taken by the monetary authority and therefore on the inflation rate. In the case of a Banker's multiperiod appointment and imperfect observability of its goals on the part of private agents, the latter, to the extent that they are not directly informed about those goals, may infer them from the decisions taken by the Central Banker.

The paper considers in particular the case of an economy in which a Central Banker is appointed for two periods and information about its objectives is distributed in society as follows: an exogenous fraction p of agents has incentives and the capacity to invest resources in the observation of the objectives assigned to the independent institution and take account of that information when formulating their expectations about the inflation rate. A fraction $1 - p$ of agents does not have this information and therefore in the first period formulate expectations about the inflation rate according to their a priori beliefs about the type of Banker, while in the second period their expectations are conditioned by the Banker's behaviour in the first period.

The monetary policy game describe therefore divides into two periods and has the characteristics typical of signalling games. The temporal sequence of the decisions is as follows: at time $t = 0$ monetary policy is delegated to an independent Banker with particular preferences regarding the trade-off between inflation and output (unemployment) and which remains in office for two periods. At time $t = 1$, given the agents' expectations, the Central Banker fixes an inflation rate considering that future expectations (at time $t = 2$) of fraction $1 - p$ (those that do not observe the BC's preferences at $t = 0$) will be conditioned by observation of the current decision of the Central Banker. At time $t = 2$, the Central Banker decides the money supply, the macroeconomic results are achieved and the game concludes.

Introducing the hypothesis of heterogeneity in the private sector, in a standard monetary policy model (Vickers, 1986), extended to the case of a continuous support of types (Mailath, 1987) enables one to analyse the behaviour of a just-appointed policymaker, or of institutions created *ex novo* at a given point in time and in a particular place.[2] The presence in the economy of private agents with a different

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[2] An extension of signalling models for monetary policy to the case of a continuous support of types is also present in D'Amato and Pistoresi (1996) and Sibert (2002). Both models substantially confirm

degree of observability with respect to the Central Banker's preferences gives rise to a private learning process which generates more or less strong incentives for the just-appointed policymaker, or the new institutions, to acquire a reputation.

With respect to the previous literature (D'Amato and Pistoresi, 1996; Sibert, 2002), therefore, the contribution of this paper from a technical point of view consists in two extensions: first, it considers the case of agent heterogeneity in terms of the information set; second, it studies and resolves the game without imposing restrictions on the support of the distribution of the agents' beliefs across the possible types of Central Banker. These extensions will enable me to characterize the nature and properties of a 'semi-separating' equilibrium (also called 'partial pooling'), and also to study the relationships between monetary policy strategies in the presence of time inconsistency and the degree of transparency and observability of the objectives of a Central Banker in a simple economy.

The results of the model show that, in the case of an economy characterized by a large number of private agents, about which the Central Banker possesses private information, the hypothesis of a continuum of Central Bankers signifies that it is not economically convenient for the 'tougher' types (strongly inflation-averse), within a given support, to separate themselves from each other, because this gives rise to high signalling costs[3], whereas it is instead optimal for them join with the type which sets a nil inflation rate. Instead, each 'wet' type (those most sensitive to the level of economic activity) in the support, obviously excluding the worst possible type, separates from the one closest to it.[4]

Vickers' result (separating equilibrium) that the presence of wet types disciplines the behaviour of tough types.

[3] In monetary policy models the cost of the signal is represented by the fall of the employment level below the natural rate.

[4] In substance, the equilibrium obtained represents a 'partial pooling' or 'semi separating'.

Conversely, as the private sector's uncertainty about the true identity of the monetary decreases (economy characterized by a large number of agents informed about the type of Central Banker), the model converges on the results obtained by D'Amato and Pistoresi (1996) and Sibert (2002): that is, it produces a complete separating equilibrium, so that once again the presence of wet types disciplines the behaviour of tough types.

The introduction of partial observability also has implications for the strategic delegation that would emerge in equilibrium. The presence of signalling costs substantially alters the incentives for commitment and depends on the degree of observability. This study will not concern itself with deriving the government's optimal strategy. It restricts itself to pointing out that, in the case where the economy is characterized by situations in which observation by the private sector is close to being perfect, introducing a commitment mechanism into monetary policy may be a way to evade signalling costs. Otherwise, there may arise commitment costs sufficiently high to induce the government to reduce the use of delegation and assign inflation-control targets less stringent than in the case of high transparency.

This interpretation may help explain why in the industrialized countries, where institutional conditions are such to guarantee the high observability of the policy-makers' preferences, monetary policy is often characterized by the presence of legal rules, or by institutions created by constitutional laws (Central Banks independent from political power, pegging of the exchange rate to a strong currency, etc.) which essentially serve the purpose of specifying a partial commitment mechanism.

The rest of the paper is organized as follows. Section 2 presents the monetary policy game, while in Section 3 the model is solved for a separating equilibrium and a pooling equilibrium in the monetary policy game. A number of simulations are performed in Section 4 in order to analyse, other conditions remaining equal, the impact on the

inflation rate of an increase in the observability of the Central Banker's preferences. Section 5 sets out the conclusions.

1.2. A monetary policy signalling game

The game of monetary policy analyzed here describes the relationship between a Central Banker appointed for two periods and the private sector.

The starting-point is the monetary authority's pay-off functions – which are widely used in the literature and were proposed for the first time by Barro-Gordon (1983a) – in which a welfare function is assigned for each period *t*.

CB: The welfare of the Central Banker (CB) in period *t* depends on actual inflation and unexpected inflation. We thus have the following functions:

$$W_t = w(\pi_t; \pi_t - \pi_t^e) \tag{1.1}$$

where π_t represents the inflation rate in each period *t*, which by hypothesis is completely controlled by the monetary authority, and π_t^e is the inflation expected by the private sector.[5] It is therefore assumed that positive inflation is a cost for the Central Banker, whilst so-called "*surprise inflation*", $\pi_t - \pi_t^e$, gives rise to welfare.[6]

To simplify the analysis, it is also assumed that the welfare function is linear in unemployment, rather than quadratic as in Barro and Gordon (1983a). This assumption, which has been made by Barro and Gordon (1983b) and Vickers (1986), is attractive for our model because it ensures that the Banker has a dominant strategy

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[5] The description by the particular function of macroeconomic payoff adopted clearly represents a considerable simplification but it has the disadvantage of not being strictly microfounded. Nevertheless, this structure is widely used in the literature to study the problem of the credibility of monetary policy. See Cukierman (1992) for an extensive discussion of this issue.

[6] "Surprise inflation" is a benefit for the monetary authority because it pushes unemployment below the natural rate, which is assumed to be too high. Alternatively, the benefit can be interpreted in terms of advantages connected with the presence of debt stock issued in nominal terms or short-period rigidity of the tax system. In the rest of the analysis, the model will use mainly the first of these interpretations.

during the final period in which it is in office, and therefore enables the expected inflation of the previous period to be considered a constant. Hence W_t has the following functional form:

$$W_t = -\frac{1}{2}\pi_t^2 + \alpha(\pi_t - \pi_t^e) \qquad (1.2)$$

where $\alpha \geq 0$ is the parameter of preferences that the Banker assigns to unexpected inflation, and therefore to the trade-off between inflation and unemployment, and $t = 1; 2$.

Private sector: This parameter α is only in part private information for the Central Banker. In fact, from the point of view of private agents, for the fraction of agents equal to *1-p*, it is distributed assuming a priori `beliefs' about the distribution function $F(\alpha)$ defined in a continuous support $\alpha \in \left[a, A^{BC}\right]$[7]; whilst the fraction *p* of private agents possesses complete information about the type of Banker because it observes at the moment when the Central Banker is appointed and then behaves rationally.

There are several reasons for considering the private sector as divided into two parts, most notably Posen's hypothesis that a crucial role is played in society by nominal net creditors (such as banks and financial companies), which have a greater interest in gathering information about the preferences of a newly-appointed policy-maker. In fact, financial institutions rely for their existence on the possibility to borrow in the short term from savers and then grant long-term loans to firms. They are therefore severely damaged if unexpected increases in inflation occur.[8]

The possibility that the financial sector has more information about monetary policy than other private-sector agents has already been evidenced by various authors. In an

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[7] Both the distribution function and the support constitute knowledge shared by the players and can be arbitrarily defined. However, it can be shown that the conditions for the existence of a separating equilibrium, under the hypothesis of a continuum of types, can restrict the support (Mailath, 1987).

[8] Kane (1980) argues that constructors and building worker unions form an anti-inflation interest group interest for similar reasons. Alternatively, the division of the private sector into two parts can be seen as the presence in the economy of a fraction of agents *p* which fixes nominal long-term contracts ahead of monetary policy decisions and is therefore necessarily interested in knowing Central Banker's preferences from the moment when it takes office.

empirical study, Peek et al. (1999) discussed the information complementarity between the banking sector and the Federal Reserve. They showed that constant exchange of information between banks and the monetary authorities is beneficial for both the conduct of monetary policy and bank supervision.

Gabillon and Martimort (2004) discuss a similar information structure in order to analyse the institutional design of monetary policy. In their model, anti-inflation financial groups are able to access data important for the management of monetary policy with respect to other agents in the economy. Moreover, these groups have no incentive to disseminate information to other agents because they try to collude with the monetary authorities in order to defend their interests.

Timing of the game: The time structure of events has the usual sequence of monetary policy games[9]: the private agents form their expectations on the first-period inflation rate, π_1^e (first stage), the Central Banker observes π_1^e and then chooses the effective first-period inflation π_1 (second stage). In the first stage of the second period, private agents form their inflation expectation, which will be equal to: $\pi_2^e = pE(\pi_2 \mid \alpha) + (1-p)E(\pi_2 \mid \pi_1)$: that is, the fraction of informed private agents fixes expectations about the inflation rate conditioned by the type of Banker α observed from the time when it takes office, while the fraction of private agents not informed at the time of the Banker's appointment will form their expectations on the basis of what they observed in the previous period, *i.e.* π_1, but not α. Finally, in the second stage of the second period, the Central Banker observes π_2^e and then chooses the effective inflation.

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[9] See Backus and Driffill (1985), Vickers (1986), D'Amato and Pistoresi (1996), Sibert (2002).

In formulating their expectations, conditioned by their information set, the private agents minimize the cost of the inflation rate forecast error through the following quadratic function of the pay-offs for each period t:

$$u_t = -(\pi_t - \pi_t^e)^2 \tag{1.3}$$

The solution concept used to determine the optimal strategies is the Bayes-Nash perfect equilibrium. Obtained in this way is a couple of inflation rates played by the Central Banker, $s = \{\pi_1(\alpha), \pi_2(\alpha)\}$, and a couple of expected inflation rates played by the private agents, $e = \{\pi_1^e, \pi_2^e\}$, where $\pi_1^e = pE(\pi_1 \mid \alpha) + (1-p)E(\pi_1)$ is the expected inflation in the first period for the entire private sector, calculated on the basis on the distribution function of *a priori* beliefs for non-informed private agents, and instead conditioned to the type α of Central Banker for informed private agents; while $\pi_2^e = pE(\pi_2 \mid \alpha) + (1-p)E(\pi_2 \mid \pi_1)$ represents the expected inflation of the second period, which for informed agents once again depends on the type α, and instead for non-informed agents on inference of the Central Banker's preferences using the inflation rate observed in the first period.

Finally, it is assumed for simplicity that the players do not discount the future, so that the pay-offs function over the game's entire time horizon is as follows:

$W = W_1 + W_2$.[10]

1.3. Equilibrium in the monetary policy signalling game

As said, the model considered is a typical signalling game applied to monetary policies. It may therefore produce different equilibria: *separating*, *pooling*, or '*hybrid*'.

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[10] Both Vickers (1986) and D'Amato and Pistoresi (1996) use the same hypothesis to resolve the game.

The analysis focuses mainly on the separating equilibrium and on the 'hybrid' equilibrium; that is, on those in which decisions on the inflation rate in the first period are constrained by a non-trivial subset of types of banker in the support $\left[0, A^{BC}\right]$.

In this section, I determine the conditions under which in the entire support $\left[0, A^{BC}\right]$ there exists a complete separating equilibrium characterized by a strictly monotonic strategy in the type of banker: $\pi_1 = \phi(\alpha)$. I then analyse the strategies of a 'hybrid' equilibrium, $\pi_1 = \lambda(\alpha)$, where, $\lambda(\alpha)$ satisfies the compatibility constraint of the incentives only in one subset $k(\alpha) \subseteq \left[0, A^{BC}\right]$.

The possible type of optimal strategy for the CB can be determined by resolving the game backwards: in fact, the equilibrium value of the inflation rate for the second stage of the second period can be easily obtained by solving the following programme:

$$\max_{\pi_2} W_2 = -\frac{1}{2}\pi_2^2 + \alpha(\pi_2 - \pi_2^e) \tag{1.4}$$

whose first-order condition is:

$$\pi_2 = \alpha \tag{1.5}$$

that is, in the period $t = 2$, there is no future to consider, so that the Central Banker's dominant strategy corresponds to (5).

At this point in the first stage of the second period, the informed fraction of private agents p fixes the expected inflation rate on the basis of the type α that it has observed at the moment of the appointment: $E(\pi_2 \mid \alpha) = \alpha$, while the uninformed private agents $(1 - p)$ anticipate the choice of the inflation rate $\pi_2 = \alpha$ and minimize the forecasting error, fixing their modified expectations on the basis of the Bayes rule: that is, on the basis of the inflation rate observed in the first period: $E(\pi_2 \mid \pi_1) = E(\alpha \mid \pi_1) = \hat{\alpha}$. It follows that the non-informed agents infer the 'type' of BC from observation of π_1.

In general, the fraction of agents $(1 - p)$ conjectures that in the first period the Central Banker's strategy is $\pi_1 = \phi(\alpha)$ [11] in the case of a separating equilibrium. Instead, in the case of a 'hybrid' equilibrium, for a subset of types of bankers, *i.e.* $\alpha \in k(\alpha)$, it holds that $\pi_1 = \lambda(\alpha)$, where $\lambda(\alpha) = \phi(\alpha)$ and $\lambda(A) = A$, while for $\alpha \notin k(\alpha)$, $\lambda(\alpha)$ is a constant function of the space of types to that of the strategies, so that in this case $\lambda(\alpha) \neq \phi(\alpha)$.

In the second stage of the first period, the Central Banker takes expectations as given, but takes account of learning by the fraction of private agents $(1 - p)$ for formation of inflation expectations in the second period, and may therefore have an incentive to signal its type.[12]

Given the equilibrium result of the second period, the reduced form of the Central Banker's pay-off function in the first period is given by:

$$\max_{\pi_1} \widetilde{W} = -\frac{1}{2}\pi_1^2 + \alpha(\pi_1 - \pi_1^e) - \frac{1}{2}\alpha^2 + \alpha[\alpha - p\alpha - (1 - p)\hat{\alpha}] \tag{1.6}$$

Using the definition of the separating equilibrium strategy, $\pi_1 = \phi(\alpha)$, and the Bayes rule, $\hat{\alpha} = \phi^{-1}(\pi_1)$ [13] the first-order condition is obtained for the Central Banker:

$$-\phi + \alpha - \alpha(1 - p)\frac{d\hat{\alpha}}{d\phi} = 0 \tag{1.7}$$

which, valued in equilibrium, in the point $\alpha = \hat{\alpha}$ determines the following first-order homogeneous non-linear differential equation, whose solution satisfies a separating equilibrium:

$$\frac{d\phi}{d\alpha} = \frac{\alpha(1 - p)}{\alpha - \phi} \tag{1.8}$$

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[11] This is a biunivocal function: that is, there is a one-to-one correspondence between the space of types and that of strategies (see Mailath, 1987), so that $\hat{\alpha} = \phi^{-1}(\pi_1) \forall 0 < \pi_1 \leq A^{BC}$.

[12] The two-period of monetary policy game examined here therefore comprises a single-period signalling game.

[13] This expresses the second-period beliefs of the uninformed private agents about the type of Central Banker.

In the continuous support $\alpha \in \left[a, A^{BC} \right]$, with $a \geq 0$ there exists a monotonic function $0 < \phi(\alpha) \leq A^{BC}$ that represents the solution of equation (8).

This equation can in fact be resolved analytically by separating the variables and integrating so as to obtain the implicit function describing the separating strategy. The selection of the relevant branch of the implicit function as the only separating strategy equilibrium can be obtained using Mailath's second condition (1987)[14] and an initial condition.

The initial value condition will be given by the equality $\phi(A^{BC}) = \pi_1(A^{BC}) = A^{BC}$, that is, in a separating equilibrium of separation, the worst possible type of Central Banker has no incentive to signal itself and fixes the inflation rate at the same level that it would do if the game had been with complete information.

In particular, given that $\dfrac{d\phi}{d\alpha} = \dfrac{1-p}{1-\dfrac{\phi}{\alpha}}$ and setting $\dfrac{\phi}{\alpha} = x$, from which $\phi = \alpha x$, it follows that: $d\phi = \alpha dx + x d\alpha$. Therefore, after some algebraic steps, it is possible to rewrite (8) in the following separable form:

$$\frac{1}{\alpha} d\alpha = \frac{1-x}{1-p-x+x^2} dx \tag{1.9}$$

Integrating both members of (9) yields:

$$\int \frac{1}{\alpha} d\alpha = \int \frac{1-x}{1-p-x+x^2} dx \tag{1.10}$$

The integral of the right-hand side of the (10) admits three solutions according to whether Δ is greater than, smaller than, or equal to zero.

The first is with Δ < 0, *i.e.* Δ = 1 − 4 (1 − p) < 0; from which it follows that $p < \dfrac{3}{4}$, and therefore (10) will be equal to:

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[14] The monotonicity condition of the types allows one to establish that the relevant stretch of the solution of the differential equation has a positive slope (for details see the section in the 1.6 Appendix).

$$\log \alpha = -\frac{1}{2}\log|x^2 - x + (1-p)| + \frac{1}{2}\frac{2}{\sqrt{3-4p}}\arctan\frac{2x-1}{3-4p} + c_1 \qquad (1.11)$$

The second solution of the integral of (10) is with $\Delta = 0$ from which it follows that

$p = \frac{3}{4}$, and therefore (10) will be equal to:

$$\log \alpha = -\frac{1}{2}\left(x - \frac{1}{2}\right)^{-1} - \log\left|x - \frac{1}{2}\right| + c_0 \qquad (1.12)$$

Finally, the third solution of the integral of (10) is with $\Delta > 0$, from which it follows

that $p > \frac{3}{4}$ and therefore we have:

$$\log \alpha = -\frac{1}{2}\log|x^2 - x + (1-p)| + \frac{1}{2}\frac{1}{\sqrt{4p-3}}\log\left|\frac{2x-1-\sqrt{4p-3}}{2x-1+\sqrt{4p-3}}\right| + c_2 \qquad (1.13)$$

Consequently, on eliminating the auxiliary variable x, one obtains the implicit final

form of the solution in the original variables of (10), which too will clearly admit to

three solutions.

The first, with $p < \frac{3}{4}$, will be:

$$\log \alpha = -\frac{1}{2}\log\left|\left(\frac{\phi}{\alpha}\right)^2 - \left(\frac{\phi}{\alpha}\right) + (1-p)\right| + \frac{1}{\sqrt{3-4p}}\arctan\frac{2\frac{\phi}{\alpha}-1}{3-4p} + c_1 \qquad (1.14)$$

The second, with $p = \frac{3}{4}$, will be:

$$\log \alpha = -\frac{1}{2}\left(\frac{\phi}{\alpha} - \frac{1}{2}\right)^{-1} - \log\left|\frac{\phi}{\alpha} - \frac{1}{2}\right| + c_0 \qquad (1.15)$$

The third, with $p > \frac{3}{4}$, will be:

$$\log \alpha = -\frac{1}{2}\log\left|\left(\frac{\phi}{\alpha}\right)^2 - \left(\frac{\phi}{\alpha}\right) + (1-p)\right| + \frac{1}{2}\frac{1}{\sqrt{4p-3}}\log\left|\frac{2\frac{\phi}{\alpha}-1-\sqrt{4p-3}}{2\frac{\phi}{\alpha}-1+\sqrt{4p-3}}\right| + c_2 \qquad (1.16)$$

where c_1, c_0 and c_2 respectively represent the constants of integration, which can be

obtained fixing the initial value condition $\phi(A^{BC}) = A^{BC}$.

In defining the support[15], on which it is possible to determine a separating equilibrium in the first period, we proceeded by not specifying whether or not a is greater than zero.

In effect, as said, two different cases exist. The first is the one in which $a = 0$ and $\phi(0)$ and is part of the function $\phi(\alpha)$; therefore, in the support $\left[0, A^{BC}\right]$ the equilibrium is completely separating. The second is the case in which $a = \alpha^s > 0$, with $\lim_{\alpha \to \alpha^s} \phi(\alpha) = 0$, given the strict monotonicity of function $\phi(\alpha)$. In this second case, we have a 'hybrid equilibrium': in fact, for $\alpha \in \left[0, \alpha^s\right]$ a pooling strategy exists, while for $\alpha^s < \alpha \leq A^{BC}$ a separating equilibrium continues to exist.

Characterization of both these cases requires that in equilibrium $\phi'' > 0$.[16] This result is such that for $\phi(A^{BC}) = A^{BC}$, the relevant branch of the separating strategy $\phi(\alpha)$ is an increasing monotonic convex function.

The results derived can be synthesized into two Propositions.

Proposition 1 *In the case in which ¾ ≤ p ≤ 1, in the support $\left[0, A^{BC}\right]$ of F(α), a complete separating equilibrium exists. The complete characterization of the separating equilibrium is given by the following strategies:* $s^s = \left\{\pi_1^s(\alpha), \pi_2^*(\alpha)\right\}$, $e^s = \left\{\pi_1^e, \pi_2^e\right\}$, *where*

$\pi_1^s(\alpha) = \phi(\alpha)$,[17] $\pi_2^*(\alpha) = \alpha$, $\pi_1^e(\alpha) = pE(\pi_1 \mid \alpha) + (1-p)E(\pi_1)$,

$\pi_2^e(\alpha) = pE(\pi_2 \mid \alpha) + (1-p)E(\pi_2 \mid \pi_1)$.

To demonstrate that the separating equilibrium of Proposition 1 exists and is unique, one must use both Mailath's regularity conditions (1987), and the second-

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[15] *i.e.:* $\alpha \in \left[a, A^{BC}\right]$.

[16] The control of the second-order condition on equation (8), with the purpose of demonstrating that $\phi'' > 0$, *i.e.* the convexity of the function $\phi(\alpha)$, is shown in the Appendix. This condition derives from the simplified expression proposed by Mailath (1987, p.1355).

[17] More specifically, if $p = 3/4$, $1/2\alpha \leq \phi(\alpha) \leq \alpha$. If $p > 3/4$, $\dfrac{1+\sqrt{4p-3}}{2}\alpha \leq \phi(\alpha) \leq \alpha$. See the section in the Appendix.

order condition of (8), which implies that $\phi(\alpha) \geq \dfrac{1 + \sqrt{4p-3}}{2}\alpha$ (see the Appendix for

the derivation of these conditions). Figures 1 and 2 show, respectively for two different

regimes of p considered, the relevant part of the contour diagram of the solution of

equation (8) in the signal-types space.

Figure 1-1: Case with $p > \dfrac{3}{4}$: Complete Separating Equilibrium.

π^*: inflation level with complete information.

$\phi(\alpha)$: inflation level in separating equilibrium.

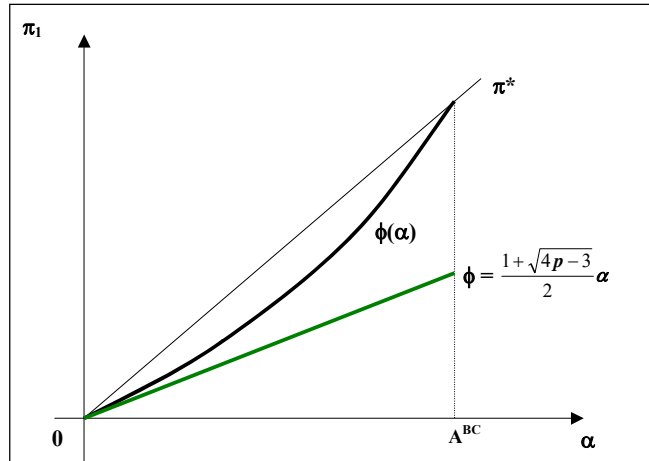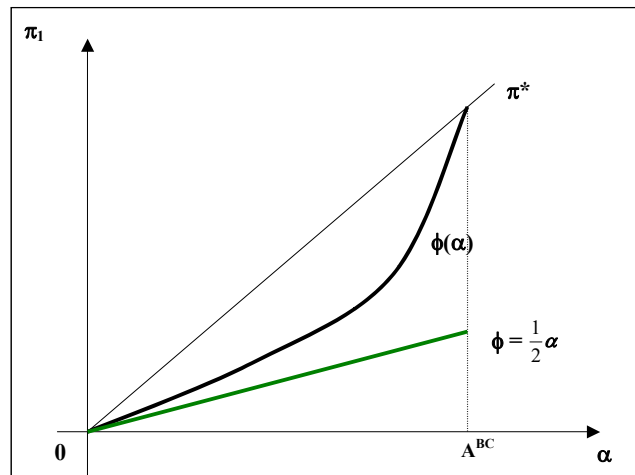Figure 1-2: Case with $p = \dfrac{3}{4}$:Complete Separation Equilibrium.

π^*: inflation level with complete information.

$\phi(\alpha)$: inflation level in separating equilibrium.

The Central Banker's separating strategy is such that in the first period the 'types' comprised in the interval $0 < \alpha < A^{BC}$, will choose a lower inflation rate than in the case of complete information,[18] thereby reducing the inflationary distortion.[19]

In other words, the risk that the public may revise its beliefs negatively serves as a commitment mechanism for the monetary authority. The fraction of private agents (1 – p), that is, those not informed when the Banker is nominated, will anticipate this behaviour and in the first period they will fix a lower expected level of inflation.

This result extends the work of D'Amato and Pistoresi (1996) and Sibert (2002), where in both cases a complete separating equilibrium is obtained, but by arbitrarily restricting the initial support to that part in which the single crossing condition[20] is strictly satisfied for every type of banker. In my case, instead, the equilibrium of complete separation is obtained without any restriction. The difference is due to my assumption of the partial observability of the banker's objectives by the private sector. In fact, if the fraction of informed agents is large (*i.e.* $p \geq \frac{3}{4}$), the distortion due to the incentive compatibility constraint in the support $\left[0, A^{BC}\right]$ does not violate the single crossing property. Therefore, for the entire support there exists a complete separating equilibrium in which every type *α* of Central Banker is distinguished from that type closest to it.

---

[18] Note that the 'tougher' $\left(\alpha = 0\right)$ and the 'weaker' $\left(\alpha = A^{BC}\right)$ type play the same strategy with respect to the case of complete information (Barro-Gordon). In fact, whatever the economy's parameters, they always have as their dominant strategy respectively $\phi(0) = 0$ and $\phi\left(A^{BC}\right) = A^{BC}$.

[19] The separating strategy introduces a lower constraint $\phi(\alpha) = \dfrac{1 + \sqrt{4p - 3}}{2}\alpha$ for *p* > 3/4 and instead $\phi(\alpha) = \dfrac{1}{2}\alpha$ in the case of *p*=3/4.

[20] The single crossing condition is one of the regularity conditions of Mailath (1987). See the Appendix for the definition of this condition.

Characterization of the equilibrium in the case where $p < \dfrac{3}{4}$ is slightly more complex. In this case, in fact, the model produces a 'hybrid' equilibrium. This result can be synthesized in Proposition 2.

Proposition 2 *In the case where* $0 \le p < 3/4$ *, for the support* $\left[0, A^{BC}\right]$ *of F(α), there exists a 'hybrid' equilibrium. In the interval* $\alpha^s < \alpha \le A^{BC}$ *, where α^s>0 , there exists a separating equilibrium that satisfies (8). The equilibrium strategies in this interval are therefore the following:* $s^s = \left\{\pi_1^s(\alpha), \pi_2^*(\alpha)\right\}$ $e^s = \left\{\pi_1^e, \pi_2^e\right\}$, *where* $\pi_1^s(\alpha) = \lambda(\alpha) = \phi(\alpha)$ *,*

$\pi_1^e(\alpha) = pE(\pi_1 \mid \alpha) + (1-p)E(\pi_1)$, $\pi_2^e(\alpha) = pE(\pi_2 \mid \alpha) + (1-p)E(\pi_2 \mid \pi_1)$. *In the interval* $\left[0, \alpha^s\right]$, *with* $\alpha^s \le \dfrac{A^{BC}}{2}$ *, there exists a pooling equilibrium which satisfies (8). More specifically, outside equilibrium beliefs [i.e.* $\lambda^{-1}(\pi_1)$ *],* $\lambda(\alpha) = 0$.[21]

To show that the separating equilibrium $\lambda(\alpha)$ of *Proposition 2*, in the interval $\alpha^s < \alpha \le A^{BC}$, exists and is unique, it is again necessary to bear in mind both Mailath's regularity conditions (1987) and the second-order condition on (8) satisfied for $\alpha > \alpha^s$. Considering that $\lambda(\alpha) = \phi(\alpha)$ in the interval $\alpha^s < \alpha \le A^{BC}$, one resolves the same problem as Proposition 1 (see the Appendix for details).

In the case of pooling, the strategy expressed by $\lambda(\alpha) = 0$, will be instead be an equilibrium if the monetary authority has no incentive to deviate from the equilibrium, given the specification of the out-of-equilibrium 'beliefs'. This therefore requires that $w^D(\alpha) < w^P(\alpha)$[22] for $0 < \alpha \le \alpha^s$ [23] (see the Appendix for the proof).

The pooling/separating strategy is shown in figure 3.

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[21] The concept of perfect Bayesian equilibrium does not impose any restriction on the specification of out-of-equilibrium beliefs, except those that support the equilibrium.

[22] Where w^P is welfare from pooling strategy and w^D are the benefits from deviation of the pooling strategy.

[23] In this signalling game there may exist a pooling equilibrium for the entire support [a, A^{BC}]. This case is not analysed here, but has been thoroughly discussed in D'Amato and Pistoresi (1996) and Sibert (2002).
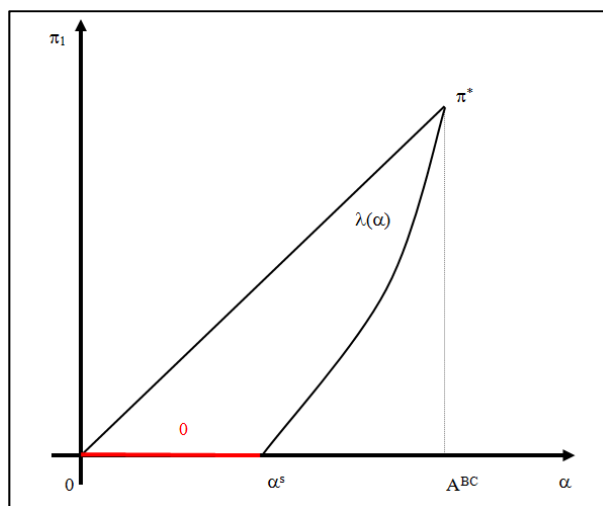
Figure 1-3:   Case with $p < \dfrac{3}{4}$: Partial Pooling Equilibrium.

π*: inflation level with complete information.

$\lambda(\alpha) = \phi(\alpha)$: inflation level in separating equilibrium.

The information context in which the signalling game develops is essential in determining the model's different equilibria. The economic intuition is very simple. The signalling cost that the different types of bankers are prepared to bear in order not to be mistaken for bankers who are weaker than their type is higher, the smaller the fraction *p* of informed agents in the economy.

If $p < \dfrac{3}{4}$, the signalling effect that reduces inflation in the first period, becomes excessively costly for tough types, that is, for $0 \le \alpha \le \alpha^s$. In fact, the separating equilibrium collapses in this part of interval and a pooling strategy $\lambda(\alpha) = 0$ instead arises.[24]

Therefore, the difference between the result obtained here and that of Vickers (1986), is that in Vickers the pooling equilibrium comes about with a positive inflation

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[24] See the red segment in figure 3. This segment states that for $\alpha \le \alpha^s$ there exist some types of bankers who have no incentive to increase their future reputations and they decide in the first period to choose the same strategy, that is, a nil rate of inflation. They in fact to separate themselves should play a negative inflation rate in the first period, which become too expensive for even the tough types.

rate in the period $t = 1$, and the player with 'small' α (the toughest type)[25] can still separate by playing a lower, though still positive, inflation rate. In Vickers, deviating, choosing to separate, is always advantageous with respect to the pooling equilibrium. This does not happen in the model considered here, where a hybrid *pooling/separating* equilibrium is instead obtained.[26]

An implication of the pooling/separating equilibrium obtained is that it is the 'intermediate' types that signal themselves most, and are therefore those with the widest gap between the actual inflation rate and the time-consist inflation rate *à la* Barro-Gordon.

A further conclusion to be drawn from the analysis of the different information contexts in which the monetary policies game takes place (*i.e.* with $p \gtreqqless \frac{3}{4}$) is that the closer one approaches the case of perfect observability of the Central Banker's preferences (*i.e.* with increasingly higher values of p), the more the marginal cost of the signal diminishes[27] (compare in this regard figures 1, 2 and 3).

This result can be confirmed by performing a comparative statics exercise to analyse – as the number of private agents in the economy increase and observe the Central Banker during his term of office – how the results of the equilibria determined may change. From an analytical point of view, this involves considering the total differential of the implicit solution of the differential equation (8):

$$d\phi F_\phi + dp F_p = 0 \rightarrow \frac{d\phi}{dp} = -\frac{F_p}{F_\phi} \tag{1.17}$$

where F refers to the RHS of 14, 15 or 16.

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[25] In Vickers' model, the types that the BC can assume are only two: a 'tough' type and a 'weak' type.

[26] This result can again be compared with those of D'Amato and Pistoresi (1996) and Sibert (2002), where the part of the support $\left[0, \alpha^s\right]$, which in both cases is arbitrarily eliminated to derive the strategy, $\phi(\alpha)$ is used here to determine a pooling region.

[27] This represents the marginal cost of fixing the inflation rate below the optimal level of the complete information case, that is, less than α.

Unfortunately, neither the sign of F_p, nor that of F_ϕ can be determined analytically in an unequivocal manner. Consequently, in the next section I shall perform simulations to determine the impact of a variation p on the equilibrium determined.

1.4. Some simulations

This section reports some results obtained using simulations[28] which enable us to characterize the effects of a variation in the exogenous variable p: that is, the number of agents informed about the Banker's preferences at the moment of its appointment, in $\dfrac{d\phi}{d\alpha} = \dfrac{\alpha(1-p)}{\alpha - \phi}$.

Given that our model focuses on the case in which the Central Banker's preferences are only in part private information, we analyse the impact on the equilibrium inflation rate of an increase in the observability of the Banker's preferences for the private sector. In other words, from an analytical point of view, we analyse $\dfrac{d\phi}{dp}$.

Figure 4 illustrates a numerical simulation of equation (8) which shows the relevant part of the contour diagram of the equation, that is, the Central Banker's strategy. It will be noted that if $p = 0.1$, the separating strategy $\phi(\alpha)$ cuts the α-axis at the point $\alpha^s = 0.5$.

Figure 5 shows, within the interval of the current parameters, the impact of an increase in observability ($p = 0.2$). In this case, $\alpha^s = 0.45$. Figure 6 shows the case of $p = 0.5$, and therefore $\alpha^s = 0.2$. Finally, Figure 7 considers the three simulations simultaneously in a single graph.

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[28] The simulations were obtained using the Mathematica 4.0 program.

Figure 1-4: Simulation 1: *p* = 0.1
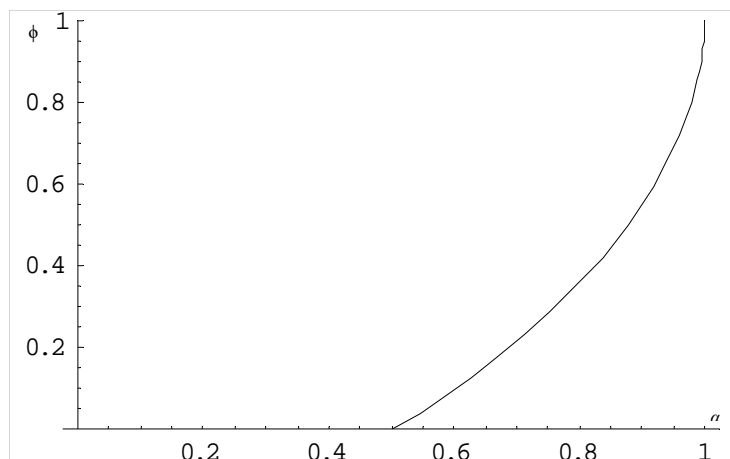
Figure 1-5: Simulation 2: *p* = 0.2
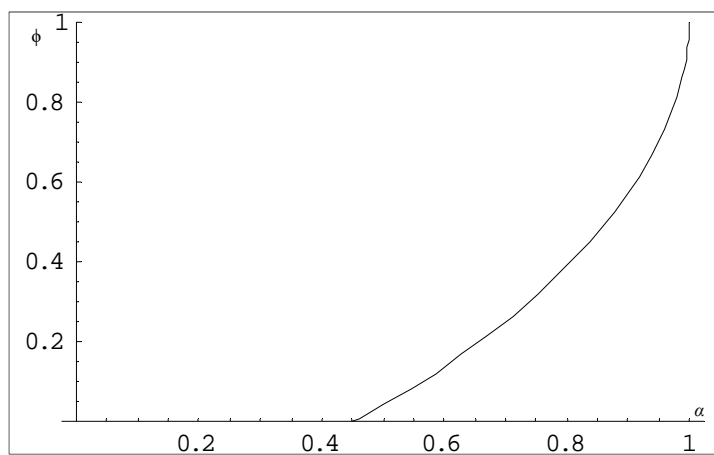
Figure 1-6: Simulation 3: *p* = 0.5
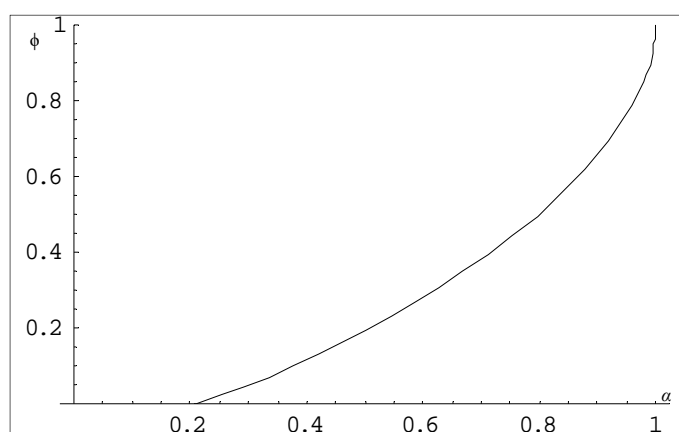
Figure 1-7: Comparison of simulations 1, 2 and 3.
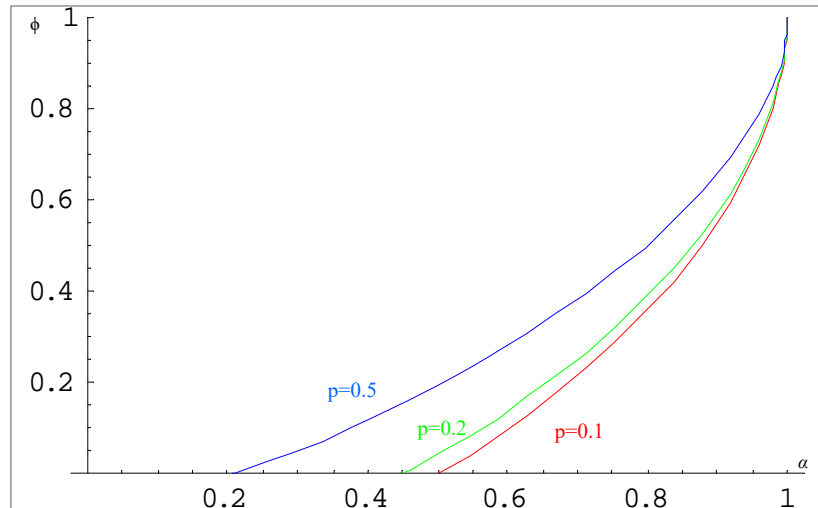
This suggests that $\dfrac{d\phi}{dp} > 0$ and that $\dfrac{d\alpha^s}{dp} \leq 0$.

As expected, the greater is p, *i.e.* the number of agents informed at t = 0, the more the central banker separation strategy approaches to the result of the monetary policy game in the case of perfect information (Barro-Gordon: $\pi_1 = \alpha$).

The intuition of this result is very simple: if within an economy, the fraction of agents informed about the banker's preferences is high, in the event of a significant increase in the first period of the "surprise inflation", *i.e.*, $\pi_1 - \pi_1^e$, the cost in terms of loss of reputation for the banker is lower.[29] Consequently, the central banker distorts less, and therefore the rate of inflation is higher, since it reduces the incentive to maintain his reputation.

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[29] Loss of reputation is represented by an increase in the second period of inflation expectations, π_2^e.

1.5. Conclusions

The paper has presented an extension of the monetary policy models presented by D'Amato and Pistoresi (1996) and by Sibert (2002) to the case in which the private sector is not homogeneous in regard to the observability of the Central Banker's preferences. More precisely, it has assumed that there are two different fractions of private agents: one completely informed about the type of Central Banker when it is appointed; and one about which the Central Banker has private information. The results obtained show that the information context and the degree of transparency and observability of the processes that lead to the strategic delegation of monetary policy significantly influence the nature of the equilibrium.

In the case in which the economy is characterized by high uncertainty among private agents about the identity of the Central Banker (*i.e.* an economy with a small number of agents that observe the type α at the moment of the appointment), one obtains a hybrid pooling/separating equilibrium in which the weaker types separate from each other, while the tougher types behave as an intermediate type which chooses an inflation rate equal to zero. In equilibrium, therefore, no Central Banker utilizes a strategy with an inflation rate less than zero (as shown by Figure 3). This is in substance an example in which, even though there are infinite types of Banker and infinite actions, each type does not select a different type in order that it can be identified. In effect, only the less inflation-averse types reveal their identity unequivocally to the public.

In the case where one moves towards situations of the monetary authority's perfect observability – in other words, there is a large number of agents informed about type α in the economy – the pooling equilibrium breaks down and there emerges a complete separating equilibrium where each type selects an inflation rate lower than that

selected by the wet type closest to it. In both equilibria (partial pooling and complete separating), it is the intermediate types that greatly reduce the inflation rate compared to the case in which preferences are fully known (Barro-Gordon).

As pointed out in the introduction, the observability of commitment and the nature of the Banker's equilibrium strategies influence the design of the government's strategic delegation.

An interesting problem for future research is modification of the game by introducing an initial stage in which a continuum of governments appoint a Central banker whose preferences are not perfectly observable by the private sector. In this case, does a government with certain preferences have the incentive to appoint Bankers with preferences different from its own?

1.6. Appendix

1.6.1. Regularity conditions on the Central Banker's welfare function

As said in Sections 2, and 3 in order to demonstrate that the separating equilibrium exists and is unique, one must check Mailath's (1987)[30] regularity conditions defined on equation (8), which are: belief monotonicity, type monotonicity, and single crossing.

Belief monotonicity condition

$$\widetilde{W}_{\hat{\alpha}} = -\alpha(1-p) < 0$$

This condition represents the Central banker's incentive to be believed 'tough' in combating inflation. In effect, $\alpha(1-p)$ represents the marginal cost of the loss of reputation; given α, the marginal cost is decreasing in p.

Type monotonicity condition

$$\widetilde{W}_{\pi_1\alpha} = 1 > 0$$

This condition represents the marginal benefit due to the inflation surprise, for each given belief, that private agents have about the type of Central Banker. This condition states that the greater the weight that the monetary authority assigns to unemployment, the greater, at the margin, is the positive effect of inflation for each given belief that $1 - p$ agents have about the type of Central Banker.

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[30] Mailath (1987) provides two results that are useful in proving the existence of separating equilibria and characterizing such equilibria for a broad class of signaling games. A key element in the analysis of separating equilibria is the examination of the implied incentive compatibility constraints. It is shown that these constraints together with one of two conditions imply differentiability of strategies when the set of possible types is an interval. The first condition, implied by sequentiality in many games, is an initial value condition on the informed agent's strategy. The second condition is a monotonicity condition that turns out to be necessary and sufficient for there to be a strictly monotonic strategy satisfying the incentive compatibility constraints.

Single crossing condition

$$\partial(\widetilde{W}_{\pi_1}/\widetilde{W}_{\hat{\alpha}})/\partial\alpha = -\pi_1/\alpha^2\,(1-p) < 0$$

This condition is satisfied in that it does not change sign for $\pi_1 = \phi(\alpha) > 0$: that is, we restrict the analysis to positive inflation rates. The marginal substitution rate between an increase in inflation in the first period and the consequent loss of reputation in the second period is an increasing monotonic function in α. In other words, the weaker the Central Banker, the greater the cost that it must bear in terms of future reputation for one additional unit of current inflation.

Under these conditions a single equilibrium of separation exists and is described by the solution of the differential equation (8).

The second-order condition on (8)

The equilibrium characterization of complete separating and *"hybrid"* equilibrium: pooling / separating requires that the function $\phi(\alpha)$[31] is convex *i.e.*: $\phi''(\alpha) > 0$.

It can be shown after simple algebra that $\phi''(\alpha) > 0$ [32] if $\phi'(\alpha) > \dfrac{\phi(\alpha)}{\alpha}$.

By evaluating the inequality at (8) It is therefore necessary to consider the integral equation[33]:

$$\int \frac{1}{\alpha}\,d\alpha = \int \frac{1-x}{1-p-x+x^2}\,dx$$

that is defined for different intervals according to that: $\Delta \lesseqgtr 0$.

---

[31] This is the function that solves the equation (8), given the initial condition $\phi(A^{BC}) = A^{BC}$. Also remember that in the case in which: $p < \dfrac{3}{4}$ the function $\phi(\alpha) = \lambda(\alpha)$.

[32] $\phi''(\alpha) = \dfrac{-\phi(1-p) + \alpha(1-p)\phi'}{[\alpha-\phi]^2}$

[33] With $0 < x < 1$, where $x = \dfrac{\phi(\alpha)}{\alpha}$,

With $\Delta < 0$ *i.e.* $p < \dfrac{3}{4}$, the fraction of integral[34] dx is always verified with $0 < x < 1$, and then $\phi''(\alpha) > 0$ for $0 < \dfrac{\phi(\alpha)}{\alpha} < 1$.

With $\Delta > 0$ *i.e.* $p > \dfrac{3}{4}$ [35], the fraction of integral dx is verified only for $x \in \left[0; \dfrac{1-\sqrt{4p-3}}{2}\right]$

and $x \in \left[\dfrac{1+\sqrt{4p-3}}{2}; 1\right]$. The initial condition $\phi(A^{BC}) = A^{BC}$ requires that $x = 1$ is part

of equilibrium and then for $p > \dfrac{3}{4}$, we have that inequality $\phi'(\alpha) > \dfrac{\phi(\alpha)}{\alpha}$ it satisfied for

$x \in \left[\dfrac{1+\sqrt{4p-3}}{2}; 1\right]$ which implies that $\phi''(\alpha) > 0$.

With $\Delta = 0$ *i.e.* $p = \dfrac{3}{4}$, the fraction of integral dx is verified only for $x \in \left[0; \dfrac{1}{2}\right]$ and

$x \in \left[\dfrac{1}{2}; 1\right]$.

The initial condition $\phi(A^{BC}) = A^{BC}$ requires that $x=1$ is part of equilibrium and the for

$p = \dfrac{3}{4}$, we have: $x \in \left[\dfrac{1}{2}; 1\right]$ which again implies $\phi''(\alpha) > 0$.

Separating equilibrium for different information contexts

If $p > \dfrac{3}{4}$, the second-order condition examined in the previous section implies that:

$$\alpha \geq \phi \geq \dfrac{1+\sqrt{4p-3}}{2}\alpha$$

In this case, the definition of $\alpha^s \in \left[0; A^{BC}\right]$, such that $\lim\limits_{\alpha \to \alpha^s} \phi(\alpha) = 0$, is verified for

$\alpha^s = 0$. For this reason, the function $\phi(\alpha)$, *i.e.* the solution of the differential equation

(8), is the separating strategy for the support of $\alpha \in \left[0, A^{BC}\right]$.

---

[34] i.e., $\dfrac{1-x}{1-p-x+x^2}$

[35] In this case we would have that the roots of x will be:

$x = \dfrac{1 \mp \sqrt{4p-3}}{2}$, *i.e.* $x \in \left[0; \dfrac{1-\sqrt{4p-3}}{2}\right] \cup \left[\dfrac{1+\sqrt{4p-3}}{2}; 1\right]$.

If $p = \dfrac{3}{4}$ second-order condition examined in the previous section implies that:

$$\alpha \geq \phi \geq \frac{1}{2}\alpha$$

In this case, too, definition of $\alpha^s \in \left[0, A^{BC}\right]$, such that $\lim\limits_{\alpha \to \alpha^s} \phi(\alpha) = 0$, is verified for

$\alpha^s = 0$. Hence, once again the function $\phi(\alpha)$ is the separating strategy for the entire

interval of $\alpha \in \left[0, A^{BC}\right]$.

If $p < \dfrac{3}{4}$, then $\lambda(\alpha) = \phi(\alpha)$ is only a separating equilibrium in the interval

$\alpha^s < \alpha \leq A^{BC}$. In fact, the *single crossing* property constrains the separating strategy, in

that it imposes positive inflation rates, *i.e.* $\phi(\alpha) > 0$. If $\phi(\alpha^s) = 0$, then $\lim\limits_{\alpha \to \alpha^s} \phi'(\alpha) = 1 - p$.

Moreover, for $\phi(\alpha) > 0$, then $\lim\limits_{\alpha \to 0} \phi'(\alpha) = 0$ and $\lim\limits_{\alpha \to A^{BC}} \phi'(\alpha) = +\infty$. Given the continuity

of the two functions $\phi(\alpha)$ and $\phi'(\alpha)$ it is necessary that $\phi'(\alpha) = 1 - p$ for $0 < \alpha^s < A^{BC}$.

This demonstrates that $\lambda(\alpha) = \phi(\alpha)$ satisfies equation (8) for $\alpha^s < \alpha \leq A^{BC}$.

The Central Banker's incentive of to deviate from the pooling equilibrium

It was stressed in the third section that for the strategy $\lambda(\alpha) = 0$, in the interval

$0 \leq \alpha \leq \alpha^s$, to be a pooling equilibrium, it must be that:

$$w^D(\alpha) < w^P(\alpha) \text{ with } 0 \leq \alpha \leq \alpha^s \qquad (1.18)$$

that is, the monetary authority does not need to have an incentive to deviate from the

inflation rate equal to zero. To demonstrate (18), it is first necessary to discuss the

following lemma.

Lemma 1 *In a 'hybrid' equilibrium, the pooling region is limited by* $\alpha^s \leq \dfrac{A^{BC}}{2}$.

The function $\lambda(\alpha)$ is a monotonic and convex function in the interval $\alpha^s < \alpha \leq A^{BC}$ (for $p<3/4$); therefore, given the initial condition $\lambda(A^{BC}) = A^{BC}$, it must be that:

$$(1-p)(\alpha - \alpha^s) \leq \lambda(\alpha) \leq \frac{A^{BC}}{A^{BC} - \alpha^s}(\alpha - \alpha^s) \qquad (1.19)$$

from which follows:

$$\int_0^{A^{BC}} zdz - \int_{\alpha^s}^{A^{Bc}} \left[z - \frac{A^{BC}}{A^{BC} - \alpha^s}(z - \alpha^s) \right] dz \geq \int_0^{A^{BC}} \lambda(z)dz \geq \int_{\alpha^s}^{A^{BC}} (1-p)(z - \alpha^s)dz \qquad (1.20)$$

This inequality is verified for $\alpha^s \in \left[-\frac{1}{2}\left(\frac{p}{1-p}\right)A^{BC}; \frac{A^{BC}}{2} \right]$. From which, given the

definition of α^s as the critical value for equation (8),[36] we have that in equilibrium:

$$\alpha^s \leq \frac{A^{BC}}{2}.$$

It is now possible to verify (18).

In the case of a pooling equilibrium such that $\pi_1^p = \lambda(\alpha) = 0$, the regime of expectations in the first period, for the entire private sector, can be synthesised as follows:

$$E(\pi_1^p) = p\pi_1^p + (1-p)E[\lambda(\alpha)]$$

where: $E[\lambda(\alpha)] = \int_0^{A^{BC}} \lambda(\alpha)dF(\alpha)$.

It is therefore necessary to determine the optimal deviation, given the specification of out-of-equilibrium beliefs, where the entire private sector, after having observed a positive rate of inflation, sets $\hat{\alpha} = \phi^{-1}(\pi_1)$.

This specification of out-of-equilibrium beliefs is highly intuitive for those private agents that do not have information about type α at the moment of appointment, that is, the $(1 - p)$. In fact, for whatever type belonging to the interval $0 < \alpha \leq \alpha^s$, its

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[36] The exact value of α^s depends on the parameter p and on the initial condition. If we normalize the support to 1, *i.e.* A^{BC} =1 and consider p = 0, α^s, the point that divides the separation region from the pooling region, will be equal to 0.504.

deviation in favour of a positive inflation rate is interpreted by the fraction 1-*p* as an equilibrium strategy $\lambda(\alpha) = \phi(\alpha) > 0$ chosen by a type $\bar{\alpha} > \alpha^s$.

The specification of out-of-equilibrium beliefs is more complex if imposed on the fraction equal to *p.* In this case, we assume that such agents, after a deviation played by a banker, do not exploit the information available to them at moment of the banker's appointment to infer the type α; but they too use the observed inflation rate to fix their future expectations of inflation. From this we have that:

$$\pi_2^e = E(\pi_2 \mid \pi_1 > 0) = E[\pi_2 \mid (\pi_1, \alpha) > 0] = \hat{\alpha} = \lambda^{-1}(\pi_1).$$

It is therefore possible to obtain the following function of the welfare deriving from the deviation strategy:

$$W^D = -\frac{1}{2}(\pi_1^D)^2 + \alpha\left\{\pi_1^D - p\pi_1^p - (1-p)E[\lambda(\alpha)]\right\} - \frac{1}{2}\alpha^2 + \alpha(1-p)[\alpha - E(\pi_2 \mid \pi_1 > 0)] \quad (1.21)$$

Maximization of (21) with respect to π_1^D yields the optimal deviation, which will be:

$$\pi_1^D = \alpha \qquad (1.22)$$

If a deviation from $\pi_1^p = 0$ exists, it will be $\pi_1^D = A^{BC}$, *i.e.* the case of the worst possible type.

The pay-off function in the case of deviation, given the equilibrium strategy of the second period and the beliefs of the private sector after the deviation, is equal to :

$$W^D = -\frac{1}{2}(A^{BC})^2 + \alpha\left\{A^{BC} - (1-p)E[\pi_1]\right\} - \frac{1}{2}\alpha^2 + \alpha(1-p)[\alpha - E(\pi_2 \mid \pi_1 > 0)] \qquad (1.23)$$

The pay-off function in the case of pooling for $\pi_1 = 0$, given the equilibrium strategy of the second period and the beliefs of the private sector, is equal to:

$$W^p = -\alpha(1-p)E[\pi_1] - \frac{1}{2}\alpha^2 + \alpha(1-p)[\alpha - E(\pi_2 \mid \pi_1 = 0)] \qquad (1.24)$$

At this point, using (24) and (23), it is possible to verify that $w^D(\alpha) < w^P(\alpha)$ for $0 \le \alpha \le \alpha^s$. In fact, after some algebraic steps, one finds that this inequality is always verified in the case in which $\alpha^s \le \dfrac{A^{BC}}{2}$.

Chapter II:
On the determinants of central bank independence in open economies[*]

2.1. Introduction

Several studies have documented how the independence of the monetary authority is an essential part of the explanation for why inflation rates differ among countries.[37] In particular, Cukierman, Webb and Neyapti (1992) show that inflation is generally higher in the high-income countries with less independent central banks, whereas the relation does not hold for other countries. Moreover, this empirical literature shows that there is no relation between central bank independence and volatility of the real economy, at least in the subset of high income countries. This finding has been interpreted to indicate that guaranteeing the central bank's independence gives a 'free lunch', in that average inflation is reduced without entailing a cost in terms of greater output instability. All these studies suggest the idea that central bank independence is a way out, possibly a "quick fix", of the inflationary equilibrium outcome. Nevertheless, there exists significant variation in central bank independence across countries.

The aim of this paper is to contribute to the empirical study of the determinants of central bank independence in open economies. Following the bulk of the literature on this problem, we follow the perspective in Rogoff (1985a) and interpret delegation of monetary policy as a commitment device to eradicate the inflationary bias. Among others, Cukierman (1994) develops a rich conceptual framework, based on the

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[37] Most notable among them are Bade and Parking (1988), Grilli, Masciandaro and Tabellini (1991), Cukierman, Webb and Neyapti (1992), and Alesina and Summers (1993).

commitment hypothesis, that allows us to formulate a hypothesis that can account for cross country variation in Central banker degree of independence in a closed economy.[38] That central bankers have to be interpreted as a commitment device in the hands of the political body to refrain from inflation temptations has been assumed in the literature on monetary institutions at least since the time of Ricardo (1824).

Despite the presence of many empirical studies on the determinants of Central Bank independence, the evidence that there is indeed a strategic pre-commitment mechanism at the root of the delegated power is not strong. The failure of the indexes of central bank independence to affect long run inflation in countries other than the highly-industrialized ones may suggest that commitment is irrelevant in the economies lagging behind in the process of development.

In his interpretation of the determinants of long run inflation, Romer (1993) argues that commitment contributed to overcome the inflationary bias only in the most highly industrialized countries. He finds that the same mechanism does not seem to have been at work in other countries and notices that "the data are not at all supportive of the view that the extent to which countries have solved the dynamic inconsistency problem is a smoothly increasing function of their level of development", leaving the question of what drives the incentives to adopt the institutional solution open. Campillo and Miron (1997) in their detailed empirical study on the determinants of long run inflation conclude that the data suggest that there is no quick fix to be

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[38] To explain cross country variation in the observed degree of independence the commitment approach (Rogoff, 1985a; Lohmann, 1992) argues that the costs of an independent Central Bank, from the government's point of view, consist mainly of the loss of flexibility in monetary policymaking. The balance between flexibility and credibility determines the equilibrium degree of central bank independence in a country (see Alesina and Grilli, 1993), for a median voter interpretation of the Rogoff's model). The balance between costs and benefits in delegating the power to manage paper money may depend on many aspects of the economy and on its institutional framework. Any economic factor increasing the inflationary bias and reducing the exogenous source of variability should, *coeteris paribus*, increase the incentive to commitment. Theoretical studies on central bank independence have focused on both political and economic factors shaping the incentives to commitment. They mainly rely on articulated models of political equilibria, focusing on closed economy determinants of the inflationary bias, on the redistributive aspects of monetary policy and on political institutions (Cukierman, 1992; Cukierman, 1994; Drazen, 2000; De Haan and van't Haag, 1995).

exploited for the solution of the inflationary bias, casting some doubts on the empirical relevance of the commitment hypothesis for all the economies in their sample. Daniels et al. (2005) argue that the index of central bank independence is relevant for understanding the relationship between openness and the sacrifice ratio faced by policy makers.

Why then have only some countries solved the dynamic inconsistency problem whereas others have not? Is the commitment hypothesis empirically relevant for our understanding of the institutional framework of monetary policy around the world?

To verify whether the commitment is empirically relevant and to address what incentives may drive its adoption, we study some positive implications of the commitment hypothesis for the design of monetary institutions in open economies testing for the determinants of central bank independence on a sample of 55 countries.

Our approach follows quite closely the empirical strategy in Romer (1993), relocating his analysis of the inflationary bias at the commitment level. Testing the implications of the commitment hypothesis is as important as testing the implications of the inflationary bias hypothesis, for at least two reasons. On the one hand, commitment is one of the most influential policy implications of the inflationary bias literature and testing its empirical relevance is crucial. On the other hand, this allows us to address important questions like why, as Romer (1993) puts it, only high income countries seem to have solved the credibility problem through commitment?

To this aim we extend previous empirical work in three directions: (a) the role of openness in the incentives to commitment, (b) the related issue of synchronicity of business cycles among countries as a driving force of the institutional design of monetary authorities and (c) the determinants of the effectiveness of the commitment technology. Specifically, we study three testable implications of the commitment hypothesis that have not been investigated in previous contributions by focusing on

the implications of the game theoretic analysis of the pre-commitment strategies and on the determinants of the inflationary bias and related incentives to commitment in open economies.

The first testable implication is derived from the game theoretic frame of commitment choices. In order to be valuable as a commitment device in the government's hand, a delegated institution has to be visible and credible among the general public. *Coeteris paribus*, the more transparent[39] to the general public the institution is, the larger the equilibrium level of commitment is expected to be, *i.e.* the larger the independence and the scope of the delegated power to that institution (Fershtman and Kalai, 1997).

The other testable implications we focus on refer to specific features of the incentives to commitment of monetary policy in open economies. If theory suggests, and data confirm, that openness is relevant for understanding the inflationary bias, it must be also relevant for understanding the incentives to commitment. Rogoff (1985b) and Romer (1993), have argued and documented that the inflationary bias has specific features in open economies that are not taken into account in the closed economy formulation, due to the interdependence in the stabilization monetary policy. Campillo and Miron (1997) and Lane (1997) provide additional empirical evidence in support of this view. Dolado, Griffith and Padilla (1994) and D'Amato and Martina (2005) have explored the implications of openness for the equilibrium degree of commitment of monetary policy.

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[39] Geraats (2000) has classified different meanings that the term "transparency" may refer to in the context of monetary policy making. Here we focus on what Geraats (2000) defines as "political transparency", meaning the capacity of the general public to understand policy objectives and institutional arrangements that shape monetary policy reply and then the inflationary bias. We use average daily newspaper circulation in a country to measure the degree of visibility of a monetary institution among the general public. This is admittedly quite an approximate measure, especially because it may capture other effects other than the degree of transparency of a monetary institution. A detailed discussion of this issue is postponed to the following section.

In particular, the second implication is derived from a straightforward extension of the model in Romer (1993): incentives to commitment have to be inversely related to the degree of openness in the economy since, under flexible exchange rate, the terms of trade mechanisms are a "self-built-in check" on inflation temptations. The third implication of a commitment model in open economies requires the degree of independence to be positively related to the size of the worldwide common components in the business cycles of each country. This latter hypothesis is a less straightforward implication of the model in Romer (1993) and rests on the idea that, in the presence of common components, stabilization policy provided in one country has a positive spill-over on the amount of stabilization policy provided abroad at no costs in terms of credibility. Because of this strategic externality, each country in the world economy will try to free ride on the stabilization provided by central bankers abroad to save on credibility costs at home and it will appoint more independent central bankers, with strong commitment to anti inflationary objectives. The size of this incentive directly depends on the relative size of the common component over the country specific component of the business cycle in each economy, (see D'Amato and Martina, 2005, for further details).

In our analysis we use the data-set constructed by Cukierman, Webb and Neyapty (1992) as for the overall index of Central Banker degree of independence covering the period 1980-89.[40] It has to be noticed that a few institutional reforms of central bank institutions has occurred in several countries in the last decade not covered by the index above whose analysis may be of interest.[41] The reason why we decided to limit

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[40] See the Appendix for the definition.
[41] Several countries in our sample were interested by institutional reforms in the degree of CB independence during the nineties. Most notable among them are the establishment of the European Central Bank 1998; others are Argentina 1992, Chile 1989, Colombia 1992, Egypt 1992, Honduras 1995, Indonesia 1998, Japan 1998, Korea 1998, Mexico 1994, New Zealand 1989, Pakistan 1994, Peru 1992, Philippines 1993, South Africa 1989, Sweden 1998, Turkey 1989, Uganda 1993, U.K. 1998, Venezuela 1992.

our investigation of the determinants of central bankers' degree of independence by using the original Cukierman, Webb and Neyapty (1992) data set is twofold. Firstly, our aim is to analyze the determinants of what these authors define as actual independence (compared to legal independence) and, as far as we are aware of, there exist no updated data set for the overall index covering the whole sample used in our analysis.[42] The other reason is that our investigation is aimed at testing the implications of the commitment hypothesis on a data set commonly adopted in previous studies and we prefer to preserve homogeneity in order to compare our results and interpretation with the benchmark literature.

Our findings show that all the predictions above are supported in the data. Controlling for other variables, openness, the degree of synchronization among business cycles and a measure of institutional transparency turn out to be significant in the regression for the degree of monetary authority dependence, with the signs predicted by the commitment hypothesis. Therefore, even if the commitment approach does not seem to be relevant in the data for explaining long run inflation in countries other than the highly-industrialized ones, our exploration of the determinants of independence is consistent with the view that strategic delegation is indeed at the root of the delegated power and objectives of the monetary institutions across all countries. The point is that in some countries it is more effective than in others because of economic and strategic reasons.

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[42] Indeed a few studies have updated the index of central banks' legal independence. Specifically, Polillo and Guillen (2005) update the Cukierman's legal index up to 2000, Arnone, Laurens and Segalotto (2006) update both the Cukierman's legal index up to 2003 and the Grilli, Masciandaro and Tabellini (1991) index up to 2003. This latter index covers the original sample (18 countries in the OECD group) considered by Grilli et al. (1991). A few developing countries (Brazil, Egypt, India, Israel, Mexico, Peru, Philippines, South Africa) have been considered in the latter study but, in this case, the index only covers the decade of the 90s. Therefore, we cannot use these indexes as a proxy of actual independence to enlarge our time span because this interpretation is debatable (Cukierman, 1992) since it would reduce significantly the size of our sample.

The rest of the paper is organized as follows: Section 2 summarizes the theoretical framework and the relevant related literature. Section 3 sets out the empirical results of the analysis. Section 4 presents the conclusions.

2.2. A framework for the analysis of commitment in open economies and related literature

In this section we cast a framework for the estimated empirical model. The explanation of cross country differences in central bank degree of independence relies on several variants of the commitment hypothesis put forward by Rogoff (1985a). Cukierman (1994) summarizes testable implications derived from this approach. We reappraise here some of these implications with a specific focus on open economies. To this aim we additionally consider: 1) the determinants of inflationary bias in an open economy and 2) the degree of observability of the institutional strategic commitment.

Several factors, influencing the inflationary bias and thus enter the regression for the degree of dependence as the endogenous variable. The measure of central bank degree of dependence, we consider, is the one constructed by Cukierman, Webb and Neyapti (1992) and also used by Romer (1993), Lane (1997).[43] We use this index because it is reported for the largest number of countries covering both OECD and non-OECD economies. On the basis of this framework, the following testable implications can be obtained:

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[43] The theoretical literature distinguishes between the political independence and the functional independence of the central bank. Political independence is the freedom of a central bank to pursue a monetary policy strategy consistently with price stability. Functional independence concerns tactics: that is, the freedom to choose the monetary control instruments and techniques which enable achievement of a given objective. The indices used by the empirical literature to measure the degree of a central bank's independence consider both types of independence.

a. Central bank dependence is larger the larger the degree of openness

According to Romer (1993) and Lane (1997) a larger degree of openness reduces the inflationary bias for the Central Banker and therefore, as shown in D'Amato and Martina (2005), reduces the incentive to commitment for the Government. As a proxy for the degree of openness we use the same index as in Romer (1993) that is the import share over the GDP.

The impact of openness on the incentive to commitment also works through an alternative channel: the level of synchronization between the country's business cycle and the world business cycle.

b. Central bank dependence is larger the lower the degree of business cycles synchronization across countries

The size of the world-wide common component in the business cycle will turn out to be a crucial variable for the understanding of why institutional solutions to the inflationary bias problem have been adopted only in highly industrialized countries. To understand why this is relevant consider that when the correlation between the shocks to the level of economic activity at home and abroad is positive, Governments will rationally expect their economies to be in the same state of the world (booms or slumps) as foreign economies. The inflationary bias hypothesis predicts that more stabilization abroad entails larger flexibility of the policy response by the national Central Banker.[44] Hence all Governments in each country have a strategic incentive to commit monetary policy in order to try to free-ride on the stabilization provided abroad and gain credibility at home. The larger the degree of correlation among

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[44] Consider the case of bad shocks abroad. An increase in money supply by the foreign Central Banker reduces the perceived cost of inflation for the CB at home because of the terms of trade effect and the associated deflation on the CPI index. This mechanism the same as in Romer (1993) and Rogoff (1985b) induces complementarities in the policy response by CBs. See D'Amato and Martina (2005) for further details on this issue and a formal derivation of the result summarized in the text.

shocks, the larger the incentives to commitment. To proxy the size of the common component in the business cycle in the countries included in our sample, we compute the correlation between real GDP growth rate in each country and the analogous measure for the US.[45]

The third testable implication of the commitment hypothesis considered in our analysis relates to the formal game theoretic argument about strategic conditions that make commitment profitable:

c. Central bank dependence is larger, the lower the degree of observability of the delegated institution

This is another crucial variable that enable us to test for the strategic commitment approach to central bank independence. As it is well known, the results obtained in the literature on commitment and observability (Bagwell, 1995; Fershtman and Kalai, 1997) show that the benefits accruing to a player from constraining its actions through commitment (via delegation) are crucially linked to the likelihood that the commitment choice will be observed by other players.[46] In the case of monetary policy, therefore, if the commitment approach to institutional design has empirical relevance, one would expect a positive relation between the extent to which delegation is observable by the private sector and the equilibrium level of commitment. Intuitively, the larger the degree of observability of the Government's choice, the higher will be its incentive to commit (direct effect). There is also an indirect effect: the larger the

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[45] A possible alternative proxy is the correlation between the GDP growth in each country and a weighted average of the growth rates of the economies in the sample. As we will see the choice of the proxy does not affect our results.

[46] This is the result obtained by Fershtman and Kalai (1997) and it contrasts with the one obtained by Bagwell (1995). In this latter model, followers face a small probability of error about the leader's action. This small probability makes the information about the action useless: the incentive to commitment collapse. By contrast, in Fershtman and Kalai (1997) model there is also a probability that the player is informed about his opponent's action but, and this is the crucial difference, when a player is informed about his opponent's action this information is accurate. This accuracy restores the incentives to commit and commitment is, intuitively, increasing in the probability that one player's action is observed.

degree of observability of the Central Banker's objectives the more difficult is to engineer an inflation surprise, the worse the inflationary bias equilibrium from the point of view of the government.[47] As a proxy for the degree of observability of institutions by the general public we use is the average per capita circulating daily newspapers which measures of the strength of the public opinion. This is, of course, not close to our ideal proxy for the variable in question. The main problem is that it may be correlated with other variables also affecting the incentive to strategic commitment. In particular, per capita daily newspapers may capture different forces related to the level of development of the economy and its financial system, the efficiency of the tax system and other variables that may influence the inflationary bias. To disentangle these effects, we will also include real per capita GDP as a separate variable in our equations.

We include also a set of control variables to capture other factors considered in the literature as potentially relevant for understanding the inflationary bias and the delegation choice.

d. Central bank dependence and the past experience of inflation

There are two different explanations for why past inflation may be important as a determinant of current institutional arrangements, under the commitment hypothesis.

Following Cukierman (1992), we may argue that inflation, when sufficiently sustained, will erode central bank independence. High and sustained inflation leads to the evolution of automatic or semi-automatic accommodative mechanisms, like indexation of contracts in the labor and capital markets to the general price level or to

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[47] This argument follows from a straightforward modification of the streamlined version of the Rogoff (1985a) model along the lines of the model by Fershtman and Kalai (1997) where the delegation choice is observed only by a fraction of agents.

the price of foreign exchange.[48] Society becomes accustomed to inflation, thereby reducing opposition to inflation and public pressure for an independent central bank.

De Haan and van't Hag (1995) and Hayo (1998) on the other hand argued that the experience of high levels of inflation, for prolonged periods of time, generates popular support for anti-inflationary monetary policies. Countries which have experienced high rates of inflation in the past may be more aware of its harmful consequences and may therefore develop greater aversion to the problem. This idea is frequently used to explain the low inflation rates recorded in Germany after the Second World War and the independence of the Bundesbank (Issing, 1993). The idea that, after periods of hyperinflation, a 'culture' in favor of price stability in 'society' may arise (Hayo, 1998)[49] suggests that there is a positive relation between past inflation and the central bank's degree of independence.

Both these positions find empirical support. We have no prior about which of the two mechanisms described above has empirical relevance and we leave the answer to our data.

e. Central bank dependence and political instability

The relationship between political instability and the level of dependence is not clear-cut in the commitment literature. On the one hand, the high variability of the political environment may imply a lower ability to achieve commitment of monetary policy through delegation to an independent institution. On the other hand, a larger political instability may increase the benefits to commitment. From an empirical point

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[48] Countries such as Brazil, Argentina, and Israel experienced elaborate indexation for many years. But even in countries with relatively mild inflationary experiences such United States, Italy, France, Britain an increase in the proportion of indexed contracts followed the inflationary experience of the 1970s.

[49] In fact, after Germany's inflation explosion of 1923, monetary stability was not a goal pursued by the Bundesbank alone but a priority for society as a whole. On this point also see the literature cited in De Haan and van't Hag (1995).

of view, the relation between political instability and Central bank independence is ambiguous and it mainly depends on the variable used to proxy instability.[50] For example, Cukierman (1992, 1994) predicts and verifies empirically that a high level of party political instability induces a larger level of independence, whereas the regime political instability has a negative effect on Central Bank independence. A partial list of similar studies, in which different measure of political instability and several indices of central bank independence are used, includes De Haan and van't Hag (1995), De Haan and Siermann (1996), Bagheri and Habibi (1997), Farvaque (2002). We use the index of regime political instability as in Romer (1993). A richer analysis of the political determinants of the incentives to commit would have severely limited the size of our sample.

f. Central bank dependence is larger the lower the Government's debt and deficit

From the empirical point of view, a large body of empirical evidence (Poterba and Rotemberg; 1990; Grilli, Masciandaro and Tabellini, 1991; Cukierman, 1992) shows that cross-country differences in average inflation rates relate with considerations based on the level of optimal taxation. Countries with weak public budget suffer from an excessive inflationary bias which may increase the interest burden. Therefore, the benefits from commitment will tend to be larger (Barro, 1983; Cukierman, 1994). In our empirical specification we will use the level of public expenditure over GDP, the level of public deficit over the GDP as a measure for the governmental financial position because we were not able to reconstruct public debt for many countries for which the index of central bank dependence exists. Similar arguments hold for the

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[50] Party political instability refers to the frequent changes of government between competing political parties democratically elected within a given constitutional context, while regime political instability reflects changes in a country's political-institutional system brought about by non-democratic methods. We consider the regime political instability see the Appendix for details.

expected impact of the share of banking sector credit held by the private sector (*i.e.* M2/GDP) as a nominal asset and a tax base for the inflation tax.

g. Central bank dependence and the level of development

From the point of view of the inflationary bias approach to monetary policy the impact of per capita GDP on average inflation is not clear-cut. On the one hand, a higher level of per capita income level entails a lower degree of (real and financial) market failures in the economy, a more efficient fiscal system and therefore a lower incentive to create inflation for the central banker. On the other hand, economic agents in high income countries might be better hedged against inflation, so their inflation aversion may be lower (Campillo and Miron, 1997). Opposite effects on the inflationary bias in monetary policy entail opposite effects on the incentives to pre-commit monetary policy. We consider the real GDP per capita as an indicator of a general measure of development. In Romer (1993, table III, p. 882) a larger per capita GDP has a negative impact on inflation. Lane (1997, table 5, p. 343)[51] and Campillo and Miron (1997) obtain a positive sign for the log per capita GDP on average inflation.

h. Central bank dependence is larger the larger the size of the economy

Size captures the importance of the terms of trade effect (Lane, 1997), *i.e.* the larger the real exchange rate depreciation after monetary surprise, the lower the inflationary bias. A lower inflationary bias reduces the incentives to commit monetary policy. Also notice that since openness and size are correlated variables in the data, omitting size from the regression would introduce a bias into the estimation of the effect of

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[51] In Romer (1993) a negative impact of GDP on average inflation is obtained except for the case of the Asian countries subsample. In Lane (1997) a positive impact of GDP on average inflation is obtained except for the subsample of "rich countries".

openness on the degree of central bank independence. In the empirical analysis, we use the real total GDP as a proxy for the size.

Finally note that we do not include closed economy determinants of the inflationary bias in our regressions. The reason is twofold. Firstly, due to data constraints, their inclusion would severely limit our sample. Secondly the empirical evidence available for the importance of these variables points against them. De Haan and van't Hag (1995) show that, in regressions for central bank independence as a dependent variable, the coefficients of proxies for average employment-motivated inflationary bias[52] are insignificant in a cross-section of OECD countries.

The next section presents the empirical evidence for the hypotheses formulated above.

2.3. Empirical specification and procedure

We examine the determinants of central bank degree of dependence as measured by Cukierman et al. (1992) overall index for the period 1980-89 (dependent variable: CBD). This index varies between 0 and 1. A high value measures a lower level of central bank independence for a country. This measure is available for a sample of 63 countries. Our study is, however, performed on a sample of 55 countries[53] because of limits in the availability in other variables included in the empirical analysis. Moreover, following Romer (1993) and Campillo and Miron (1997), we split our sample into two

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[52] The two proxies for the inflationary bias in their study are the equilibrium rate of unemployment, as estimated by Layard, Nickell and Jackman (1991), for nineteen industrial countries and the difference between the actual and the equilibrium rate of unemployment during the 1980s.

[53] The list of countries is in the 2.6.2. section of the Appendix.

subsamples, made of 23 OECD countries and 32 non-OECD, respectively, to explore the relationship between incentives to commitment and development.

The general specification for our regression contains the following explanatory variables: an index of political instability for the period 1961-85 (INSTABILITY), the correlation between the GDP growth rates of each country and the U.S GDP growth rates for 1961-79 (CORRELATION), the average inflation rate for 1961-1979 (INFLATION), the average stock of M2 over the GDP for 1970-79(LIQUIDITY), the average public deficit over the GDP for 1970-79 (DEFICIT), the average government expenditure over the GDP for 1970-79 (EXPENDITURE), the average daily newspapers per-capita for 1972-88 (TRANSPARENCY), the average real GDP per-capita for 1960-79 (DEVELOPMENT), the average level of real GDP for 1960-79 (SIZE), the average share of import over the GDP for the period 1970-79 (OPENNESS). For a detailed definition of the variables and the source of our database see the Appendix.

It may be noticed that, in order to take potential endogeneity problems into account, some of the covariates are lagged with respect to the time period covered by the CB dependence index. For instance, since the innovation to the GDP growth rate is endogenous with respect to the monetary policy reply, CORRELATION has been constructed for the period spanning from 1961 to 1979, whereas the Cukierman index refers to the period 1980-1989. The same strategy has been adopted for all the other variables except for INSTABILITY and TRANSPARENCY. These are safely assumed to be exogenous with respect to CBD: political turmoil are not likely to depend on the legal framework for monetary authority and transparency (proxied by the daily circulation of newspapers) certainly does not depend on CBD.

The estimation technique is Ordinary Least Squares. No correction for the estimated standard errors is required, since all our regressions pass the tests for homoscedasticity and normality of the residuals (tests reported in the output tables).

Following Romer (1993), Lane (1997) and Campillo and Miron (1997), we examine different specifications using either levels or logs for INFLATION, SIZE and DEVELOPMENT (semilog-specification). The results do not change in a significant way, we reported them for the sake of completeness and as an indication of robustness. Another indication of the good performance of our specifications on the data is the relatively high level of the adjusted R-square ranging from a minimum of 0.45 for the non-OECD sample to 0.68 for the full sample. For the OECD economies, all the specifications/models deliver adjusted R-square around 0.6.

In each table, we report different estimated models: from a general model (Model 1) to a final parsimonious model. The final model is suggested by the higher adjusted R-square. The model reduction strategy is performed deleting the variables with the lowest t-values (one or two variables are deleted at each deletion step).

2.4. Results

Tables 1 and 2 review the results for the full sample of countries. In particular, Table 1 presents the outcome for the specification in levels, whereas Table 2 presents the semilogs specification. Tables 3 and 4 report the results for the OECD sub-sample and Tables 5 and 6 the outcome for the non-OECD sub-sample. There is no significant difference, both in terms of signs and precision of the coefficients, between the two specifications (levels and semilogs). In terms of adjusted R square, the specification in levels may be preferred in each sample. Remarkable stability in the sign, size and significance of the coefficients emerges across models within each table.

In particular, Tables 1 and 2 show that OPENNESS and TRANSPARENCY are highly significant and have the expected signs consistent with the commitment interpretation

of the monetary policy institution. Transparency captures the core of the strategic aspect of the hypothesis of commitment, *i.e.* its observability. Openness turns out to be a substitute for commitment. CORRELATION has the expected sign: the larger is the common component in the GDP growth among the economies, the larger is the commitment incentive. However, this variable is not significant. This outcome suggests that commitment by governments in open economies does not take into account, to a sizeable extent, strategic externalities induced by the terms of trade effects at world scale. From the literature on the international business cycle, we know that "Poorer economies are more likely to experience country-specific cycles. Evidently, there is a world business cycle, and, unsurprisingly it reflects economic activity in the developed economies" (Kose et al., 2003). Therefore, we expect correlation to play a major role in the subset of OECD countries.

Past INFLATION is also highly significant and positively affects the degree of dependence suggesting that the persistency of the determinants of current inflation emphasized by Campillo and Miron (1997) is also at work at the institutional design stage.

The measures of SIZE and DEVELOPMENT of an economy are statistically negligible. As for the role of development in affecting the incentive to institutional commitment, the data, as in Romer (1993), do not support the view that the extent to which countries have solved the dynamic inconsistency problem is an increasing function of their development level. As in the case of OPENNESS and CORRELATION, a different role for DEVELOPMENT will emerge in the two subsamples.

Political INSTABILITY has a positive sign: the larger the level of instability the lower the incentive of commitment. However, this factor plays a mild role in terms of explanatory power.

Table 2-1: All Countries

Dependent variable CBD

Explanatory variables	Model 1	Model 2	Model 3*	Model 4	Model 5
Constant	0.164 (6.41)	0.165*** (6.77)	0.164*** (6.74)	0.15*** (6.52)	0.127*** (7.36)
INSTABILITY	0.06 (1.43)	0.060 (1.48)	0.057 (1.42)	0.070* (1.73)	0.081** (2.02)
CORRELATION	-0.020 (-0.78)	-0.020 (-0.87)	———	———	———
INFLATION	0.0018*** (5.05)	0.0018*** (5.14)	0.019*** (5.29)	0.0019*** (5.63)	0.0019*** (5.45)
LIQUIDITY	-0.045 (-1.04)	-0.051 (-1.36)	-0.054 (-1.46)	———	———
DEFICIT	-0.028 (-1.007)	-0.003 (-1.28)	-0.003 (-1.39)	———	———
EXPENDITURE	-0.015 (-1.36)	-0.001 (-1.69)*	-0.001* (-1.84)	-0.001 (-1.49)	———
TRANSPARENCY	-0.171** (-2.12)	-0.188*** (-3.29)	-0.189*** (-3.30)	-0.253*** (-5.36)	-0.268*** (-5.73)
DEVELOPMENT	-0.935e-06 (-0.33)	———	———	———	———
SIZE	0.301e-11 (0.21)	———	———	———	———
OPENNESS	0.0012*** (3.41)	0.0012*** (3.69)	0.001*** (3.85)	0.001*** (3.49)	0.001*** (3.24)
R^2	0.73	0.72	0.72	0.70	0.68
$Adjusted - R^2$	0.66	0.68	0.68	0.67	0.66
Jarque-Bera/ Salmon-KieferTest	$\chi^2(2)$= 1.174 cv5%=5.99	$\chi^2(2)$= 1-145 cv5%=5.99	$\chi^2(2)$=0.1.37 cv5%=5.99	$\chi^2(2)$=1.81 cv5%=5.99	$\chi^2(2)$=2.00 cv5%=5.99
Breusch-PaganTest	$\chi^2(10)$=7.93 cv5%=18.31	$\chi^2(8)$=6.59 cv5%=15.51	$\chi^2(7)$=5.90 cv5%=14.07	$\chi^2(5)$=4.23 cv5%=11.7	$\chi^2(4)$=2.72 cv5%=9.49

Notes: *10%, ** 5%, ***1% significant level; (t-value); Model*: final specification.

Table 2-2: All Countries Semilog specification

Dependent variable: CBD
Inflation, Size and Development are in logs

Explanatory variables	Model 1	Model 2*	Model 3	Model 4	Model 5
Constant	-0.134 (-1.13)	-0.060 (-0.63)	-0.011 (-0.12)	0.070* (1.98)	0.043 (1.46)
INSTABILITY	0.069 (1.58)	0.070* (1.63)	0.077* (1.78)	0.078* (1.84)	0.082* (1.92)
CORRELATION	-0.020 (-0.75)	——	——	——	——
INFLATION	0.040 (3.54)***	0.041*** (3.83)	0.041*** (3.74)	0.042*** (3.96)	0.047*** (4.65)
LIQUIDITY	-0.088* (-1.92)	-0.075* (-1.71)	-0.063 (-1.45)	-0.054 (-1.35)	——
DEFICIT	-0.003 (-1.38)	-0.003 (-1.36)	——	——	——
EXPENDITURE	-0.001 (-1.52)	-0.001* (-1.74)	-0.0008 (-1.08)	——	——
TRANSPARENCY	-0.261*** (-3.59)	-0.265*** (-3.69)	-0.283*** (-3.98)	-0.236*** (-4.46)	-0.262*** (-5.33)
DEVELOPMENT	0.016 (1.18)	0.020 (1.59)	0.013 (1.13)	——	——
SIZE	0.005 (1.05)	——	——	——	——
OPENNESS	0.001*** (3.66)	0.001*** (3.82)	0.0012*** (3.60)	0.0012*** (3.51)	0.0012*** (3.40)
R^2	0.70	0.69	0.68	0.66	0.65
Adjusted – R^2	0.63	0.63	0.63	0.63	0.62
Jarque-Bera/Salmon-Kiefer Test	χ^2 (2)= 0.58 (cv5%=5.99)	χ^2 (2)= 1.03 (cv5%=5.99)	χ^2 (2)= 1.73 (cv5%=5.99)	χ^2 (2)= 1.18 (cv5%=5.99)	χ^2 (2)= 0.70 (cv5%=5.99)
Breusch-Pagan Test	χ^2 (10)=10.70 (cv5%=18.31)	χ^2 (8)= 7.78 (cv5%=15.51)	χ^2 (7)=5.31 (cv5%=14.07)	χ^2 (5)= 11.07 (cv5%=11.07)	χ^2 (4)= 9.49 (cv5%=9.49)
Sample	55	55	55	55	

Notes: *10%, ** 5%, ***1% significant level; (t-value); Model*: final specification.

The estimated signs for the coefficients of the variables (LIQUIDITY, DEFICIT, G) relating the inflationary bias to considerations regarding public finance, optimal taxation and seignorage, are consistent with the commitment hypothesis: the larger the inflationary bias coming out of public finance considerations, the larger the incentive to commit. However, all these estimates are weakly significant.

As for the two different sub-samples, tables 3 and 4 report results for the OECD sample, tables 5 and 6 report results for the non-OECD sample. A scrutiny of Table 3 to 6 (OECD *vs* non-OECD samples) confirms that our empirical strategy allows us: 1) to support our working hypothesis about the relevance of strategic commitment for understanding monetary institution, and 2) to spell out our contribution to the understanding of why the institutional solution has been adopted only in highly industrialized countries over the period under analysis.

The empirical relevance of strategic commitment emerges in both sub-samples and across models: the degree of observability of institutional objectives of the Central Banker (TRANSPARENCY), the variables related to openness (OPENNESS and CORRELATION) and the effect of past inflation (INFLATION) remain statistically significant and with the expected signs.

As for the explanation of why the institutional solution has been adopted only in highly industrialized countries, a different mechanism appears to operate in relation to the variables related to openness. In the regressions for the OECD countries, the size of the common component in the international business cycle (CORRELATION) is statistically significant with the expected (negative impact on the dependence) sign. The degree of openness (OPENNESS) also has the correct sign but it is statistically negligible. The opposite pattern emerges among the non-OECD countries where the

common component in the world business cycle is irrelevant[54], whereas the degree of openness (OPENNESS) is highly significant.

Therefore, our analysis supports the view that the level of development is not the right determinant of the incentives to strategic commitment in open economies. The reason why the problem of dynamic inconsistency of optimal monetary policy has been solved by strategic commitment only in highly developed countries has to do with the features of the business cycle in these countries. As explained in the previous section, a large degree of synchronization of the business cycle, *coeteris paribus*, reinforces the incentives to commitment in open economies. In non-OECD countries this mechanism does not operate since their degree of integration with the world economy is low. Indeed, in these latter countries, commitment is mainly affected by OPENNESS. As shown by Romer (1993), a large degree of openness reduces the inflationary bias and in turn weakens the incentives to commit: openness and commitment are substitute in the eyes of the political body delegating monetary policy.

As already mentioned, there are other differences in the relevant variables for the explanation of the observed degree of commitment emerging in the two subsamples. These differences do not contradict the picture emerged so far.

For the OECD sample, Tables 3 and 4, the variables related to public finance considerations (LIQUIDITY, DEFICIT, G) as well as DEVELOPMENT and SIZE are not significant. Political instability becomes more relevant than in the full sample, confirming the result in Cukierman (1992). For the non-OECD countries, on the other hand, variables related to public finance considerations have the same signs as in the full sample and a larger statistical significance: in the face of less developed fiscal

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[54] These results do not depend on the proxy for the common component. Similar results are obtained by using as a proxy the correlation between the GDP growth in each country and a weighted average of the growth rates of the economies in the sample. The weights used are the GDP levels in each country delivering the following formula for the world growth rate: $\dfrac{\frac{GDP_{1,t}-GDP_{1,t-1}}{GDP_{1,t-1}}*GDP_{1,t-1}+\frac{GDP_{2,t}-GDP_{2,t-1}}{GDP_{2,t-1}}*GDP_{2,t-1}+...}{GDP_{1,t-1}+GDP_{2,t-1}+...}$.

system a commitment mechanism is at work for monetary policy. Also notice that the real GDP per-capita, proxy for the level of development (DEVELOPMENT), has a positive and significant effect on the level of dependence. Concerning the positive sign of DEVELOPMENT, this is consistent with the commitment interpretation of the results in Romer (1993) where a larger per capita GDP has negative impact on average inflation that is reduced the inflationary bias.

Table 2-3: OECD Countries

Dependent variable: CBD

Explanatory variables	Model 1	Model 2	Model 3	Model 4*
Constant	0.124* (1.99)	0.123* (2.70)	0.130*** (3.42)	0.095*** (4.25)
INSTABILITY	0.116 (1.42)	0.117* (1.80)	0.115* (1.88)	0.132** (2.31)
CORRELATION	-0.054 (-1.46)	-0.052** (-2.23)	-0.052** (-2.38)	-0.044** (-2.18)
INFLATION	0.00245 (1.22)	0.023 (1.33)	0.003* (1.81)	0.033 (2.45)**
LIQUIDITY	-0.035 (-0.88)	-0.036 (-1.008)	-0.0035 (-1.08)	⸺
DEFICIT	-0.0006 (-0.23)	-0.0009 (-0.38)	⸺	⸺
EXPENDITURE	0.0003 (0.29)	0.0003 (0.30)	⸺	⸺
TRANSPARENCY	-0.129* (-1.92)	-0.130** (-2.50)	-0.141*** (-3.01)	-0.135*** (-2.96)
DEVELOPMENT	-0.351e-06 (-0.093)	⸺	⸺	⸺
SIZE	0.312e-10 (0.258)	⸺	⸺	⸺
OPENNESS	- 0.0004 (-0.469)	-0.0005 (-0.69)	-0.0002 (-0.48)	⸺
R^2	0.72	0.72	0.71	0.69
Adjusted – R^2	0.49	0.56	0.60	0.62
Jarque-Bera/Salmon-Kiefer Test	χ^2 (2)= 0.152 (cv5%=5.99)	χ^2 (2)= 0.164 (cv5%=5.99)	χ^2 (2)=0.241 cv5%=5.99)	χ^2 (2)=0.218 cv5%=5.99)
Breusch-Pagan Test	χ^2 (10)=11.20 (cv5%=18.32)	χ^2 (8)=11.08 (cv5%=15.51)	χ^2 (6)=10.05 cv5%=12.9)	χ^2 (4)=8.20 cv5%=9.49)
Sample	23	23	23	23

Notes: *10%, ** 5%, ***1% significant level; (t-value); Model*: final specification.*

53

Table 2-4: OECD Countries Semilog specification

Dependent variable: CBD
Inflation, Size and Development are in logs

Explanatory variables	Model 1	Model 2	Model 3	Model 4*
Constant	0.583 (1.039)	0.107 (1.52)	0.096* (1.70)	0.055 (1.36)
INSTABILITY	0.08 (1.00)	0.12 (1.75)*	0.120** (2.02)	0.127** (2.13)
CORRELATION	-0.0265 (-0.66)	-0.052** (-2.11)	-0.050** (-2.23)	-0.043** (-2.00)
INFLATION	0.006 (0.19)	0.018 (0.86)	0.024 (1.36)	0.033** (2.11)
LIQUIDITY	-0.021 (-0.46)	-0.004 (-1.03)	-0.035 (-1.04)	——
DEFICIT	-0.0014 (0.51)	-0.0013 (-0.55)	——	——
EXPENDITURE	0.0006 (0.49)	0.0002 (0.22)	——	——
TRANSPARENCY	-0.008 (-1.18)	-0.128** (-2.36)	-0.14*** (-2.92)	-0.131** (-2.76)
DEVELOPMENT	-0.04 (-0.88)	——	——	——
SIZE	-0.003 (-0.36)	——	——	——
OPENNESS	-0.0009 (-0.72)	-0.0005 (-0.60)	——	——
R^2	0.72	0.70	0.69	0.66
Adjusted – R^2	0.49	0.53	0.59	0.59
Jarque-Bera/Salmon-Kiefer Test	χ^2 (2)= 0.147 (cv5%=5.99)	χ^2 (2)= 0.157 (cv5%=5.99)	χ^2 (2)= 0.25 (cv5%=5.99)	χ^2 (2)= 0.126 (cv5%=5.99)
Breusch-Pagan Test	χ^2 (10)=13.72 (cv5%=18.31)	χ^2 (8)= 13.79 (cv5%=15.51)	χ^2 (5)= 11.03 (cv5%=11.07)	χ^2 (4)= 11.09 (cv5%=9.49)
Sample	23	23	23	23

Notes: *10%, ** 5%, ***1% significant level; (t-value); Model*: final specification.

Table 2-5: Non-OECD Countries

Dependent variable: CBD

Explanatory variables	Model 1	Model 2	Model 3	Model 4*
Constant	0.162*** (5.46)	0.159*** (5.47)	0.157*** (5.44)	0.152*** (5.44)
INSTABILITY	-0.120 (-0.24)	——	——	——
CORRELATION	0.035 (0.88)	0.034 (0.37)	——	——
INFLATION	0.002*** (4.52)	0.019*** (4.72)	0.019*** (4.77)	0.020*** (5.35)
LIQUIDITY	-0.099 (-1.01)	-0.098 (-1.03)	-0.069 (-0.77)	——
DEFICIT	-0.010** (-2.09)	-0.010** (-2.18)	-0.009** (-2.12)	-0.009* (-2.02)
EXPENDITURE	-0.004* (-2.00)	-0.004** (-2.12)	-0.003* (-2.01)	-0.003** (-2.16)
TRANSPARENCY	-0.520** (-2.14)	-0.52** (-2.18)	-0.41* (-2.02)	-0.37* (-1.89)
DEVELOPMENT	13.999e-06** (2.25)	13.677e-06** (2.29)	11.607e-06** (2.13)	9.659e-06* (2.02)
SIZE	6.545e-11 (1.10)	6.565e-11 (1.13)	5.7453e-11 (1.09)	5.521e-11 (0.98)
OPENNESS	0.001* (1.81)	0.001*** (3.02)	0.001*** (2.90)	0.001** (2.89)
R^2	0.629	0.628	0.616	0.605
Adjusted – R^2	0.46	0.48	0.48	0.49
Jarque-Bera/Salmon-Kiefer Test	χ^2 (2)= 5.85 (cv5%=5.99)	χ^2 (2)= 4.30 (cv5%=5.99)	χ^2 (2)=2.27 cv5%=5.99)	χ^2 (2)=2.48 cv5%=5.99)
Breusch-Pagan Test	χ^2 (10)=12.83 (cv5%=18.31)	χ^2 (9)=9.70 (cv5%=16.92)	χ^2 (8)=7.16 cv5%=15.51)	χ^2 (7)=6.14 cv5%=14.07)
Sample	32	32	32	32

Notes: * 10%, ** 5%, ***1% significant level; (t-value); Model*: final specification.

Table 2-6: Non-OECD Countries Semilog specification

Dependent variable: CBD
Inflation, Size and Development are in logs

Explanatory variables	Model 1	Model 2*	Model 3	Model 4
Constant	-0.505** (-2.73)	-0.507*** (-2.81)	-0.521*** (-2.86)	-0.495** (-2.78)
INSTABILITY	0.078 (0.16)	‒‒‒	‒‒‒	‒‒‒
CORRELATION	0.038 (0.98)	0.039 (1.05)	0.030 (0.82)	‒‒‒
INFLATION	0.048*** (3.61)	0.048*** (3.89)	0.044*** (3.66)	0.043*** (3.63)
LIQUIDITY	-0.152 (-1.63)	-0.151 (-1.66)	-0.166* (-1.82)	-0.147* (-1.68)
DEFICIT	-0.009* (-1.97)	-0.009** (-2.14)	-0.005* (-1.82)	-0.005* (-1.90)
EXPENDITURE	-0.002 (-1.08)	-0.002 (-1.21)	‒‒‒	‒‒‒
TRANSPARENCY	-0.499** (-2.68)	-0.496** (-2.73)	-0.539*** (-3.00)	-0.483*** (-2.92)
DEVELOPMENT	0.052*** (2.83)	0.052*** (2.91)	0.046** (2.67)	0.043** (2.56)
SIZE	0.011 (1.50)	0.011 (1.55)	0.014* (1.98)	0.014* (1.98)
OPENNESS	0.002*** (3.47)	0.002*** (3.55)	0.002*** (3.44)	0.002*** (3.38)
R^2	0.63	0.63	0.60	0.59
Adjusted – R^2	0.45	0.48	0.46	0.47
Jarque-Bera/Salmon-Kiefer Test	$\chi^2 (2)= 0.35$ (cv5%=5.99)	$\chi^2 (2)= 0.31$ (cv5%=5.99)	$\chi^2 (2)=0.46$ cv5%=5.99)	$\chi^2 (2)=0.59$ cv5%=5.99)
Breusch-Pagan Test	$\chi^2 (10)=7.47$ (cv5%=18.31)	$\chi^2 (9)=6.83$ (cv5%=16.92)	$\chi^2 (8)=6.35$ cv5%=15.51)	$\chi^2 (7)=5.17$ cv5%=14.07)
Sample	32	32	32	32

Notes: * 10%, ** 5%, ***1% significant level; (t-value); Model*: final specification.

From our point of view, the reduced inflationary bias lowers the incentive to commit with positive impact on the level of dependence of the Central Bank. Also notice that this positive sign is consistent with the evidence, discussed above, regarding the

hypothesis that the level of development has little relevance for understanding commitment in highly industrialized countries.

2.5. Conclusions

In this paper, we explored the determinants of central bank independence on a sample of 55 countries. In particular, we studied three testable implications of the commitment hypothesis for the institutional solution to the inflationary bias in monetary policy in open economies. The first testable implication comes from game theoretical models of commitment and concerns the positive impact of the observability among the general public of governmental choices about monetary policy delegation. This is strongly supported by the data in the full sample (and in each subsample of OECD and non-OECD countries). Two other testable implications are derived from extensions of the Rogoff (1985a) model to open economies. In particular, our data deliver the following results: 1. the degree of independence turns out to be negatively related to openness among the non-OECD countries (in accordance with a straightforward extension of the model by Romer, 1993); 2. The degree of independence is positively related to the strength of the correlation with the international business cycle in the sub sample of the OECD countries (in accordance with D'Amato and Martina, 2005).

All our findings support the relevance of the commitment hypothesis and Romer's (1993) results that openness is not important in affecting average inflation in the long run, among the highly-industrialized countries. Moreover, our analysis also suggests that the reasons why these countries are the only ones that seem to have solved the

inflationary bias problem of monetary policy through the institutional solution is definitely consistent with the commitment hypothesis.

Finally, whereas in the literature after Rogoff (1985a) the emphasis for the commitment hypothesis has shifted towards the political determinants of Central Bank independence, our results document fairly consistent empirical evidence in support of the hypothesis that institutional solutions to the inflationary bias problem in different countries are related to the strategic and economic features underlying the delegation process. Indeed, we show that it is affected by the game-theoretical frame of the commitment choice and by the features of the business cycles in the economies where the institution is devised.

Our results show that there seems to be a fix to the inflationary bias problem but it is far from being a "quick fix" at least in terms of the incentives political institutions have in adopting it. How effective the fix is, depends on many economic factors that affect the balance between costs and benefits of flexibility in monetary policy in the open economy. Fundamental economic features, like the degree of synchronization between the domestic and the world-wide business cycle, and the strategic aspects of the specific game between public governments and private sector seem to be quite important for the empirical explanation of central bank independence. Economic forces and the related strategic issues seem to be quite important in the data we analyze and they downplay the role of explanations mainly based on procedural and formal aspects of modern democracies.

2.6. Appendix

2.6.1. Data definition and sources

CBD = Measure of central bank dependence over the period 1980-89. This index, proposed by Cukierman, Webb and Neyaptis (1992), is based on two variables: the turnover rate of central bank of governor and index of legal dependence. The weight on the turnover and legal independence in this index are derived by regressions of average inflation on the two variables, using separate regressions for industrialized and non-industrialized countries. This index is also available in Romer (1993).

INSTABILITY = Measure of political instability. It is mean number of revolutions, terrorist attack and coups per year for the period 1960-85. Source: Romer (1993).

DEVELOPMENT = Real GDP per capita, average over the period 1960-79. Source: Penn world tables 6.1.

POP = population (1960-79). Source: Penn world tables 6.1.

SIZE = DEVELOPMENT * POP (1960-79).

CORRELATION = Yearly correlation between US real GDP growth and country-specific real GDP growth (1961-79). Our elaboration.

CORRELATION*** **=** Yearly correlation between World real GDP growth and Country specific real GDP growth (1961-79). Our elaboration.

TRANSPARENCY = Daily newspaper circulation per capita, average over the period 1972-1987. Source: Banks (1999).

INFLATION = Change in the GDP deflator, average over 1961-1979. For countries for which this series is not available, we use the change in the CPI instead. Source: IMF supplement series, n.12, 1986.

OPENESS = Share of imports over the GDP, average over the period 1970-1979. Source: IMF supplement series, n.4, 1982.

EXPENDITURE = Total government expenditure as percentage of GDP, average over 1970-79. Source: IMF supplement series, n.11, 1986.

DEFICIT = Central government deficit as percentage of GDP, average over 1970-79. Deficit is defined as the total of revenue plus grants minus the total of expenditure plus lending minus repayments. Source: IMF supplement series, n.11, 1986.

LIQUIDITY = M2 over GDP, average over the period 1970-79, where M2 is money plus quasi-money *i.e.* the sum of money and time, savings and foreign currency deposit with the monetary authorities and deposit money banks. These deposits exclude deposit by the central government and by non-residents. Source: IMF supplement series, n.5, 1983.

2.6.2. The sample of 55 countries

Country	OECD *membership*	Country	OECD *membership*
Argentina		Malaysia	
Australia	√	Mexico	
Austria	√	Nepal	
Barbados		Netherlands	√
Belgium	√	NewZealad	√
Botswana		Nicaragua	
Brazil		Norway	√
Canada	√	Pakistan	
Chile		Panama	
Colombia		Peru	
Costa Rica		Philippines	
Denmark	√	Portugal	√
Egypt		Singapore	
Finland	√	South Africa	
France	√	Spain	√
Germany	√	Sweden	√
Ghana		Switzerland	√
Greece	√	Tanzania	
Honduras		Thailand	
Iceland	√	Turkey	√
India		UK	√
Indonesia		USA	√
Ireland	√	Uganda	
Israel		Uruguay	
Italy	√	Venezuela	
Japan	√	Zambia	
Kenya		Zimbabwe	
Korea			

Chapter III:
Political institutions and central bank independence revisited*

3.1. Introduction

Research on "political macroeconomics" during the last twenty years showed growing interest in factors affecting monetary policy and its performance.

Several studies have examined the causes for monetary instability in different countries and at different historical times. To account for differences in inflation rates among countries, empirical analyses have highlighted the key role of Central Bank independence (hereinafter "CBI"): in fact, it is widely documented that a higher degree of CBI is associated with a lower inflation rate in developed countries.[55]

The recognition of this link has encouraged the study of factors that influence the CBI. In particular, wide empirical literature exists[56], analysing the economic and social determinants that cause changes in the degree of commitment to the monetary policy of individual countries.[57]

The institutional systems of countries also represent a crucial factor in determining the degree of independence of the central bank. Research on this topic is, however,

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* A shorter version of this chapter (with B. Pistoresi and D. Ferrari) was published in 2011 in Applied Economics Letters.

[55] For a survey see Cukierman (1992) and Cukierman (2008).

[56] Recent works on this topic include: D'Amato, Pistoresi, and Salsano (2009); Polillo and Guillem (2005).

[57] To explain cross country variation in the observed degree of independence the theoretical commitment approach (Rogoff 1985a; Lohmann 1992) argues that the costs of an independent Central Bank, from the government's point of view, consist mainly of the loss of flexibility in monetary policymaking. The balance between flexibility and credibility determines the equilibrium degree of central bank independence in a country. The balance between costs and benefits in delegating the power to manage paper money may depend on many aspects of the economy and on its institutional framework.

very limited. Two major studies exist: Farvaque (2002) and Moser (1999), who have shown how the legal CBI is significantly higher in OECD countries where legal procedures are characterized by extensive checks and balances[58] and the state has a federal form.

The aim of this paper is to investigate this issue further. Changes with respect to the works by Farvaque (2002) and Moser (1999) develop in three directions.

The first concerns the time horizon of the analysis, carried out until 2005 using the update by Polillo and Guillem (2005) of the legal independence index of Cukierman (1992). The cross-country and time-series dimensions of this new dataset enable us to study the dynamic behaviour of CBI over the past couple of decades. During this period Central Banks in advanced economies continue to enjoy greater independence, in particular at the end of 2003, all country groups exhibit a higher level of CBI than that reached by advanced economies in the late 1980s.

The second concerns the fact that the institutional variables are examined together with a number of economic variables that were not considered by Farvaque (2002) and Moser (1999), including in particular the correlation between the country's business cycle and the world business cycle. The goal is to analyse the impact of synchronization of international business cycles on the incentives of policymakers to pre-commit monetary policies to CBI. As recently described by D'Amato and Martina (2005), the correlation of economic cycles may reinforce or countervail the traditional argument holding for the case of commitment in closed economies and they may contribute to explaining why some countries strategically commit monetary policy whereas others may rationally neglect such a solution.

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[58] In a checks and balances system the legislative function is equally divided between at least two decision-making bodies (two-chamber parliamentary system, or the opportunity for the active voters to request a referendum), which hold veto powers.

Finally, we use the least absolute shrinkage and selection operator (Lasso) (Tibshirani, 1996) for selecting the determinants of CBI from a large set of explanatory variables. Differently from traditional information-theoretical procedures producing over-fitting models (with small model bias but large variance), selection by Lasso is optimal in terms of balancing such a trade-off.

The main contribution of the present paper is to show the existence of an economic "*external constraint*" that seems to account for the choice of the degree of CBI in the different countries: the correlation between the shocks to the level of economic activity and, for a sub-sample of economies, the convergence criteria to join the European Monetary Union (EMU).

3.2. Data and methodology

In this paper the CBI is considered to be an endogenous variable, measured by the legal independence index of Cukierman (1992), updated by Polillo and Guillem (2005) until 2003. The 54 exogenous variables considered are economic and institutional determinants of the CBI. Our sample includes 24 OECD countries[59] and spans from 1980 to 2003.

The economic variables used are the following: the world-wide common component in the business cycle (*i.e.*, the correlation between the country's GDP growth and the world GDP growth[60]), the past inflation, and the size of the economy (*i.e.* real GDP total). They have been selected following the results of D'Amato, Pistoresi, and Salsano

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[59] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Holland, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK, US.
[60] We use the correlation between the GDP growth in each country and a weighted average of the growth rates of the economies in the sample. The weights are the GDP levels in each country. The result does not depend on the proxy for the common component. On this point, see D'Amato, Pistoresi, and Salsano (2009).

(2009), which show how these are the relevant variables for the OECD countries to account for the CBI.[61]

Sources of such data include IMF (2008) and World Bank (2008). In addition, the dummy variable EUROPEAN MONETARY UNION (EMU) is considered, which takes the value of 1 (in the 1998-2003 period) for the countries that joined the EMU after complying with the convergence criteria provided for by the Maastricht Treaty.

The political and institutional variables are taken from the DPI database (2006) of the World Bank. Such variables are basically divided into seven different groups: those relevant to the executive power, the parties that make up the legislative power, the electoral rules, the stability of the political system, the checks and balances system, and the state form, *i.e.*, whether or not it is a federal state.[62] These last two groups include the variables analysed by Farvaque (2002) and Moser (1999).

To select the determinants of the CBI from the database of 54 potential explanatory variables, we use the Lasso method for linear regression (Tibshirani, 1996). This method minimizes the sum of squared errors, with a bound on the sum of the absolute values of the coefficients. The tightness of the bound depends on a tuning parameter, usually selected by cross-validation (e.g., see Hastie et al., 2001), as is the case in this work. Differently from traditional information-theoretical procedures producing over-fitting models (with small model bias but large variance), selection by Lasso is optimal in terms of balancing such a trade-off.

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[61] See D'Amato, Pistoresi, and Salsano (2009) for further details on the variables and their relation with the CBI.

[62] Please refer to the DPI (2006) for a definition of each variable included in the above-mentioned groups. The previous version of this database is described in Beck at al. (2001). The updated DPI (2006) by Keefer (2006) is maintained at the URL: http://go.worldbank.org/2EAGGLRZ40. Note that we use the same variable definitions when we comment the results.

3.3. Regression results

The Lasso method suggests 13 determinants of CBI out of 54 making up the whole sample considered. Their coefficients are estimated by OLS and presented in Table 1. We exclude the outcome from the reduced specification, (Model 2) in which there are no significant variables from Model 1.

Table 3-1: Determinants of the Central Bank Independence (CBI) optimally chosen by the selection operator Lasso

	MODEL 1		MODEL 2	
	Estimate (OLS)	t-value	Estimate (OLS)	t-value
INTERCEPT	0.41***	13.91	0.38***	23.39
Party variables				
GOV2SEAT	0.0007***	3.65	0.0007***	4.09
GOVOTHST	- 0.0032***	- 4.92	-0.003***	- 4.95
OPPVOTE	-0.0007	-1.35	--------------	-----------
OPP2VOTE	-0.0002	- 0.18	--------------	-----------
OPP3VOTE	- 0.007***	- 4.58	-0.008***	-5.80
EXECSPEC	- 0.12***	- 5.55	- 0.11***	
Electoral Rules				
PLURALITY	0.08***	4.96	0.079***	4.98
HOUSESYSTEM	- 0.16***	- 9.80	-0.17***	-10.87
Stability - Checks and Balance				
TENSHORTLAX	0.001	0.47	--------------	----------
Federalism				
FEDERALISM	0.091***	5.74	0.096***	6.42
Economic variables				
PAST INFLATION	- 0.002**	- 2.91	-0.002**	-2.93
WORLD CYCLE	0.128***	5.76	0.131***	6.08
Monetary institution				
EMU	0.45***	28.63	0.38***	23.39
Degrees of freedom	**555**		**563**	
Adjusted R^2	**0.7045**		**0.7048**	

Notes: Asterisks denote significance at the 1% (***), 5% (**) level.

Central Bank independence is larger the higher the correlation between the country's business cycle and the world business cycle (WORLD CYCLE). To understand this result, consider that governments expect their economies to be in the same state as the world's (booms or busts) as foreign economies. All governments in each country have a strategic incentive to commit monetary policy in order to free ride on the stabilization provided abroad and gain credibility at home. Hence, the larger the correlation is among shocks, the larger the incentive to hold a commitment (*i.e.*, the larger the CBI).

A negative relation between CBI and PAST INFLATION supports the idea stressed by Cukierman (1992) that inflation leads to the evolution of automatic accommodative mechanisms such as indexation of contracts in the labour and capital markets to the general price level. Society reduces opposition to inflation and public pressure for an independent Central Bank.

The dummy EMU suggests that the participation in the EURO encouraged individual countries to change the institutional design of the monetary policy in view of greater price stability.

We find FEDERALISM is a significant element of a country's institution associated with CBI. As suggested by Farvaque (2002) and Moser (1999), federalist countries may promote a stable monetary policy by constraining fiscal policy. In addition, federalism determines society's inclination towards price stability by strengthening the influence of the financial opposition to inflation (Posen, 1995).

Both variables relevant to the electoral systems are highly significant: PLURALITY and HOUSESYSTEM.

PLURALITY (which points to the presence of a uninominal majority electoral system) is positively correlated: The countries whose governments are elected using the majority system are generally supported by strong and broad majorities, and this

leads the political contenders to subtract the monetary policy *ex ante* from the scope of the government, lest it be exploited for electoral purposes.

Such interpretation seems to be confirmed by the negative correlation of HOUSESYSTEM (which points to the presence of a mixed electoral system, *i.e.*, partly majority-based and partly proportional). The countries where such electoral laws are in place are characterized by greater political fragmentation and by a stricter control over the government by the opposition. Therefore, their incentive to commit is weaker.

This result is further confirmed, in part, by the party variables. In fact, OPP3VOTE (rate of votes of an opposition made up of three parties) is significant and negatively correlated. This means that highly fragmented parliaments have a negative impact on the degree CBI. The EXECSPEC variable (which specifies whether the governing parties support any special interests) has a negative impact on the degree of CBI. Finally, the GOV2SEAT variable (the share of votes of 2-party governments) has a positive impact.

3.4. Conclusions

This paper confirms the role of federalism as one of the determinants of a country's incentive to commit to monetary policy stressed by Farvaque (2002) and Moser (1999), while the role of the checks and balances does not look significant. Another finding is the existence of an "*external constraint*", which seems to guide the individual countries in their choice of the institutional design of the monetary policy. In particular, such constraint is posed both by written rules (*i.e.*, compliance with the convergence criteria to join the EMU), and by the correlation between the country's business cycle and the world business cycle.

Chapter IV:
Political Stabilization by an independent Central Bank

4.1. Introduction

The question of the Central Bank, its political independence, its tasks, and how it fulfils them, has returned to the centre of political discussion. The Anglo-American subprime crisis of 2007 and the European sovereign debt crisis of 2011 generated intense pressure by politicians, financial institutions, employers and trade unions for a further extension of the competence of Central Banks in financial supervision, and for expansion of the objectives and degrees of freedom in the monetary policy that Central Banks implement.

This paper examines a case in which the Central Bank must pursue its objectives, while diverse actors, such as political institutions (government or parliament), financial institutions (commercial banks, investment funds, insurance companies) and in general all organized interest groups (lobbies) apply strong pressure on the Central Bank in order to 'capture' it and ensure monetary policy decisions which do not conflict with their interests.[63]

This is a problem common to all processes of delegation by a principal – the government, parliament or politicians in the broad sense – to an agent – the 'authority' or an independent bureaucrat.

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[63] Canova (2007, p. 3) discussed the non-state actors that impacted on the present global economic order by capturing state institutions – the regulated industry capturing the regulator – often with promises of future employment, political support, and campaign contributions. But he mentioned that there was a "relative silence regarding the capture of Central Banks, perhaps the most significant agency capture by non-state actors in today's *de-jure* international financial setup".

The core question is this: what are the costs and benefits of granting independence to these regulatory authorities?

A body of economic literature (Stigler, 1971; Posner 1974; Laffont and Tirole, 1993; Laffont and Martimort, 1999; Faure-Grimaud and Martimort, 2001) has sought to give an answer to this question by analysing the interactions among a regulatory agency, its political principals, and the interest group which is supposed to be regulated.

In the case of monetary policy, the conflict of interest among economic agents, which in turn reflects their diversity, is essential for interpretation of these costs and benefits.

The conflict of interest relates to the creditors/debtors issue in the economy. Inflation reduces the real weight of a non-indexed debt – *i.e.* one which remains fixed in nominal terms – while disinflation aggravates that weight. For debtors, inflation means lower real debt, whereas disinflation means higher debt. Thus generated is a symmetrical redistributive effect: inflation redistributes from creditors to debtors; disinflation does so from debtors to creditors. In a context of this kind, the banks and large financial groups[64] are anti-inflation actors.[65] By contrast, small business owners and farmers, who have an incentive to favour 'surprise inflation' in order to pay lower real wages, or all economic actors exposed to the banking sector, are pro-inflation groups.[66]

To be noted is that interest groups (lobbies) have a particularly influential role only if they can corrupt and acquire particular economic information also available to the Central Banker: in this case the lobbies have an interest in inducing the monetary authority to conceal important information so that they can gain an advantage.

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[64] On this see Posen (1995), who argues that the financial sector is generally the main supporter of the Central Bank's political independence.

[65] Kane (1980) argues that builders and construction unions also form an anti-inflationist group for similar reasons.

[66] Of course, there have been moments in history – for example, the financial crisis of 2007 – when also the financial sector has found it convenient to ease its debts.

The institutional design of monetary policy – for example, the degree of independence of the Central Bank – may also influence the relationship between interest groups and the monetary authority (Cukierman, 2013).

It can be also hypothesised that the more a Central Bank is independent of the government, the more vulnerable it will be to the pressure of interest groups.

All these aspects have been analysed by Gabillon and Martimort (2004), who consider a 'two-tier' model of monetary policy where the Central Banker is subject to both explicit influence by the elected political principal through a contract and implicit influence by anti-inflation interest groups seeking to 'capture' monetary policy. The degree of political independence therefore influences the agency costs paid to control the Central Banker. The result obtained by Gabillon and Martimort (2004) is that political independence increases the agency costs (*agency cost effects*) but prevents greater fluctuations in inflation due to exogenous political uncertainty with respect to the election result (*stabilization effect*). On comparing the two effects, *ex-ante* social welfare increases in the case of political independence.

This paper investigates how the independence of the Central Bank influences the election outcome when political uncertainty is endogenized in Gabillon and Martimort's model, considering forward-looking voters who make their decisions by comparing the policy platforms proposed by the two main political competitors.

The rest of the paper is organized as follows. Section 2 presents a summary of Gabillon and Martimort's model; Section 3 describes our extension of this model; finally, Section 4 sets out the conclusions.

4.2. The Gabillon-Martimort model

Gabillon and Martimort (2004) provide an explanation for a possible link between the degree of independence of a Central Bank (CB) and policy stabilization. The first key ingredient of the model is the possibility of capture of these agencies by the interest groups in the financial sector. Indeed, in a world of information asymmetries, regulators accumulate information about the welfare effects of different policies and they can be bribed to manipulate information. The second ingredient is political uncertainty. The extent to which a Central Bank is affiliated to a political party affects the likelihood that this particular agency remains in place as political powers alternate in office. The status of the Central Bank thus significantly changes the collusive opportunities between this Central Bank and the financial industry.

In this section, we summarize the main elements of the Gabillon-Martimort model. This will serve the purposes of the next section, in which we proceed with extension of this model.

Contrary to the literature on monetary institutions that takes the contractual approach, the CB's incentive mechanisms are not designed by a social planner, but by partisan political principals[67] who want to please different constituencies and thus express different concerns for the trade-off between price control and surprise inflation depending on whether they represent a leftist or a rightist constituency.[68] Because of information asymmetry between the CB and the government, there is also scope for collusion between private interest groups and the CB. However, the scope for capture depends on the exact control rights that principals retain over the CB.

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[67] The political principal can be conceived as the elected legislative or executive branch of the government.
[68] It is a contract between an elected political principal, a CB, and the private sector in a two-tier model of monetary policy.

4.2.1 Preferences

CB: The CB receives a monetary transfer *s* from whichever political principal has been elected to perform the monetary policy. The CB's utility is V = s.

This transfer can be viewed as the share of the central bank budget and resources that can be diverted by the monetary authority for its private use. Alternatively it can also be interpreted as the probability of being promoted to a higher position in the civil service times the benefits of this higher position.

Political Principals: A political principal maximises an objective function *à la* Barro-Gordon (1983):

$$SW_{\alpha i} = -\pi^2/2 + \alpha_i \theta(\pi - \pi^e) - s \qquad (4.1)$$

where π is the inflation level, π^e its expectations, $\alpha_i > 0$ (with $i \in \{L, R\}$) is the weight that the political principal gives to creating surprise inflation. θ is a macroeconomic shock affecting both political principals' concerns for output expansion. *s* is the transfer given to the CB.[69]

A rightist government is less willing to create surprise inflation than a leftist one. $\Delta\alpha = \alpha_L - \alpha_R > 0$ represents the degree of polarization of the society *i.e.* the difference between the concerns for surprise inflation between a leftist party and a rightist one. The probabilities of each of these two political principals being elected are exogenous ($\alpha = \alpha_R$ with probability *p* and $\alpha = \alpha_L$ with probability 1 - *p*). In the next section we will change this assumption.

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[69] The Central Bank has no weight in the principal's objective function, capturing the fact that redistributing wealth to bureaucrats as such is not part of the government's objective. Alternatively, civil servants represent a group with negligible social weight. The main insights of the analysis are robust to the case where parties' objective functions give the same positive (but less than one) weight to the regulator's utility. (See Laffont and Martimort, 1999; Faure-Grimaud and Martimort, 2003, where they show that the separation of powers in regulation may act as a commitment against the threat of regulatory capture). This means considering the objective function in this way: $SW_{\alpha i} = -\pi^2/2 + \alpha_i \theta(\pi - \pi^e) - \lambda s,$ for any $0 < \lambda < 1$.

Interest group: The anti-inflationist group obtains a utility from unexpected inflation which is equal to: $IG = -\beta\theta\left(\pi - \pi^e\right)$ with $\beta > 0$.[70]

4.2.2. Information structure

The shock is θ drawn from a common knowledge distribution on $\Theta = \left\{\overline{\theta}, \underline{\theta}\right\}$ with respective probabilities 1 - v and v. It is possible to normalise $\overline{\theta} = 1$ so that we have $\Delta\theta = 1 - \underline{\theta} > 0$. Anti-inflationist incentives are thus greater when $\underline{\theta}$ is realised. The CB and the interest group have complete information on the shock θ. This information structure has already been discussed in the literature by Peek, Rosemgren, and Tootell (1999), who analyze the relationship between monetary policy and problems in the banking sector, which may serve as an early indicator of deteriorating macroeconomic conditions.

Instead, at the time when the CB's incentives are designed, the political principals and the (non-financial) private sector remain uninformed about the exact value of this shock.

The CB can conceal verifiable evidence that the economy is doing badly $\left(\overline{\theta}\right)$ and instead announce that $\hat{\theta} = \underline{\theta}$. The mere possibility that the CB can conceal such information is the 'key' to understanding the scope for collusion with an anti-inflationist interest group. Conversely, the CB can issue credible reports about the real state of the economy.[71]

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[70] The pro-inflationist interest group can be easily seen in the model. In this case the utility of this group is: $IG = \gamma\theta\left(\pi - \pi^e\right)$ with $\gamma > 0$.

[71] A 'credible report' means that the CB presents documents produced by its research department showing that the economy is in a good or bad state.

4.2.3. Incentive contract

Study of the properties of mechanisms designed to prevent collusion between several members of an organization has become a highly active area of research since the pioneering work of Tirole (1986).

When, as in our case, a supervisor (CB) and an agent (Financial Sector) have complete information about an event (the real situation of the economy), while a principal (Political Principal) is not informed about this event, we can verify that agent–supervisor coalitions can be formed to maximize private objectives and potentially defeat the purpose for which that supervision has been established. Our analysis will now take account of the possibility that such collusive behaviour of the agent and the supervisor may occur. We can assume that the two parties agree by way of *a side-contract*. This side-contract will reduce the ability of the principal to extract information from the supervisor. To avoid such collusion, the principal can in turn reward the supervisor for every report on the true state of the economy.

The optimal contract is always the contract that deters collusion. Should collusion occur, at the optimum the principal can always alter the contract by making quantity transfers independent of the supervisor's report, and collusion will be deterred because it is no longer useful to the agent. This is known as the *collusion-proofness principle.*

Hence, to deter collusion, the principal must be sure to reward the supervisor for reporting the truth by an amount that is exactly equal to the maximum bribe that the agent can offer the supervisor to keep quiet: anything less will open the door to collusion, and anything more will be a waste of money.

4.2.4. CB contracts and Collusion technology

The *grand-contract* between the elected political principal and the CB consists of wages *s* and inflation targets π. $\left(\underline{s}_i, \underline{\pi}_i\right)$ (resp. $\left(\bar{s}_i, \bar{\pi}_i\right)$) represents, respectively, the wage and inflation target when the economy is going well $\underline{\theta}$ (resp. goes badly, $\bar{\theta}$).

The *side-contract* or collusion between the CB and the interest group consists of secret side-transfers. The CB has all the bargaining power in the design of side-contracts. When the economy is going badly, the anti-inflationist interest groups want the CB to report $\underline{\theta}$ to keep inflation low. From the false report of the CB to the political principal, the interest group earns:

$$\beta\bar{\theta}\left[\left(\bar{\pi}_i - \pi_i^e\right) - \left(\underline{\pi}_i - \pi_i^e\right)\right] = \beta\Delta\pi_i.$$

The interest group is not willing to bribe the CB to misreport when $\underline{\theta}$ realizes, since doing so would increase inflation. However, because of the illegal nature of capture, the side-contract between this group and the CB suffers from some transaction costs[72]. The exchange of τ units of bribes only yields the CB a private benefit from holding office:

$K(\tau) = k\tau - \dfrac{r}{2}\tau^2$, where $0 < k \leq 1$ and r >0, so that the transaction costs of side-contracting are equal: $\tau - K(\tau)$.[73]

4.2.5. The legal status of the CB

The CB has *political independence* (PI) when he cannot be fired by the newly-elected political principal. Under *political control* (PC) the CB is in power if the party with

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[72] See Tirole (1992) for a first discussion of the origins of these transaction costs.
[73] Gabillon and Martimort (2004) assume that K(.) is strictly concave and increasing in the interval (0, k/r). These two assumptions capture the fact that transferring more wealth to the CB makes it easier for the interest group to affect his decision-making but the marginal efficiency of doing so decreases.

which he is affiliated is elected. In this case, the principal has control rights on who should be the head of the Central Bank.

4.2.6. Timings

The timing of the game depends on the legal status of the Central Bank. Under *political control* it is as follows:

T = 0: The electoral outcome realizes, and the preferences of the elected political principal are known to all players including the private sector of the economy.

T = 1: The CB receives a grand-contract from the political principal that has just been elected. This contract stipulates wages and inflation targets. The private sector forms its expectations on inflation and negotiates wage contracts.

T = 2: *Ex-post collusion stage.* If the CB has accepted the grand-contract, he offers a side-contract to the interest group. This side-contract consists of a bribe in exchange for hiding the item of information that he has available. This side-contract is accepted or rejected.

T = 3: θ is learned by the CB and the interest group.

T = 4: The CB makes an announcement on the state of the economy, and the corresponding inflation target and wage are implemented. Side-transfers, if any, are exchanged.

Importantly, under *political control* the CB and the interest group cannot agree on a side-contract before political uncertainty is resolved. Instead, an *independent CB* and the interest group can also agree on an *ex-ante* side-contract.

With an independent CB, the timing of the game is in part as above:

T = 0: Both political parties propose their electoral platforms non-cooperatively. These platforms consist of incentive contracts to the CB. These grand-contracts

stipulate budgets and inflation targets conditionally on whether the offering party is elected. The CB accepts or rejects both grand-contracts, being still uninformed on the state of the economy θ.

$T = 1$: *Ex-ante* collusion stage. If the CB has accepted the grand-contracts, he offers a side-contract to the interest group. This side-contract is now conditional on the electoral outcome.

$T = 2$: The electoral outcome realizes and the preferences of the political principal are known to all players including the private sector of the economy, which now forms its expectations on inflation.

Stages $T = 3$ and $T = 4$ are then the same as with affiliated CBs.

4.2.7. A benchmark with complete information

Under complete information, the first best inflation targets, $\underline{\pi}_i$ and $\overline{\pi}_i$, offered by the elected political principal i maximize expected welfare defined as:

$$\underset{(\underline{\pi}_i, \overline{\pi}_i)}{Max} \; v\left[-\frac{\underline{\pi}_i^2}{2} + \underline{\theta}\alpha_i\left(\underline{\pi}_i - \pi_i^e\right) \right] + (1-v)\left[-\frac{\overline{\pi}_i^2}{2} + \alpha_i\left(\overline{\pi}_i - \pi_i^e\right) \right]$$

s.t. $\pi_i^e = v\underline{\pi}_i + (1-v)\overline{\pi}_i$.

Rewriting the principal's objective as a function of average inflation π_i^e and the difference in inflation targets $\Delta\pi_i = \overline{\pi}_i - \underline{\pi}$ the principal's problem becomes:

$$\underset{(\pi_i^e, \Delta\pi_i)}{Max} \; -\frac{\left(\pi_i^e\right)^2}{2} + v(1-v)\left(\alpha_i\Delta\theta\Delta\pi_i - \frac{\left(\Delta\pi_i\right)^2}{2} \right).$$

In the case of full commitment to a policy rule, the optimal monetary policy requires:

$$\pi_i^{FBe} = 0$$

The difference in inflation targets between both states of the world is thus:

$$\Delta\pi_i^{FB} = \alpha_i\Delta\theta > 0$$

The above commitment policy has been extensively criticized for not being time-consistent. Gabillon and Martimort investigate instead how this policy is robust to political pressures. Taking this perspective highlights that different institutional designs offer different responses to agency problems. They find that: $\Delta\pi_R^{PC} < \Delta\pi_R^{PI} < \Delta\pi_L^{PI} < \Delta\pi_L^{PC}$.[74] However, granting political independence to the CB somewhat insulates monetary policy from political fluctuations: *a stabilization effect*. The cost of independence is nevertheless that the CB is more prone to capture by interest groups: *a delegation effect*. The stabilization effect is always strong enough to dominate the delegation effect. Hence*, ex ante* social welfare is greater under political independence than under political control.

4.3. An extension of Gabillon-Martimort's model with endogenous political uncertainty

In this section, election probabilities are thus endogenized, with each party's probability of success depending on both its own and the other parties' policies. This approach[75] considerably revises the properties of the classic partisan model. Most notably, we demonstrate that endogenous voting will have important consequences for the magnitude of the partisan effect.

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[74] The difference in inflation targets under political control is: $\Delta\pi_i^{PC} = \dfrac{\alpha_i\Delta\theta - k\beta/v}{1 - r\beta^2/v}$ with $i \in \{L, R\}$.

The difference in inflation targets under political independence is: $\Delta\pi_R^{PI} = \dfrac{\alpha_R\Delta\theta - k\beta/v + (1-p)(r\beta^2/v)\Delta\theta\Delta\alpha}{1 - r\beta^2/v}$ and $\Delta\pi_L^{PI} = \dfrac{\alpha_L\Delta\theta - k\beta/v - p(r\beta^2/v)\Delta\theta\Delta\alpha}{1 - r\beta^2/v}$.

[75] A similar approach is considered by Alesina (1988), Balke (1988) and Ellis (1991).

Let us now endogenize political uncertainty in Gabillon-Martimort's model by assuming that forward-looking voters decide their ballot by comparing the expected payoffs that they will obtain with each party. Voters are ideologically differentiated with respect to the trade-off that they would implement between surprise inflation and price stabilization *i.e.* with respect to their α.[76] This parameter may in this case be interpreted as representing the voter's location in the wealth distribution.

4.3.1. Monetary policy under political control

Let us first consider the case when the Central Banker is under political control. Because agent α is indifferent between a rightist policy $\Delta\pi_R$ and a leftist policy implementing $\Delta\pi_L$, it must obtain the same expected payoff with both policies. Hence:

$$SW_\alpha(\Delta\pi_R) = SW_\alpha(\Delta\pi_L)$$

Following Gabillon and Martimort (2004), we now write social welfare, in regime political control with party $i \in \{L, R\}$, under asymmetric information and the threat of capture, thus:

$$SW(\Delta\pi_i) = -\frac{(\pi_i^e)^2}{2} + v(1-v)\left(\alpha_i \Delta\theta\Delta\pi_i - \frac{(\Delta\pi_i)^2}{2}\right) - AC_i^{PC}(\Delta\pi_i)^{[77]} \qquad (4.2)$$

where $AC_i^{PC}(\Delta\pi_i) = (1-v)K(\beta\Delta\pi_i)$ is the agency cost associated with the delegation of monetary policy to the CB.[78]

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[76] This depends on differences in the ideologies if voters are rightist or leftist.

[77] Even in the case of monetary policy offered when the central banker benefits from political independence, the SW function is the same; only the agency cost AC changes.

[78] In effect, an optimal monetary policy proposed by principal *i* must implement collusion-proofness at minimal agency cost: $AC_i^{PC}(\Delta\pi_i) = \min_{\{\underline{s}_i, \overline{s}_i\}} v\underline{s}_i + (1-v)\overline{s}_i$ s.t. a *collusion-proofness constraint* and *participation constraint.* For the first constraint, the Central Banker must be sufficiently rewarded to report truthfully, so that colluding with the anti-inflationist interest group becomes a dominated strategy. The grand-contract must thus satisfy a *collusion-proofness constraint*: $\overline{s}_i - \underline{s}_i \geq K(\beta\Delta\pi_i)$. The

Under asymmetric information and political control, the optimal collusion-proof monetary policy offered by a political principal i entails no inflationary bias, so that:

$$\pi_i^e = 0$$

We now rewrite the social welfare function as follows:

$$SW(\Delta\pi_i) = v\left(\alpha_i\Delta\theta\Delta\pi_i - \frac{(\Delta\pi_i)^2}{2}\right) - \left[k\beta\Delta\pi_i - \frac{r}{2}(\beta\Delta\pi_i)^2\right] \qquad (4.3)$$

The probability of the political party i (with i= Right, Left) being elected is a function of politically induced fluctuations in the variance of inflation, thus: $P = p(\Delta\pi_L - \Delta\pi_R)$.

We take from Friedman the hypothesis of variance of inflation. Indeed, Friedman (1977) considered why policy makers may be affected by inflation variability. Friedman wanted to explain why there is a positive correlation between the level of inflation and the variability of inflation across countries and over time for any given country. In Friedman's analysis, a government may temporarily pursue a set of policy goals (output, employment) that lead to high inflation; this, in turn, elicits strong political pressure to reduce the debasing of the currency. Chowdhury (1991) re-examined the relation between the level and the variability of inflation for a sample of sixty-six countries over the 1955–90 period. His results indicate the presence of a significant positive relation between the rate of inflation and its variability.

In a Nash equilibrium of the choice of the political right-wing party platforms, Z_R chooses $\Delta\pi_R$ so that it maximizes:

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left-hand side represents the wage differential necessary to prevent collusive behaviour and to induce a truthful announcement by the Central Banker. The right-hand side represents the benefits that the Central Banker can obtain from his collusive relationship with the anti-inflationist interest group. For the second constraint, the Central Banker prefers to enter the public sector rather than obtain a utility equal to zero, so that the *participation constraint* must be satisfied: $\underline{s}_i \geq 0$. Note that when $\Delta\pi_i = \overline{\pi}_i - \underline{\pi} > 0$, the two constraints imply also $\overline{s}_i > 0$. This last *participation constraint* can be omitted in what follows as long as the stake for collusion remains positive. For further details on *collusion-proofness constraint* and *participation constraint* see Gabillon and Martimort (2004, p. 364).

$$p(\Delta\pi_L - \Delta\pi_R)SW_{\alpha R}(\Delta\pi_R) + [1 - p(\Delta\pi_L - \Delta\pi_R)]SW_{\alpha_R}(\Delta\pi_L) \qquad (4.4)$$

Then:

$$p(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_R\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} +$$

$$+[1 - p(\Delta\pi_L - \Delta\pi_R)]\left\{v\left(\alpha_R\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\}$$

Z_R now takes into account the impact of its policy choice on the probability of being elected. The corresponding first-order condition (FOC) is now written as:

$$p(\Delta\pi_L - \Delta\pi_R)\left\{v(\alpha_R\Delta\theta - \Delta\pi_R) - k\beta + r\beta^2\Delta\pi_R\right\} + \qquad (4.5)$$

$$- p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_R\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\}$$

$$+ p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_R\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\} = 0$$

After some algebra we obtain:

$$\Delta\pi_R^{PC} = \frac{\alpha_R\Delta\theta - \frac{K\beta}{v}}{1 - \frac{r\beta^2}{v}} +$$

$$+ \frac{p'(\Delta\pi_L - \Delta\pi_R)}{p(\Delta\pi_L - \Delta\pi_R)}\underbrace{\left\{\frac{\alpha_R\Delta\theta - \frac{K\beta}{v}}{1 - \frac{r\beta^2}{v}}(\Delta\pi_L - \Delta\pi_R) - \frac{1}{2}\left[(\Delta\pi_L)^2 - (\Delta\pi_R)^2\right]\right\}}_{\textit{Electoral effect}} \qquad (4.6)$$

In the case of the left, Z_L chooses $\Delta\pi_L$ so that it maximizes:

$$p(\Delta\pi_L - \Delta\pi_R)SW_{\alpha_L}(\Delta\pi_R) + [1 - p(\Delta\pi_L - \Delta\pi_R)]SW_{\alpha_L}(\Delta\pi_L) \qquad (4.7)$$

Then:

$$p(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_L\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} +$$

$$+[1 - p(\Delta\pi_L - \Delta\pi_R)]\left\{v\left(\alpha_L\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\}$$

The corresponding FOC is now written as:

$$p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_L\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} +$$

(4.8)

$$+\,[1 - p(\Delta\pi_L - \Delta\pi_R)]\{v(\alpha_L\Delta\theta - \Delta\pi_L) - [k\beta - r\beta^2\Delta\pi_L]\} +$$

$$-\,p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_L\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\} = 0$$

It follows that:

$$\Delta\pi_L^{PC} =$$

(4.9)

$$= \frac{\alpha_L\Delta\theta - \dfrac{K\beta}{v}}{1 - \dfrac{r\beta^2}{v}} - \frac{p'(\Delta\pi_L - \Delta\pi_R)}{1 - p(\Delta\pi_L - \Delta\pi_R)}\underbrace{\left\{\frac{\alpha_L\Delta\theta - \dfrac{K\beta}{v}}{1 - \dfrac{r\beta^2}{v}}(\Delta\pi_L - \Delta\pi_R) - \frac{1}{2}\left[(\Delta\pi_L)^2 - (\Delta\pi_R)^2\right]\right\}}_{\text{Electoral effect}}$$

(6) and (9) represent a system of nonlinear differential equations. We solve this system numerically. The results of the simulations are shown in figures (1) (2) (3) and (4) for different values of some parameters.
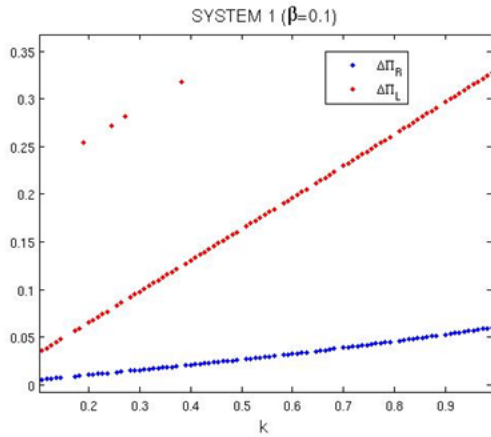
Figure: 4–1

Figure: 4–2

SYSTEM 1 (k=0.1)

SYSTEM 1 (k=0.5)
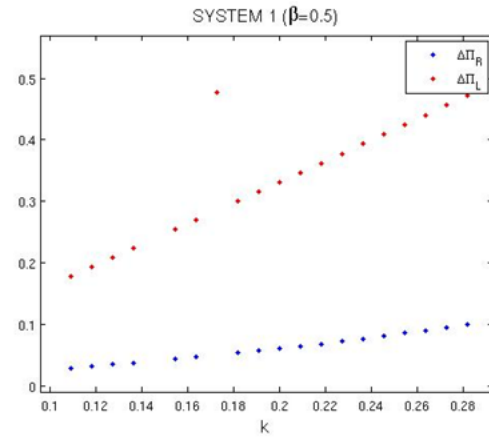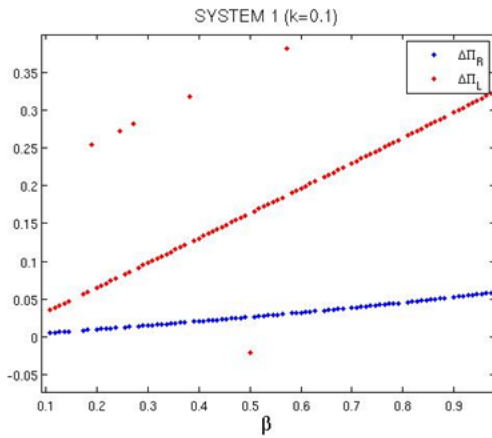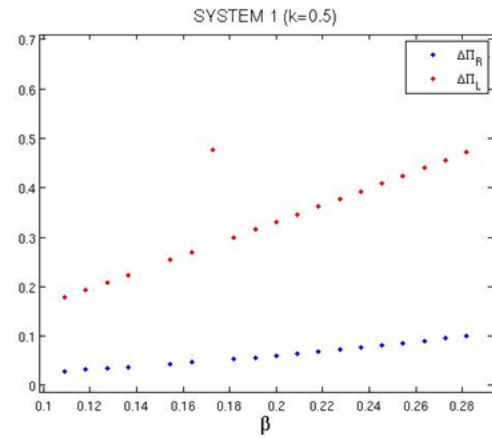
Figure: 4–3   Figure: 4–4

Direct observations show that the electoral effect is negative with the left and positive with the right.[79] Indeed, reducing (resp. increasing) the difference in inflation targets now increases the probability that the left (resp. right) is elected and, for this reason, the left offers a platform shifted downwards.

4.3.2. Monetary Policy under political independence

Under the political independence of the Central Banker, monetary policy is carried out for both political principals. For this reason, the Central Banker can offer a side-contract to the anti-inflationist interest group before political uncertainty is resolved.[80]

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[79] See note 74 to compare this results with those by Gabillon-Martimort.

[80] Gabillon and Martimort, in order to prevent collusion between interest groups and central bankers, consider an *ex ante collusion-proofness constraint*:

$$p\left(\bar{s}_R - \underline{s}_R\right) + (1-p)\left(\bar{s}_L - \underline{s}_L\right) \geq K\beta\left[\left(p\Delta\pi_R\right) + (1-p)\Delta\pi_L\right]$$

The left-hand side above represents the wages expected to prevent collusive behaviour; the right-hand side represents the bribe that the anti-inflation group is willing to pay to the Central Banker to make him lie in his announcement of the economic shock. The Central Banker strictly prefers to commit to a side-contract before political uncertainty resolves rather than wait for the outcome of the election. Indeed, because the efficiency of side-contracting $K(.)$ is a strictly concave function of the collusive stake:

$$K\beta\left[\left(p\Delta\pi_R\right) + (1-p)\Delta\pi_L\right] > pK\left(\beta\Delta\pi_R\right) + (1-p)K\left(\beta\Delta\pi_L\right)$$

84

Therefore, with political independence, the agency cost associated with the delegation of monetary policy to the CB is written thus in the case of a rightist government:

$$AC_R^{PI}(\Delta\pi_R) = \frac{1}{p}(1-v)\big[K(\beta(p\Delta\pi_R + (1-p)\Delta\pi_L)) - (1-p)(\bar{s}_L - \underline{s}_L)\big] \qquad (4.10)$$

in the case of a leftist government:

$$AC_L^{PI}(\Delta\pi_L) = \frac{1}{1-p}(1-v)\big[K(\beta(p\Delta\pi_R + (1-p)\Delta\pi_L)) - p(\bar{s}_R - \underline{s}_R)\big] \qquad (4.11)$$

Because agent α is indifferent between a rightist policy $\Delta\pi_R$ and a leftist policy implementing $\Delta\pi_L$, it must obtain the same payoff with both policies. To simplify, we focus on the case where both parties pay the same wage to the independent Central Banker in an interior equilibrium, i.e., we posit a particular distribution of the gains from dealing with a common bureaucrat.

The identity of the swing voter α is now such that:

$$SW_\alpha(\Delta\pi_R) + (1-v)K(\beta\Delta\pi_R) = SW_\alpha(\Delta\pi_L) + (1-v)K(\beta\Delta\pi_L) \qquad (4.12)$$

In a Nash equilibrium, Z_R chooses $\Delta\pi_R$ so that it maximizes:

$$
\begin{aligned}
&p(\Delta\pi_L - \Delta\pi_R)SW_{\alpha R}(\Delta\pi_R) + [1 - p(\Delta\pi_L - \Delta\pi_R)]SW_{\alpha R}(\Delta\pi_L) + (1-v)[p(\Delta\pi_L - \Delta\pi_R)k(\beta\Delta\pi_R)] + \\
&+ (1-v)\{[1 - p(\Delta\pi_L - \Delta\pi_R)]k(\beta\Delta\pi_L)\} - (1-v)k[\beta(p\Delta\pi_R + (1-p)\Delta\pi_L)]
\end{aligned}
$$

and then follows:

The optimal monetary policy proposed by principal i must implement *collusion-proofness* at minimal agency cost: $AC_i^{PI}(\Delta\pi_i) = \min_{\{\underline{s}_i, \bar{s}_i\}} v\underline{s}_i + (1-v)\bar{s}_i$ s.t. a *collusion-proofness constraint* and *participation constraint*. The *participation constraints* are identical to the case of political dependence $\underline{s}_i \geq 0$, from which it follows that $\bar{s}_i > 0$. For every detail on this point see Gabillon and Martimort, (2004, p.368).

$$p(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_R\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} +$$

$$+ [1 - p(\Delta\pi_L - \Delta\pi_R)]\left\{v\left(\alpha_R\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\} +$$

$$+ (1-v)\left\{p(\Delta\pi_L - \Delta\pi_R)\left[k(\beta\Delta\pi_R) - \frac{r\beta^2}{2}(\Delta\pi_R)^2\right]\right\} +$$

$$+ (1-v)\left\{[1 - p(\Delta\pi_L - \Delta\pi_R)]\left[k(\beta\Delta\pi_L) - r\beta^2\frac{(\Delta\pi_L)^2}{2}\right]\right\} +$$

$$- (1-v)\left\{k\beta[(p\Delta\pi_R + (1-p)\Delta\pi_L)] - \frac{r\beta^2}{2}[p\Delta\pi_R + (1-p)\Delta\pi_l]^2\right\}$$

The corresponding FOC becomes:

$$p(\Delta\pi_L - \Delta\pi_R)\left\{v(\alpha_R\Delta\theta - \Delta\pi_R) - k\beta + r\beta^2\Delta\pi_R\right\} + \tag{4.13}$$

$$- p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_R\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} +$$

$$+ p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_R\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\} +$$

$$+ (1-v)\left\{p(\Delta\pi_L - \Delta\pi_R)[k\beta - r\beta^2(\Delta\pi_R)]\right\} +$$

$$+ (1-v)\left\{[- p'(\Delta\pi_L - \Delta\pi_R)]\left[k(\beta\Delta\pi_R) - r\beta^2\frac{(\Delta\pi_R)^2}{2}\right]\right\} +$$

$$+ (1-v)\left\{[p'(\Delta\pi_L - \Delta\pi_R)]\left[k(\beta\Delta\pi_L) - r\beta^2\frac{(\Delta\pi_L)^2}{2}\right]\right\} +$$

$$- (1-v)\left\{k\beta[p - p'\Delta\pi_R + p'\Delta\pi_L] - r\beta^2[p\Delta\pi_R + (1-p)\Delta\pi_L][p - p'\Delta\pi_R + p'\Delta\pi_L]\right\} = 0$$

After some algebra we obtain:

$$\Delta\pi_R^{PI} = \frac{\alpha_R\Delta\theta - \dfrac{k\beta}{v}}{1 - r\beta^2} + \tag{4.14}$$

$$+ \frac{p'(\Delta\pi_L - \Delta\pi_R)}{p(\Delta\pi_L - \Delta\pi_R)}\left\{\frac{\alpha_R\Delta\theta - k\beta}{1 - r\beta^2}(\Delta\pi_L - \Delta\pi_R) - \frac{1}{2}[(\Delta\pi_L)^2 - (\Delta\pi_R)^2]\right\} +$$

$$- \frac{(1-v)}{v(1 - r\beta^2)} \cdot \frac{1}{p(\Delta\pi_L - \Delta\pi_R)} \cdot \left\{k\beta p'(\Delta\pi_L - \Delta\pi_R) - r\beta^2[p\Delta\pi_R + \right.$$
$$\left. + (1-p)(\Delta\pi_L)](p - p'\Delta\pi_R + p'\Delta\pi_L)\right\}$$

Electoral effect

In a Nash equilibrium, Z_L chooses $\Delta\pi_L$ so that it maximizes:

$$p(\Delta\pi_L - \Delta\pi_R)SW_{\alpha L}(\Delta\pi_R) + [1 - p(\Delta\pi_L - \Delta\pi_R)]SW_{\alpha L}(\Delta\pi_L) + (1-v)[p(\Delta\pi_L - \Delta\pi_R)k(\beta\Delta\pi_R)] +$$
$$(1-v)\{[1 - p(\Delta\pi_L - \Delta\pi_R)]k(\beta\Delta\pi_L)\} - (1-v)k[\beta(p\Delta\pi_R + (1-p)\Delta\pi_L)]$$

and then follows:

$$p(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_L\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} +$$

$$+ [1 - p(\Delta\pi_L - \Delta\pi_R)]\left\{v\left(\alpha_L\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\} +$$

$$+ (1-v)\left\{p(\Delta\pi_L - \Delta\pi_R)\left[k(\beta\Delta\pi_R) - \frac{r\beta^2}{2}(\Delta\pi_R)^2\right]\right\} +$$

$$+ (1-v)\left\{[1 - p(\Delta\pi_L - \Delta\pi_R)]\left[k(\beta\Delta\pi_L) - r\beta^2\frac{(\Delta\pi_L)^2}{2}\right]\right\} +$$

$$- (1-v)\left\{k[\beta(p\Delta\pi_R + (1-p)\Delta\pi_L)] - \frac{r\beta^2}{2}[p\Delta\pi_R + (1-p)\Delta\pi_l]^2\right\}$$

The corresponding FOC becomes:

$$p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_L\Delta\theta\Delta\pi_R - \frac{(\Delta\pi_R)^2}{2}\right) - \left[k\beta(\Delta\pi_R) - \frac{r}{2}(\beta\Delta\pi_R)^2\right]\right\} + \qquad (4.15)$$

$$+ [1 - p(\Delta\pi_L - \Delta\pi_R)]\{v(\alpha_L\Delta\theta - \Delta\pi_L) - [k\beta - r\beta^2\Delta\pi_L]\} +$$

$$- p'(\Delta\pi_L - \Delta\pi_R)\left\{v\left(\alpha_L\Delta\theta\Delta\pi_L - \frac{(\Delta\pi_L)^2}{2}\right) - \left[k\beta(\Delta\pi_L) - \frac{r}{2}(\beta\Delta\pi_L)^2\right]\right\} +$$

$$+ (1-v)\left\{p'(\Delta\pi_L - \Delta\pi_R)\left[k(\beta\Delta\pi_R) - \frac{r\beta^2}{2}(\Delta\pi_R)^2\right]\right\} +$$

$$+ (1-v)\{[1 - p(\Delta\pi_L - \Delta\pi_R)][k\beta - r\beta^2(\Delta\pi_L)]\}$$

$$- (1-v)\left\{[p'(\Delta\pi_L - \Delta\pi_R)]\left[k(\beta\Delta\pi_L) - r\beta^2\frac{(\Delta\pi_L)^2}{2}\right]\right\} - (1-v)$$

$$\{k[\beta(p'\Delta\pi_R + (1-p) - p'\Delta\pi_L)] - r\beta^2[p\Delta\pi_R + (1-p)\Delta\pi_L](p'\Delta\pi_R + (1-p) - p'\Delta\pi_L)\} = 0$$

It follows that:

$$\Delta\pi_L^{PI} = \frac{\alpha_L\Delta\theta - \dfrac{k\beta}{v}}{1-r\beta^2} + \tag{4.16}$$

$$\left.\begin{array}{l} -\dfrac{p'(\Delta\pi_L - \Delta\pi_R)}{1-p(\Delta\pi_L - \Delta\pi_R)}\left\{\dfrac{\alpha_L\Delta\theta - k\beta}{1-r\beta^2}(\Delta\pi_L - \Delta\pi_R) - \dfrac{1}{2}\left[(\Delta\pi_L)^2 - (\Delta\pi_R)^2\right]\right\} + \\[4mm] -\dfrac{(1-v)}{v(1-r\beta^2)}\cdot\dfrac{1}{1-p(\Delta\pi_L - \Delta\pi_R)}\cdot\left\{-k\beta p'(\Delta\pi_L - \Delta\pi_R) - r\beta^2\left[p\Delta\pi_R + \right.\right. \\[4mm] \left.\left. + (1-p)(\Delta\pi_L)\right](p'\Delta\pi_R + (1-p) - p'\Delta\pi_L)\right\} \end{array}\right\} Electoral\ effect$$

(14) and (16) represent a system of nonlinear differential equations. We solve this system numerically. The results of the simulations are shown in figures: (5) (6) (7) and (8) for different values of some parameters.
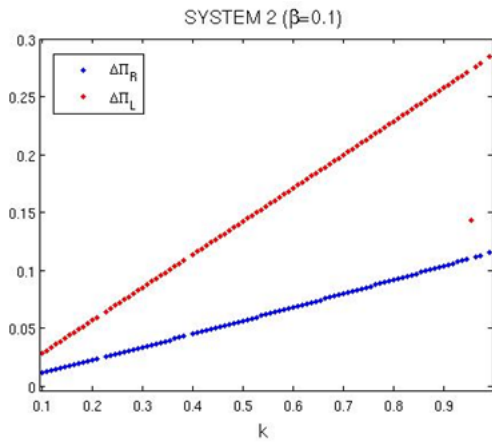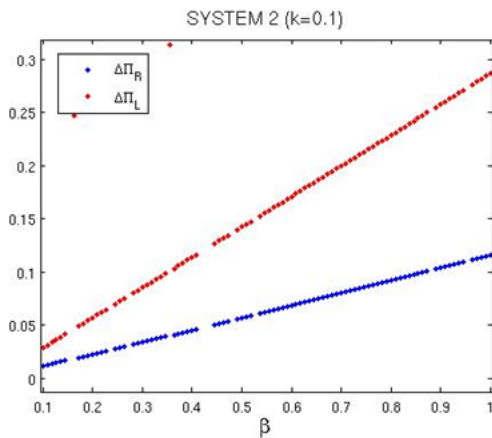

Figure: 4–5
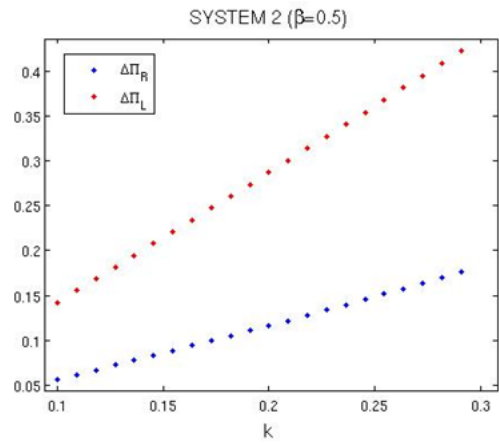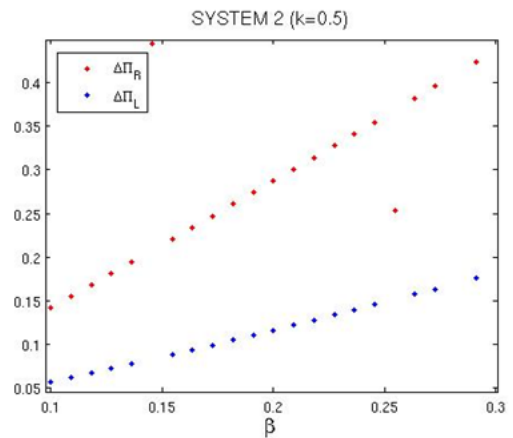

Figure: 4-6

Figure: 4–7

Figure: 4-8

For both parties, the electoral effect still includes a term taking the same form as with a politically dependent Central Banker. However, there appears a new term which captures the impact of the choice of the platform on the agency cost of delegation to an independent Central Banker.

More importantly, the greater sensitivity of the swing voter to inflation variations($\Delta \pi$) under independence may increase the convergence of the platforms towards middle-road policies. This is clear on comparing the results of the system (1) (which is the institutional monetary regime under political dependence) with the results of the system (2) (which is the institutional monetary regime under political independence).
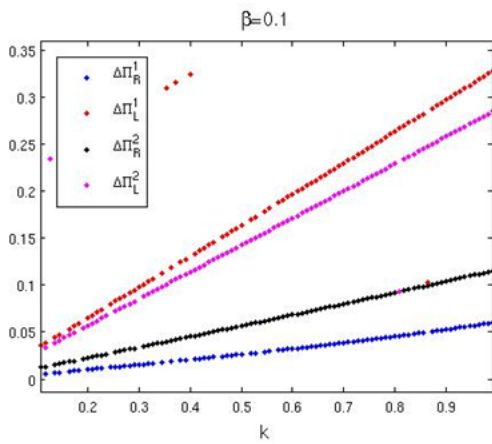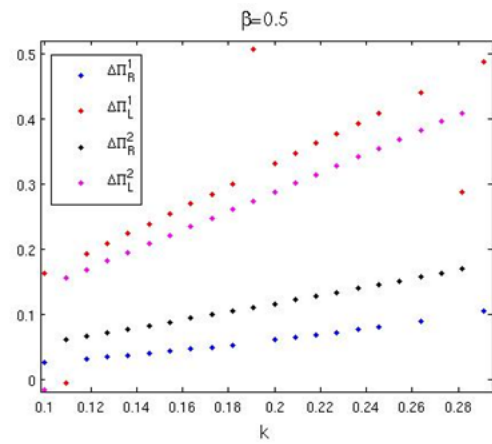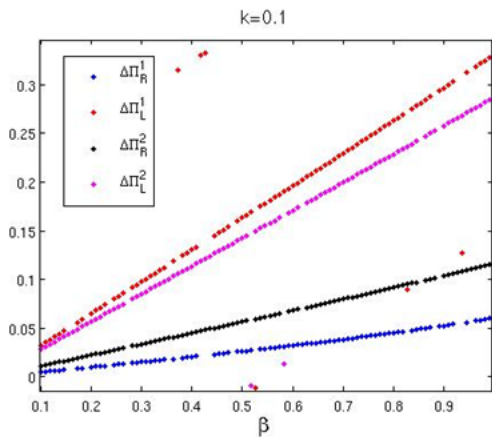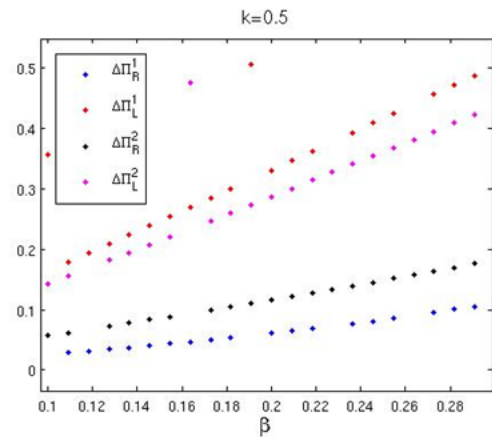

Figure: 4–9

Figure: 4–10

Figure: 4–11

Figure: 4–12

This would reinforce Gabillon-Martimorts' finding that the independent Central Banker makes policies converge further one towards the order

4.4. Conclusions

The foregoing analysis has examined the interesting feedback between institutions and election results. In this case, the amount of political uncertainty and the choice of institutional design have been determined simultaneously in the model. Endogenizing political uncertainty reinforces the stabilization effect. A rightist (resp. leftist) policymaker increases (resp. decreases) the variance of inflation and now looks much more like a leftist (resp. rightist) policymaker.

This finding strengthens the hypothesis that the independence of the CB is the best institutional design with which to protect the general interests of 'society'. In fact, a Central Banker independent from the political principal that appoints it represents the best control by the minority with respect to decisions taken by the elected political majority.

This line of research could continue in various directions. The first is consideration of political systems more complex than a two-party one: that is, multi-party systems and coalition governments, which are generally associated with parliamentary political regimes. The political economics literature[81] emphasises, in fact, that these characteristics increase political uncertainty. This suggests that the benefits of the Central Bank's political independence are greater in parliamentary systems: an aspect which should be analysed both theoretically and empirically.

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[81] See Persson and Tabellini (2000; 2003).

A second direction for further inquiry within the framework analysed is theoretical and empirical investigation of the possible separation of banking supervision from monetary policy. This should increase the transaction costs deriving from collusion between banks and monetary authorities.

Conclusions

This thesis has analysed various aspects of monetary policy, with special focus on the institutional framework within which it is implemented by the institutions in charge.

The main message that the thesis has sought to convey is that the observability of the goals of a Central Bank by the private sector may play a decisive role both in monetary policy decisions and in the choice of the institutional design.

The starting point of the discussion has been the literature on the political and institutional foundations for the goals of the monetary institutions. This literature focuses almost completely on the analysis of the "time inconsistency" problem, which examines the interaction between policies and agents' expectations. This is a feature of policies that, although optimal at present, may prove less desirable in the future, particularly when the agents anticipate the incentives of the policymaker, thus thwarting monetary policies and generating inefficient equilibria.

This literature has developed in the past thirty years since the works of Kydland and Prescott (1977) and Barro and Gordon (1983a, 1983b). It focuses on the one hand on study of the basic determinants of the time inconsistency problem and, on the other, on possible institutional solutions. Different studies have shown that time inconsistency determinants can be referred to the sequential structure that is a necessary feature of stabilization policies in a world characterized by non-indexed contracts, as well as to the existence in the economy of a conflict of interests among different economic agents with different goals. According to this interpretation, if no conflicts of interests were in place, the policymaker and the private sector would behave as a "team", *i.e.* would decide how to act in order to achieve the same goal: therefore, no agent would be

encouraged to surprise the rest of the team to obtain benefits (Chari, Kehoe and Prescott, 1989).

The economic theory offers two basic solutions to the problem of time inconsistency of the monetary policy. The first solution is founded on the introduction of specific monetary rules or institutional and legal constraints that materialize, in practice, in a variety of reforms, including the decision to ensure the independence of the monetary authority, or to set a specific target inflation rate, among others. The second solution considers self-disciplinary mechanisms as substitutes for formal rules. Examples of such mechanisms include the effects of reputation and signalling in the case of long timeframes and asymmetrical information between the monetary authority and the private sector.

Part one of the thesis introduced a model that belongs to the class of models included in this latest branch of the literature. In particular, we studied the connection – observed when a time inconsistency problem exists – between the observability of the goals of the monetary institution and the equilibrium strategies implemented by the latter. This model yielded innovative technical and economic results.

From the technical viewpoint, the study of equilibrium strategies in a simple signalling model made it possible to obtain the results of equilibrium in a monetary policy game studied by D'Amato and Pistoresi (1996) and Sibert (2002) without the constraints introduced by these works to support different types of monetary institutions. This allowed identification of the conditions for the model parameters under which a pure separating equilibrium emerges, and the conditions under which there exists a hybrid equilibrium whereby certain types of Bankers play separating strategies (Vickers, 1986; D'Amato and Pistoresi 1996; Sibert, 2002) and others play pooling strategies similar to those studied by Backus and Driffill (1985).

From the economic viewpoint, we have highlighted some emerging relations – in equilibrium – between the degree of observability and transparency of the monetary goals of the Central Banker and the inflation rate set by the latter.

The existence of an equilibrium between the degree of observability of the government's decisions with respect to monetary institutions, on the one hand, and inflation strategies on the other, induced us to investigate the relation between incentives for strategic delegation and the degree of transparency of delegation to the monetary institutions.

In part two we used the per-capita number of newspapers in the different countries as a proxy with which to study the relation between the degree of observability to private agents of the goals of the monetary institutions and the level of institutional commitment to monetary stability goals. Simple cross-country regressions showed that this assumption is strongly supported by full sample data (and in each sub-sample of OECD and non-OECD countries).

Two other testable implications were derived from extensions of the Rogoff (1985a) model to open economies. In particular, our data delivered the following results: 1. the degree of independence proved to be negatively related to openness among the non-OECD countries (in accordance with a straightforward extension of the model by Romer, 1993); 2. The degree of independence was positively related to the strength of the correlation with the international business cycle in the sub-sample of the OECD countries (in accordance with D'Amato and Martina, 2005).

These results seem to be perfectly compatible with the approach to strategic monetary policy delegation: the data seem to show that, in countries where the degree of observability and transparency of the institutions and, accordingly, the degree of observability of commitment by private agents are sufficiently high, governments tend to adopt institutional solutions to the time inconsistency problem.

The conclusion, albeit with all the caveats of both the theoretic and the empirical analysis, seems to be that, in an economy where agent expectations play a fundamental role in determining the outcome of policies, as envisaged by the theory of strategic delegation, adopting an institutional approach is facilitated by the degree of observability by private agents of the institutions.

The implication of both these two chapters in regard to decisions on the design of the monetary institutions seems to be that the top-down establishment of institutions, whose goals are substantially unclear to private agents, is not theoretically or empirically viable if the degree of transparency and the ability of private agents to construe and understand the institutional goals are not sufficiently high. In order to set up (monetary) institutions that may prove credible for private agents, the latter should be able to observe them from the bottom.

Part three contained an empirical analysis of the ability of the institutional political system, combined with certain economic variables, to influence the degree of independence of the Central Bank. In fact, the lack of transparency in a political and institutional system, as well as the lack of constraints and controls over politicians, are the main reasons for the failure of certain policy reforms (Acemoglu et al., 2008).[82]

The data suggest that Central Bank Independence is positively related to the presence of federalism, the features of the electoral system and parties, the correlation between the shocks to the level of economic activity in the countries included in the sample and, for a sub-sample of economies, the convergence criteria for entry into the European Monetary Union (EMU).

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[82] The 1995 Reserve Bank of Zimbabwe Act, which legislated a greater degree of autonomy for the central bank, is the classic example of the ineffectiveness of institutional reform in the absence of a functioning system of accountability.

Several recent papers[83] have updated measures of transparency and independence of central banks by introducing a large cross-country database on the timing of legislative changes in central bank design for more than 100 countries during period 1970-2012. These new datasets are useful means with which to conduct cross-sectional and time series studies in diverse fields. In particular, it is very interesting for future research to analyse how the new monetary policy instruments (operation twist, quantitative easing), in response to the recent financial and sovereign debt crisis, have influenced the likelihood of reforms in central bank design.

In part four we extended the Gabillon and Martimort model (2004). In that paper the authors consider a model of monetary policy by which the central banker is subject both to the explicit influence of the political principal elected[84] by contract and to the implicit influence of the anti-inflation interest groups (*lobbies)*[85] that seek to "capture" monetary policy to protect their own interests. Gabillon and Martimort show how different legal statuses of the Central Bank[86] are indeed associated with different opportunities for individual lobbies to redirect monetary policy. Thus the degree of political independence influences the agency costs incurred to control the central banker. Therefore, while political independence increases agency costs *(agency cost effects)*, it prevents greater fluctuations of inflation brought about by (exogenous) political uncertainty with respect to the electoral result *(stabilization effect)*. If both effects are compared, social welfare increases *ex ante* in the case of political independence. Our extension consisted in endogenizing political uncertainty. In our

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[83] Dincer and Eichengreen (2014), Garriga (2016).

[84] The authors only consider two political parties. According to the "political party" literature, both parties have different preferences with respect to the inflation/employment tradeoff. In particular, the party that defends the right-wing constituency is more concerned about price stability, whereas the left-wing party is more concerned with inflationary surprise to increase employment.

[85] These groups are represented by major banks and financial companies highly interested in controlling inflation.

[86] The central banker can, in fact, be independent of political power. Therefore, if he is in office upon the election of a new government, he remains in office, or can be affiliated to the political power and therefore subject to the *spoil system*, *i.e.* be substituted every time a new political principal is elected.

model, voters were forward-looking and made their decisions by comparing the policy platforms offered by competing political principals. This extension of the model made it possible to analyse the interesting feedback between the institutions and the election result. The amount of political uncertainty and the choice of the institutional design are, in this case, determined at the same time in the model. In our case, too, the idea is confirmed that the political independence of the central bank is the optimal approach for the institutional design of monetary policy in a world of political uncertainty.

Bibliography

Acemoglu, D., Johnson, S., Querubin, P. and Robinson, J., 2008. When Does Policy Reform Work? The Case of Central Banck Indipendence. *Brooklings Papers on Economic Activity*, Volume 39, pp. 351 - 418.

Alesina, A., 1988. Credibility and Policy Convergence in a Two-party System with Rational Voters. *American Economic Review* Volume 78, pp. 796-806.

Alesina, A. and Gatti, R., 1995. Indipendent Central Banks: Low Inflation at Low Cost? *American Economic Review Papers and Proceedings*, Volume 85, pp. 196-200.

Alesina, A. and Grilli, V., 1995. The European Central Bank: Reshaping monetary politics in Europe. In: P. Torsten and G. Tabellini, eds. *Monetary and Fiscal Policy.* Cambridge(MA): MIT Press, pp. 247 - 277.

Alesina, A. and Stella, A., 2010. The politics of monetary Policy. In: B. Friedman and M. Woodford, eds. *Handbook of Monetary Economics.* Amsterdam: Elsevier, pp. 1000-1054.

Alesina, A. and Summers, L., 1993. Cebntral Banck Indipendence and Macroeconomic Performance: Some Comparative Evidence. *Journal of Money, Credit and Banking,* Volume 25, pp. 151 - 162.

Arnone, M., Laurens, B. and Segalotto, J., 2006. Measures of Central Bank Autonomy: Empirical Evidence for OECD and Developing Countries, and Emerging Market Economies. *International Monetary Found Working Paper 228.*

Backus, D. and Driffill, J., 1985. Inflation and Reputation. *American Economic Review*, Volume 75, pp. 530 - 538.

Bade, R. and Parking, M., 1988. Central Bank Laws and Monetary Policy". *Working paper, University of Western Ontario.*

Bagheri, F. and Habibi, N., 1998. Political institutions and Central Bank Indipendence: a cross country analysis. *Publich Choice*, Volume 96, pp. 187 - 204.

Bagwell, K., 1995. Commitment and Observability in Games. *Games and Economic Behaviour,* Volume 8, pp. 271 - 280.

Balke, N., 1990. The Rational Timing of Parliamentary Elections. *Public choice*, Volume 65, pp. 201-216.

Banks, A., 1999. *Cross National Time-Series Data Archive,* Bighamton: Banner Software, Inc. Binghamton.

Barro, R., 1983. Inflatory finance under discretion and rules. *Canadian Journal of Economics,* Volume 16, pp. 3 - 16.

Barro, R. and Gordon, D., 1983a. A positive Theory of Monetary Policy in a Natural Rate Model. *Journal of Political Economics,* Volume 91, pp. 589-610.

Barro, R. and Gordon, D., 1983b. Rules, Discretion and Reputation in a Model of Monetary Policy. *Journal of Monetary Economics,* Volume 12, pp. 101-122.

Beck, T.; Clarke, G.; Groff, A.; Feefer, P.; Walsh, P., 2001. New tools in comparative political economy: the database of political institutions. *The World Bank Economic Review,* Volume 15, pp. 165 - 176.

Campillo, M. and Miron, J., 1997. Why does Infation differ across Countries?. In: C. Romer and D. Romer, a cura di *Reducing Infration: Motivation and Strategies.* Chicago: Chicago University Press, pp. 335 - 357.

Canova, T., 2007. Non-state Actors and International Institutional Order: Central Bank Capture and the Globalization of Monetary Amnesia. *American Society of International Law Annual Proceedings,* Volume 101, pp. 8 - 16.

Canzoneri, M., 1985. Monetary Policy Games and the Role of Incolete Information. *American Economic Review,* Volume 75, pp. 1056 - 1070.

Capie, F., Goodhart, C. and Schnadt, N., 1994. The Development of Central Banking. In: C. U. Press, a cura di *The Future of Central Banking.* Cambridge: Cambridge University Press.

Chari, V., Kehoe, P. and Prescott, E., 1989. Time Consistency and Policy. In: *Modern Business Cycle Theory.* Cambridge: Harvard University Press.

Chowdhury A., 1991. The Relationship Between the Inflation Rate and its Variability: The Issues Reconsidered. *Applied Economics*, Volume 23, pp. 993-1003.

Ciocca, P., 1983. *La moneta e l'economia. Il ruolo delle Banche Centrali.* Bologna: Il Mulino.

Cukierman, A., 1992. *Central Bank Strategy, Credibility and Indipendence: Theory and Evidence.* Cambridge(MA): MIT Press.

Cukierman, A., 1994. Commitment through delegation, political influence and Central Bank Indipendence. In: W. Onno de Beuafort, E. Sylester and H. Lex, eds. *A Framework for Monetary Stability.* Dordrecht, Boston, London: Kluver Academic Publishers, pp. 55 - 74.

Cukierman, A., 2008. Central Bank Indipendence and Monetari Policymaking Institutions - Past, Present and Future. *European Journal Political Economy,* Volume 24, pp. 722 - 736.

Cukierman, A., 2014. Euro-Area and US Banks behaviour, and ECB-Fed Monetary Policies during the Global Financial Crisis: a Comparison. In: *Money, regulation and Growth: Financing New Growth in Europe.* s.l.:SUERF Studies, pp. 73 - 90.

Cukierman, A., Webb, S. and Neyapti, B., 1992. Measuring the Indipendence of Central Baqnks and its effect on policy outcomes. *World Bank Economic Review,* Volume 6, pp. 353 - 398.

D'Amato, M. and Pistoresi, R., 1996. La Riservatezza del Banchiere Centrale è un Bene o un Male? *Politica Economica,* Volume 12, pp. 353 - 398.

D'Amato, M. and Martina, R., 2005. Credibility and Commitment of Monetary Policy in Open Economies. *European Journal of Political Economy,* Volume 21, pp. 872 - 902.

D'Amato, M. and Pistoresi, B., 1998. *Go and soothe the row. Delegation of monetary policy under private infiormation.* Salerno: Dipartimento di Scienze Economiche, Università di Salerno.

D'Amato, M., Pistoresi, B. and Salsano, F., 2009. On the Determinants of central Bank independence in Open Economies. *International Journal of Finance and Economics,* Volume 14, pp. 107-119.

Daniels, J., Farrokh, N. and Vanhoose, D., 2005. Openness, Central Bank Independence, and the Sacrifice Ratio. *Journal of Money, Credit and Banking,* Volume 37, pp. 371 - 379.

De Haan, J. and Siermann, C., 1996. Central Bank Inflation and Political Instability in Developing Countries. *Journal of Policy Reform,* Volume 1, pp. 135 - 147.

De Haan, J. and van't Hag, G., 1995. Variation in Central Bank Independence across Coutries. Some Provisional Empirical Evidence. *Public Choice,* Volume 85, pp. 335 - 351.

Dincer, N. and Eichengreen B., 2014. Central Bank Transparency and Independence: Updates and New Measures. *International Journal of Central Banking.*Volume 10, pp. 189-259.

Dolado, J., Griffiths, M. and Padilla, J., 1994. Delegation in international monetary policy game. *European Economic Review ,* Volume 38, pp. 1057 - 1069.

Drazen, A., 2000. *Political Economy in Macroeconomics.* Princeton: Princeton University Press.

Driffill, J., 1988. Macroeconomic policy games with incomplete information: a survey. *European Economic Review,* Volume 32, pp. 533 - 541.

Ellis C., 1991. Endogenous Voting in a Partisan Model with Rational Voters. *Journal of Macroeconomics*, Volume 13, pp. 267-278.

Farvaque, E., 2002. Political determinants of Central Bank Independence. *Economics Letteres,* Volume 77, pp. 131 - 136.

Faure-Grimaud, A. and Martimort, D., 2001. On some agency cost of delegated contracting. *Economic Letter,* Volume 71, pp. 75 - 82.

Faure-Grimaud, A., and Martimort, D., 2003. Regulatory Inertia. *Rand Journal of Economics*, Volume 34, pp. 413-437.

Fershtman, C. and Kalai, E., 1997. Unobserved Delegation. *International Economic Review,* Volume 38, pp. 763 - 774.

Fisher, S., 2010. Miths of monetary policy. *Israel Economic Review,* Volume 8, pp. 1-5.

Franzese, R., 1998. Partially Independent Central Banks, Politically Responsive Governments and Inflation. *American Journal of Political Science,* Volume 43, pp. 681-706.

Friedman M., 1977. Nobel Lecture: Inflation and Unemployment. Journal of Political Economy, Volume 85, pp. 451-472.

Fudenberg, D. and Tirole, J., 1991. *Game Theory.* Cambridge(Mass.): MIT Press.

Gabillon, E. and Martimort, D., 2004. The Benefits of Central Banks' Political Indipendence. *European Economic Review*, Volume 48, pp. 353-378.

Garriga, A., 2016. Central Bank Independence in the World: A New Dataset. *International Interactions,* Volume 42, pp.849-868.

Geraats, P., 2000. Why adopt transparency? The publication of central bank forecasts. *CEPR Discussion Paper 2582.*

Grilli, V., Masciandaro, D. and Tabelloni, G., 1991. Political and Monetary Institutions and Public Finance Policies in the Industria Countries. *Economic Policy,* Volume 6, pp. 342 - 392.

Hastie, T., Tibshirani, R. and Friedman, J., 2001. *The elements of statistical learning.* New York: Springer Press.

Hayo, B., 1998. Inflation Culture, Central Bank Independece and Price Stability. *European Journal Political Economy,* Volume 14, pp. 241 - 263.

Heston, A., Summers, S. and Aten, B., 2002. *Penn World Tables 6.1.* [Online] Available at: http://pwt.econ.upenn.edu/aboutpwt.html

International Monetary Foud, 1983. *International Financial Statistics Supplement on Money statistics, IMF supplement series, n.5.* Washington DC: IMF.

International Monetary Found, 1982. *International Financial Statistics Supplement on Trade statistics, IMF supplement series, n.4.* Washington DC: IMF.

International Monetary Found, 1986a. *International Financial Statistics Supplement on Government Finance, IMF suplement series, n.11.* Washington DC: IMF.

International Monetary Found, 2008. *World Economic and Financial Surveys, World Economic Outlook Database.* [Online] [Accessed March 2009].

International Monetray Found, 1986b. *International Financial Statistics Supplement on Price statistics, IMF supplement series, n.12.* Washington DC: IMF.

Issing, O., 1993. Central Bank Independence and monetary stability. In: *Occasional paper.* London: Institute of Economic Affairs.

Kane, E., 1980. Politics and FED Policy-Making. *Journal of Monetary Economics,* Volume 6, pp. 199 - 211.

Keefer, P., 2006. *Database of political institutions (DPI): changes and variable definitions.* Washington DC: Development Research Group, World Bank.

Kose, A., Otrock, C. and Whiteman, C., 2003. Internationa Business Cycles: World, Region and Country-Specific Factors. *Amercian Economic Review*, Volume 93, pp. 1216 - 1239.

Kreps, D. and Wilson, R., 1982. Reputation and imperfect Information. *Journal of Economic Theory,* Volume 27, pp. 253 - 279.

Kydland, F. and Prescott, E., 1977. Rules Rather than Discretion: the Inconsistency of Optimal Plans. *Journal of Political Economy,* Volume 85, pp. 473-491.

Laffont, J. J. and Martimort, D., 1999. Separation of regulators against collusive behaviour. *Rand Journal of Economics,* Volume 107, pp. 1089 - 1127.

Laffont, J. J. and Tirole, J., 1993. *A Theory of Incentives in Regulation and Procurement.* Cambridge(MA): MIT Press.

Lane, P., 1997. Inflation in Open Economies. *Journal of International Economics,* Volume 42, pp. 327 - 347.

Layard, R., Nickell, S. and Jackman, R., 1991. *Unemployment, Macroeconomic Performance and the Labour Market.* Oxford: Oxford University Press.

Lohmann, S., 1992. Optimal Commitment in Monetary Policy: Credibility versus Flaxibility. *American Economic Review*, Volume 82, pp. 273 - 286.

Mailath, G., 1987. Incentive Compatibility in Signaling Games with a Continuum of Types. *Econometrica*, Volume 55, pp. 1349 - 1365.

Milgrom, P. and Roberts, J., 1982. Limit Pricing and Entry Under Incomplete Information: An Equilibrium Analysis. *Econometrica,* Volume 50, pp. 443 - 459.

Moser, P., 1999. Checks and Balances, and the suppluy of Central Bank Independence. *European Economic Review,* Volume 43, pp. 1569 - 1593.

Peek, J., Rosemgren, E. and Tootell, G., 1999. Is Bank Supervision Central to Central Banking?. *Quarterly Journal of Economics,* Volume 114, pp. 629 - 653.

Persson, T. and Tabellini G., 2003. *The economic effects of constitutions.* Cambridge(MA): MIT Press.

Persson, T. and Tabellini, G., 2000. *Political Economics. Explaining Economic Policy.* Cambridge: MIT Press.

Persson, T. and Tabellini, G., 1993. Designing Institutions for Monetary Stability. *Carnegie-Rochester Conference Series on Public Policy,* Volume 39, pp. 53 - 84.

Pistoresi, B., Salsano, F. and Ferrari, D., 2011. Political insitution and central bank independence revisisited. *Applied Economics Letters,* Volume 18, pp. 679-683.

Polillo, S. and Guillén, M., 2005. Globalization Pressures and the State: the Worldwide Spread of Central Bank Independence. *American Journal of Sociology,* Volume 110, pp. 1764 - 1802.

Posen, A., 1995. Declaration Are Not Enough: Financial Sector Soucres of Central Bank Indipendence. *Nber Macroeconomics annual*, pp. 253-274.

Posner, R., 1974. Theory of Economic regulation. *The Bell Journal of Economics and Management Science,* Volume 5, pp. 335 - 358.

Poterba, J. and Rotemberg, J., 1990. Inflation and Taxation with Optimising Governments. *Journal of Money, Credit and Banking,* Volume 22, pp. 2 - 18.

Reis, R., 2013. Central Bank Design. *Journal of Economic Perspectives,* Volume 27, pp. 17 - 44.

Ricardo, D., 1824. Plan for the establishment of National Bank. In: P. Sraffa, ed. *Works of David ricardo: Pamphlet and Paper (1951).* Cambridge: Cambridge University Press, pp. 1815 - 1823.

Riley, J., 1979. Informational equilibria. *Econometrica,* Volume 47, pp. 331 - 359.

Rogoff, K., 1985a. The Optimal Degree of Commitment to an Intermediate Monetary Target. *Quarterly Journal of Economics,* Volume 100, pp. 1169 - 1189.

Rogoff, K., 1985b. Can international monetary policy cooperation be counterproductive?. *Journal of International Economics,* Volume 18, pp. 199 -217.

Rogoff, K., 1987. *Reputational Constrain on Monetary Policy.* s.l., s.n., pp. 141 - 181.

Romer, D., 1993. Openness and inflation: Theory and Evidence. *Quarterly Journal of Economic,* Volume 108, pp. 869 - 903.

Sibert, A., 2002. Monetary Policy with uncertain Central Bank preferences. *European Economic Review*, Volume 46, pp. 869 - 903.

Stigler, G., 1971. The Theory of Economic Regulation. *The Bell Journal of Economics and Management Science,* Volume 2, pp. 3 - 21.

Tirole, J.,1986. Hierarchies and bureaucracies: On the role of collusion in organizations. *Journal of Law, Economics and Organization*, Volume 2, pp. 181-214.

Tirole, J., 1992. Collusion and the Theory of Organizations. In J.J. Laffont, *Advances in Economic Theory*, volume 2, pp. 151-206, Cambridge: Cambridge University Press

Toniolo, G., 1988. *Central Banks' Indipendece in historical Perspectives.* New York: Walter de Gruyter.

Vickers, J., 1986. Signalling in a Model of Monetary Policy with Incolpmete Information. *Oxford Economic Papers*, Volume 38, pp. 443 - 455.

Vincent, D., 1998. Repeated signalling games and dynamic trading relationship. *International Economic Review,* Volume 39, pp. 275 - 293.

Walsh, C. E., 1995. Optiman contracts for central bankers. *American Economic Review,* Volume 39, pp. 150 - 167.

Wordl Bank, 2008. *World Development Indicators - WDI online.* [Online] [Accessed March 2009].