Rigidities and inflationary bias in a monetary union. The consequences of EU enlargement*

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Abstract

We analyze how the design of the central bank interacts with the implementation of structural reforms in a monetary union. We show that the formation of the single-currency area can be counterproductive for the member countries if the common monetary authorities have the social preferences and decisions on reforms are made at the national level. On the other hand, in the case where the central bank has been designed, an enlargement of the union worsens the incumbent members' welfare unless the inflation target of the monetary authorities diminishes or the accession countries implement a sufficient level of reforms prior to joining in.

Keywords: Structural reforms, Externalities, Central bank, Inflationary bias.

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1 Introduction

Since the appearance of the seminal papers of Kydland and Prescott (1977) and Barro and Gordon (1983) it is widely accepted that, when the natural level of output is suboptimally low, discretionary monetary policy tends to generate an inefficiently high level of inflation with no gain in terms of production. This outcome has been accounted for in a sequential setting where the private sector knows that if expectations on inflation are sufficiently low the policymaker will tend to carry out a monetary surprise with the aim of making output exceed the natural level. Therefore, the private sector will increase its expectations on inflation to the point where such a surprise becomes too costly for the monetary authorities. As a result, the subgame perfect (or time consistent) equilibrium implies that inflation tends to be suboptimally high.

The standard literature that deals with this "inflationary bias" has built on the assumption that the suboptimallity of the natural level of output stems from the existence of market failures, distortions, imperfections or rigidities in the economy (see for example Walsh [2003, chapter 8]). However, in this line of investigation, these structural characteristics have been considered as exogenous. Then, instead of dealing with these root causes, this literature has focused its attention on tackling their consequences by proposing different monetary institutions (Rogoff [1985], Walsh [1995], Svensson [1997]). However, recent literature (Berthold and Fehn [1998], Sibert and Sutherland [2000] and Calmfors [2001]) has considered the possibility of carrying out costly structural reforms that increase the natural level of output and, therefore, reduce the inflationary bias. Nevertheless, in contrast with the standard literature these papers have taken the design of the central bank as exogenous.

Our paper blends both approaches since we study how the design of monetary institutions interacts with the implementation of structural reforms. The main contributions of our paper to this literature are twofold. Firstly, we analyze how the degree of conservatism of the central bank exerts an influence on the level of structural reforms in a monetary union; and, secondly, we show the influence of such reforms on the optimal inflation target of the common central bank. This analysis is especially relevant in the context of the European Monetary Union (EMU) where countries share a common monetary policy but decisions on structural reforms belong to the

national level[1]; and where the currency area is expected to be enlarged by new countries with more rigid economies than the incumbent countries. In this respect, our paper is an attempt to shed light on a recent issue in the academic and policy debate. Namely, the extent to which the objectives of the common central bank in the EMU affects the incentives of current members and potential entrants to carry out structural reforms.

We consider a setup where two countries make up a monetary union and where social welfare in one member state is affected by the economic policies implemented by the other country. The study of such externalities make it possible to analyse the strategic aspect involved in the behavior of the economic authorities.

We begin by considering an scenario in which a group of countries forms a monetary union but their decisions on structural reforms belong to the national level. In this setup, we show that if the monetary authorities have the social preferences the creation of the union makes the member countries worse-off. This reduction in social welfare would not occur if countries implemented their structural reforms in a cooperative way. However, this scenario could only achieve a second-best. The first-best would only be attained on condition that the central bank were made more conservative than society.

We also consider the case where the monetary union is enlarged by new members whose economies are more rigid than the incumbents'. In this context, we show that the extension of the currency area will be counterproductive for the initial members unless the common central bank is redesigned and made more conservative. This analysis also applies to the potential future enlargement of the EMU by countries with an income per capita substantially lower than the current average of the union[2]. In this sense, representatives of community institutions as the European Commission and the European Central Bank (ECB) have repeatedly stated that the candidate countries should implement a sufficient level of reforms prior to joining the monetary union. According to this community instances (see, for example, Trichet [2004]) if

[1] Notwithstanding the progress made in the Amsterdam Council (1999), the main responsability for carrying out reforms in capital, labor and products markets still lies with the member states.

[2] Political leaders of candidate countries have pointed to different target dates for their accession to the monetary union. For instance, 2007 for Slovenia and Baltic states; 2008 for Hungary; 2009 for Poland; and 2010 for the Czech Republic and Slovakia.

these reforms were not undertaken before they access the euro, the credibility of the common monetary institution would be undermined.

The rest of the paper is organized as follows. Section 2 presents the model. Section 3 analyzes the case where the monetary authorities have the social preferences. Section 4 studies different scenarios in which the central bank has been designed. Section 5 concludes. Finally, proofs not included in the text are gathered in the Appendix.

2 The model

Our framework is based on the standard stochastic model which have been widely used in the literature on credibility in monetary policy (see, for instance, Walsh [2003, chapter 8]). However, in our study, this setup is extended in two ways. First, we depart from the typical closed-economy assumption and consider a monetary union which is made up of two countries ($i = 1, 2$). Second, the natural level of output is not exogenous since it can be increased by the implementation of structural reforms. Formally, the working of the economy is summarized by the following equations:

$$y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi_i - \pi_i^e\right) - \varepsilon, \tag{1}$$

$$L_i^S = \lambda\pi^2 + y_i^2 + \delta\phi_i^2. \tag{2}$$

Expression (1) shows that the economy possesses a Lucas supply function. Expectations are rational which implies that output (y) depends on the deviations of inflation (π) from its expected value (π^e) and on a shock (ε) with zero mean and finite variance $\left(\sigma_\varepsilon^2\right)$. However, the natural level of output $\left(-\left(\widehat{\phi} - \phi_i\right)\right)$ is endogenous since it is greater: a) the lower the initial level of rigidity that the economy has inherited from the past $\left(\widehat{\phi} > 0\right)$; and b) the greater the level of structural reforms carried out in the period of study (ϕ_i).

Equation (2) describes each country' social loss function which coincides with its government's[3]. The first two terms state that society dislikes deviations of inflation and output from optimal levels, normalized to zero. Notice that if the level of structural reforms were so high

[3] However, our conclusions hold if we consider an scenario in which the implementations of structural reforms is more costly to the goverment (e.g. because of the existence of lobbies).

that completely eliminated the rigidities of the economy, the natural level of output appearing in (1) would achieve the socially optimal value. However, in the more general case in which the reforms do not reach its upper limit ($\phi_i < \widehat{\phi}$), the natural level of output is lower that the one which is socially optimal, giving rise to the classical time consistency problem of discretionary monetary policy which will create an inflationary bias.

The third term of (2), represents the costs associated to the implementations of structural reforms. Some studies have highlighted the existence of such costs on the following grounds (see, for instance Sibert [1999] and Sibert and Sutherland [2000]). First, the uncertainty associated to the future implementation of reforms is an obstacle which prevents firms and consumers from making efficient decisions. Second, changes in tax laws modify the way in which accountancy is put into practice giving rise to "menu costs". Finally, reforms can cause an undesirable income redistribution and lobbies will struggle to protect their status quo. Notice that the positive parameters λ and δ are, respectively, the weights that the government puts on inflation and on the cost of reforms (relative to output variability).

The sequence of events is as follows:

1) Governments decide the levels of reforms (ϕ_i).

3) The private sector forms its rational expectations on inflation (π^e).

4) The realization of the output shock is known (ε).

5) The common central bank determines the inflation rate (π).

Throughout the paper, different equilibria will be obtained and evaluated making use of quadratic loss functions as the one in (2), which are standard in the literature on credibility in monetary policy. On the other hand, Dixit and Lambertini (2003 a,b) and Woodford (2003, chapter 6) have shown that this type of objective functions builds on microeconomic foundations, since it can be obtained starting from the utility function of a representative agent[4].

[4] In addition, the former vice-president of the FED, Alan Blinder (1998), has pointed out that policymakers employ their instruments in such a way that only "small" variations in the economic variables take place and for this type of changes any convex objective function is approximately quadratic.

3 A central bank with social preferences

This section analyzes the scenario in which the common central bank minimizes the joint social loss defined as the sum of the objective functions of the countries in the monetary union:

$$L^B = \sum_{i=1}^{2} \left(\lambda\pi^2 + y_i^2 + \delta\phi_i^2\right). \tag{3}$$

In this sense, it could be stated that the central bank has "the social preferences"[5]. In this respect, even though the ECB's chart provides this institution with a high level of formal independence, governments can always try to exert some influence on the monetary authorities'decisions through different means. To wit, by mobilizing public opinions, by appointing board members or by the exchange rate policy which primarily belongs to the ECOFIN, etc. Therefore, we now analyze the extreme case where governments determine the central bank policies and take up in the next section the opposite scenario in which such governmental interference is completely nonexistent.

Now, for the regime where the monetary authorities have the social preferences, we solve the game outlined above by applying backward induction.

In the last stage, once the private sector has set up its rational expectations on inflation, the central bank observes the realization of the shock (ε) and then selects the value for the common inflation rate (π) that solves the following problem (from (1) and (3)):

$$\begin{array}{ll} \underset{\{\pi\}}{Min} & L^B = \sum\limits_{i=1}^{2} \left(\lambda\pi^2 + y_i^2 + +\delta\phi_i^2\right) \\ s.a. & y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi - \pi_i^e\right) - \varepsilon. \end{array}$$

The first-order condition yields the monetary authorities' reaction function:

$$\pi = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\left(\alpha^2 + \lambda\right)} + \frac{\alpha^2\left(\pi_i^e + \pi_j^e\right)}{2\left(\alpha^2 + \lambda\right)} + \frac{\alpha\varepsilon}{\left(\alpha^2 + \lambda\right)}, \tag{4}$$

where $i, j = 1, 2;\ i \neq j$.

[5] However, assuming that the central bank does not care about the social costs of reforms would not affect our results. The reason is that the sequence of events outlined in the previous section states that the monetary authorities set their strategic variable (π) in the last stage, that is, after the level of reforms has been chosen.

This behavior is anticipated by the private sector prior to knowing the realization of the shock. Therefore, taking expectations in (4) we have:

$$\pi_i^e = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\left(\alpha^2 + \lambda\right)} + \frac{\alpha^2\left(\pi_i^e + \pi_j^e\right)}{2\left(\alpha^2 + \lambda\right)}. \tag{5}$$

Now, setting $\pi_i^e = \pi_j^e$ in (5) (since the inflation rate is common to both countries) yields:

$$\pi_i^e = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\lambda}. \tag{6}$$

From an inspection of (6) we obtain the following remark:

Remark 1: *If the common central bank has the social preferences, when any member country carries out more structural reforms, the common inflationary bias is reduced.*

The explanation of this remark is as follows. When one country implements more reforms, its natural level of output increases narrowing its difference with the value of production which is optimal from the society's point of view. This lowers the central bank's incentives to carry out monetary surprises that stimulate output above the natural level. Therefore, the common inflationary bias is reduced. Notice, that structural reforms in one country makes the other member better-off. In other words, such reforms generate positive externalities.

Now, we proceed to characterize the level of reforms which is the government's best response to the sequence of events just described. In order to do so, first, we need to know the expression for the inflation rate as a function of the levels of reforms. This is obtained by plugging (6) into (4):

$$\pi = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\lambda} + \frac{\alpha\varepsilon}{\alpha^2 + \lambda}. \tag{7}$$

Now, in the scenario analyzed in this section we assume that structural reforms are decided by the governments on a national level. Therefore, each of them selects the level of reforms that minimize its own country's expected social loss, taking its counterpart's choice as given.

Therefore, each governments faces the following problem (from (1), (2), (6) and (7)):

$$\underset{\{\phi_i\}}{Min} \qquad E\left(L_i^S\right) = E\left(\lambda\pi^2 + y_i^2 + \delta\phi_i^2\right)$$

$$s.a. \quad \begin{cases} y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi - \pi_i^e\right) - \varepsilon, \\ \pi = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\lambda} + \frac{\alpha\varepsilon}{\alpha^2+\lambda}, \\ \pi_i^e = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\lambda}. \end{cases}$$

From the first order conditions, we obtain each government's reaction function:

$$\phi_i = \frac{2\widehat{\phi}\left(2\lambda + \alpha^2\right)}{4\lambda\left(1+\delta\right) + \alpha^2} - \frac{\alpha^2\phi_j}{4\lambda\left(1+\delta\right) + \alpha^2}. \tag{8}$$

From this equations we extract the following conclusion:

Remark 2. *If the common central bank has the social preferences and structural reforms are determined on the national level, when one member country implements such reforms it reduces the other partner's incentive to do the same.*

The reason can be understood taking into account that when one country carries out more structural reforms the common inflationary bias is reduced (see Remark 1), which makes it less attractive for the other country to implement them since they are costly.

Finally, solving simultaneously the governments' reaction functions (expression (8), where $i, j = 1, 2;\ i \neq j$) we have:

$$\phi_i = \frac{\widehat{\phi}}{1 + \frac{2\delta\lambda}{\alpha^2+2\lambda}}. \tag{9}$$

In any case, equation (9) shows that level of structural reforms carried out is positive ($\phi_i > 0$) but do not reach its ceiling ($\phi_i < \widehat{\phi}$). This implies that the natural level of output is still lower than the one which is socially optimal. Therefore, reforms cannot completely eliminate the central bank's incentive to try and stimulate output beyond its natural level. This is known by the private sector, which implies that the inflation bias is not removed but takes the following positive value:

$$\pi^e = \frac{2\alpha\delta\widehat{\phi}}{2\lambda\left(1+\delta\right) + \alpha^2}. \tag{10}$$

On the other hand, the inflation rate is (substituting (9) into (7)):

$$\pi = \frac{2\alpha\delta\widehat{\phi}}{2\lambda\left(1+\delta\right) + \alpha^2} + \frac{\alpha\varepsilon}{\alpha^2+\lambda}, \tag{11}$$

and the level of output results in (plugging (9), (10) and (11) into (1)):

$$y_i = -\frac{2\delta\lambda\widehat{\phi}}{2\lambda(1+\delta)+\alpha^2} - \frac{\lambda\varepsilon}{\alpha^2+\lambda}. \tag{12}$$

Finally, substituting (9), (11) and (12) into (2) and taking expectations in the resulting expression we obtain country i's expected social loss:

$$E\left(L_i^S\right) = \frac{\left(4\lambda(1+\delta)\left(\lambda+\alpha^2\right)+\alpha^4\right)\delta\widehat{\phi}^2}{\left(2\lambda(1+\delta)+\alpha^2\right)^2} + \frac{\lambda}{\alpha^2+\lambda}\sigma_\varepsilon^2. \tag{13}$$

Now we wonder whether, in the present scenario, the creation of a monetary union can be counterproductive for the member countries:

Proposition 1: *If structural reforms are determined on the national level, the formation of a monetary union makes the member countries worse-off if the monetary authorities have the social preferences, prior and after the creation of the union.*

Proof: See Appendix.

We obtain this result since, as explained above, when countries adopt a single currency the implementation of structural reforms generates positive externalities (more reforms lower the common inflationary bias). This implies that governments have incentives to carry out suboptimally low levels of such reforms. Therefore, since this free-rider problem can only arise when the two countries share the same currency (and the same bias), the formation of the union is counterproductive. This result makes it necessary to find a mechanism that internalizes this kind of externalities arising in a monetary union.

A first alternative consists of countries cooperating in the implementation of their reforms. This regime can be modeled by assuming that they delegate such policies to a supranational authority who minimizes the expected joint social loss. In order to analyze this scenario, again we apply backward induction and solve the game in the same way as in the previous regime, with the only exception that, now, the problem to be solved in the first stage (by the supranational

authority) is:

$$\underset{\{\phi_i,\phi_j\}}{Min} \qquad \sum_{i=1}^{2} E\left(\lambda\pi^2 + y_i^2 + \delta\phi_i^2\right)$$
$$s.a. \quad \begin{cases} y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi - \pi_i^e\right) - \varepsilon, \\ \pi = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\lambda} + \frac{\alpha\varepsilon}{\alpha^2+\lambda}, \\ \pi_i^e = \frac{\alpha\left(2\widehat{\phi} - \left(\phi_i + \phi_j\right)\right)}{2\lambda}, \end{cases} \tag{14}$$

The solution to this program yields the following conclusion:

Remark 3: *If the central bank has the social preferences, comparing the scenario where the structural reforms are determined in a cooperative fashion with the one in which decisions on such reforms belong to the national level, in the former the levels of structural reforms and output are greater while the inflationary bias is lower, although it is not completely eliminated.*

Proof: See Appendix

The intuition behind this remark can be understood bearing in mind that reforms generate positive externalities, since they reduce the common inflationary bias. Therefore, when there exists cooperation in reforms, their level will be higher than in the noncooperative scenario. As a consequence, in the cooperative regime rigidities will be reduced, which will increase the natural level of output. Therefore, this level will tend to be closer to the one which is socially optimal. As a result, the incentive to carry out monetary surprises diminishes, lowering the inflation bias. Notice, however, that this bias is not removed completely since implementing reforms is costly.

4 Designing the central bank

In the previous section we have shown that in a monetary union in which the common central bank have the social preferences countries could be better-off if structural reforms were collectively determined. However, so far the feasibility of this cooperative scenario has not received empirical support in the case of the EMU. Therefore, an alternative mechanism needs to be found that makes it possible to internalize the positive externalities generated by the implementation of structural reforms.

With this aim, in this section we analyze one institution which achieves this goal. Moreover, we show that it yields a level of social welfare which is even higher than the one obtained in the cooperative regime studied above. This mechanism consists of granting independence to the central bank whose objective function is collectively chosen by the member countries.

We model this regime by adding a new stage that comes before the first stage (stage zero) where the design of such a monetary institution takes place. We follow the approach adopted by Svensson's (1997) in a closed economy which consists of selecting the level of inflation to be targeted by the central bank (π_0)[6]. Therefore, in this context, the loss function of the monetary authorities becomes:

$$L^B = \sum_{i=1}^{2} \left(\lambda \left(\pi - \pi_0 \right)^2 + y_i^2 + \delta \phi_i^2 \right). \tag{15}$$

Once more, we apply backward induction to solve the game. Thus, in the last stage, the central bank chooses the inflation rate that minimizes (15), subject to the supply functions appearing (1). The solution to this problem yields the monetary authorities's reaction function:

$$\pi = \frac{1}{2} \frac{2\lambda\pi_0 + \alpha^2 \left(\pi_i^e + \pi_j^e \right) + \alpha \left(2\widehat{\phi} - \phi_i - \phi_j \right) + 2\alpha\varepsilon}{\alpha^2 + \lambda}, \tag{16}$$

where $i, j = 1, 2; \quad i \neq j$.

Taking expectations we have:

$$\pi_i^e = \frac{1}{2} \frac{2\lambda\pi_0 + \alpha^2 \left(\pi_i^e + \pi_j^e \right) + \alpha \left(2\widehat{\phi} - \phi_i - \phi_j \right)}{\alpha^2 + \lambda}. \tag{17}$$

Thus, expected inflation is (since $\pi_j^e = \pi_i^e$):

$$\pi_i^e = \pi_0 + \frac{\alpha \left(2\widehat{\phi} - \phi_i - \phi_j \right)}{2\lambda}. \tag{18}$$

Therefore, inflation is (substituting (18) in (16)):

$$\pi = \pi_0 + \frac{\alpha \left(2\widehat{\phi} - \phi_i - \phi_j \right)}{2\lambda} + \frac{\alpha\varepsilon}{(\alpha^2 + \lambda)}. \tag{19}$$

Anticipating this process, governments implement structural reforms. We model the case in which decisions on reforms belong to the national level by assuming that governments behave as

[6] It can be shown that following Walsh's (1995) approach does not change our conclusions. On the other hand, Svensson's (1997) has the advantage of providing clearer intuitions.

Nash players. Therefore, each of them selects the level of reforms (ϕ_i) with the aim of minimizing its own country's expected loss taking the other's choice as given. From the first order condition we obtain the government's reaction function:

$$\phi_i = \frac{2\lambda\pi_0\alpha + 2\widehat{\phi}\left(2\lambda + \alpha^2\right) - \alpha^2\phi_j}{4\lambda\left(1+\delta\right) + \alpha^2}. \tag{20}$$

Applying symmetry one finds:

$$\phi_i = \frac{\lambda\pi_0\alpha + \widehat{\phi}\left(2\lambda + \alpha^2\right)}{2\lambda\left(1+\delta\right) + \alpha^2}. \tag{21}$$

From (18), (19) and (21) the expected inflation and the actual inflation are, respectively:

$$\pi^e = \frac{2\lambda\pi_0\left(1+\delta\right)}{\left(2\lambda\left(1+\delta\right)+\alpha^2\right)} + \frac{2\delta\alpha\widehat{\phi}}{\left(2\lambda\left(1+\delta\right)+\alpha^2\right)}. \tag{22}$$

$$\pi = \frac{2\lambda\pi_0\left(1+\delta\right)}{\left(2\lambda\left(1+\delta\right)+\alpha^2\right)} + \frac{2\delta\alpha\widehat{\phi}}{\left(2\lambda\left(1+\delta\right)+\alpha^2\right)} + \frac{\alpha\varepsilon}{\left(\alpha^2+\lambda\right)}. \tag{23}$$

Finally, in stage zero both governments agree on the inflation target to be aimed at by the common central bank. This target is designed so that the expected joint social loss is minimized. Formally, the problem to be solved is (from (1), (21), (22) and (23)):

$$\underset{\{\pi_0\}}{Min} \quad \sum_{i=1}^{2} E\left(\lambda\pi^2 + y_i^2 + \delta\phi_i^2\right)$$

$$s.a. \quad \begin{cases} y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi - \pi_i^e\right) - \varepsilon, \\ \phi_i = \frac{\lambda\pi_0\alpha + \widehat{\phi}\left(2\lambda+\alpha^2\right)}{2\lambda(1+\delta)+\alpha^2}, \\ \pi^e = \frac{2\lambda\pi_0(1+\delta)}{(2\lambda(1+\delta)+\alpha^2)} + \frac{2\delta\alpha\widehat{\phi}}{(2\lambda(1+\delta)+\alpha^2)}, \\ \pi = \frac{2\lambda\pi_0(1+\delta)}{(2\lambda(1+\delta)+\alpha^2)} + \frac{2\delta\alpha\widehat{\phi}}{(2\lambda(1+\delta)+\alpha^2)} + \frac{\alpha\varepsilon}{(\alpha^2+\lambda)}, \end{cases}$$

whose solution is:

$$\pi_0 = -\frac{\delta\alpha\widehat{\phi}}{\lambda\left(1+\delta\right)}. \tag{24}$$

Notice that the monetary authorities's inflation target is lower than society's (normalized to zero). In this sense, it could be stated that it is optimal to have a central bank more conservative than society.

Now, from (1), (2) and (21) − (24) one finds the equilibrium value for reforms, expected

inflation, actual inflation, output and expected social loss:

$$\phi = \frac{\widehat{\phi}}{1+\delta}, \tag{25}$$

$$\pi^e = 0, \tag{26}$$

$$\pi = \frac{\alpha\varepsilon}{(\lambda+\alpha^2)}, \tag{27}$$

$$y = -\frac{\widehat{\phi}\delta}{(1+\delta)} - \frac{\lambda\varepsilon}{(\lambda+\alpha^2)}, \tag{28}$$

$$E\left(L^S\right) = \frac{\delta\widehat{\phi}^2}{1+\delta} + \frac{\lambda}{\lambda+\alpha^2}\sigma_\varepsilon^2. \tag{29}$$

Remark 4: *When the central bank in a monetary union is optimally designed the inflationary bias is eliminated irrespective of whether or not cooperation in structural reforms takes place. Moreover, all the macroeconomic variables reach the same levels in both scenarios.*

Proof: See Appendix

The inflationary bias is removed because the central bank's inflation target has been set so low that the private sector expect that inflation will, on average, be zero. Therefore, the inflationary bias being removed implies that, in contrast with the case analyzed in the previous section, reforms no longer help reduce this bias. As a consequence, in this new regime reforms do not generate (positive) spillovers; and with no externalities to be internalized, it does not make any difference whether or not cooperation occurs. That is, in both scenarios the macroeconomic variables reach the same levels.

Proposition 2: *In a monetary union, the first-best is achieved when the common central bank is collectively designed irrespective of whether or not reforms are collectively implemented. On the other hand, comparing this scenario with the one where monetary authorities have the social preferences and reforms are carried out in a cooperative fashion, in the former regime social welfare is higher and reforms, inflation, output and the expected social loss are lower.*

Proof: See Appendix

The intuition behind this result is as follows. In the regime in which the monetary authorities have the social preferences and there is cooperation in reforms, society has just one instrument, namely, structural reforms. By contrast, in the scenario in which the central bank has been collectively designed society has an additional instrument, that is, the inflation target of the monetary authorities. Therefore, that makes it possible to reach a better outcome in terms of social welfare even if reforms are not determined collectively. More specifically, the fact that the elimination of the inflationary bias is only achieved when the central bank's inflation target is designed implies that only in this scenario externalities disappear.

On the other hand, recall that in the former case, the advantages of carrying out reforms were twofold, they reduced the inflation bias and helped output approach the socially desirable level. By contrast, in the latter regime this bias disappears (Remark 4) with does away with the first advantage of structural reforms. As a consequence, the level of such reforms is reduced.

4.1 Enlarging the union

In this subsection we explore how the above conclusions are affected when the monetary union is enlarged by other countries whose economies are more rigid than the initial members'. This analysis is relevant to understand the implications of the recent enlargement of the European Union (1stof May 2004) which has consisted of the addition of ten new members[7]. The majority of these countries are immersed in a process of transition from central planning to market economy. A recent literature (see, for example, Campos and Coricelli [2002] and Svejnar [2002]) has emphasized that, even though most of these countries have initiated ambitious programs of structural reforms, this complex process is far from finished. Progress in this area can be measured by the "transition indicator" of the European Bank of Reconstructions and Development (EBRD). Some of the aspects measured by this indicator relate to price liberalization, competition policy, privatization of firms, enterprise restructuring, bank reform and the func-

[7] These countries are: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia. In addition, Bulgaria and Romania are expected to join the union in 2007. On the other hand, Turkey has began negotiations with the union for a future accession. Finally, the former republics of Yugoslavia are likely to apply in coming years. Ukraine too has signalled potential interest in EU membership.

tioning of financial institutions. The EBRD has concluded that cross-country comparisons of this indicator show that the accession countries' economies still have a higher level of rigidity than the current EMU members'.

On the other hand, although these new members do not belong to the euro zone so far, they will be allowed to share the common currency when they fulfill the nominal convergence criteria agreed in the Maastricht treaty. The European Commission and representatives of the ECB and member states have explicitly urged the accession countries to make further progress on real economic convergence and structural reforms before joining the single currency. In this respect, Duisenberg (2002), former governor of the ECB has stated: "Stability-oriented policies can be best supported by structural reforms. Moreover, structural reforms are key determinants of growth potential. In the case of the accession countries, structural reforms are even more important because they are necessary to complete the full adjustment of the accession countries' economies toward well-functioning market economies, including the setting-up of appropriate institutions and the adoption of international best practices in a number of areas. Completing this agenda is a challenge for the accession countries, particularly because of the sheer magnitude of pending reforms".

We model this integration process by considering that the enlarged union consists of just two countries: country 1 and country 2. They could well represent, respectively, the EMU of 15 members and the block of the accession countries. We assume that country 1 's initial level of rigidity is "low" $\left(\widehat{\phi}_L\right)$ and country 2's is "high" $\left(\widehat{\phi}_H\right)$. We begin by studying the case in which the central bank's inflation target is not changed after the enlargement, i.e., it appears in (24).

Proposition 3: *Consider a monetary union which is enlarged by new countries whose economy is more rigid than the old members'. If the design of the central bank is not modified after the accession takes place, the old partners: (a) will have more incentives to carry out structural reforms; and (b) their social welfare will worsen.*

Proof: See Appendix

We now explain the idea behind this result. The difference between the socially optimal level

of output and the natural level is greater for the accession countries. Therefore, if the inflation target does not change after the enlargement, the central bank will have an incentive to stimulate output by creating monetary surprises. This will be anticipated by the private sector giving rise to an inflationary bias. As a consequence, the governments in the incumbent countries will try to partially offset this bias by carrying out a more ambitious program of reforms. Besides, since reforms are costly and the inflationary bias is not eradicated, social welfare in the old member countries worsens.

Now, we consider two possible alternatives which, if put into practice could prevent the enlargement from being counterproductive for the initial members. The following proposition refers to the first one:

Proposition 4: *When a monetary union is enlarged by new countries whose economies are more rigid than the incumbents', the central bank must be made more conservative in order to prevent the accession from being counterproductive for the initial members.*

Proof: See Appendix

The reason why we obtain this result can be understood taking into account the conclusions we have drawn in the previous subsection. We have shown that enlarging the union and keeping the central bank target at the level selected prior to the enlargement would cause an inflationary bias. Therefore, the elimination of this bias calls for an even more conservative central.

However, the implementation of this proposal is not free of drawbacks. On the one hand, for one institution to be a credible commitment technology, it should not be modified very often. This feature is the essence of credibility (see, for instance, Persson and Tabellini [2000]). In this sense, it could be argued that the EMU should not redesign its central bank each time an enlargement takes place. On the other hand, such a change of the common monetary institution would generate coordination costs.

Another alternative that would prevent the initial members from being negatively affected by the enlargement consists of conditioning the countries' accession to having implemented a sufficient level of structural reforms before joining in, so that the rigidity of their economies

converged toward the current members'. As a consequence, the inflationary bias would not arise with the enlargement and there would be no need to redesign the central bank.

However, it should be emphasized that this can only be a way out of the problem if the accession countries are faced with real incentive to carry our their pending reforms. In this sense, as Rotte y Zimmerman (1998) have stated, the convergence criteria agreed in Maastricht were fulfilled by the current members of the EMU because of two reasons. To wit, they were imposed by a supranational authority and the "punishment" implied in the case of not abiding by the "rules of the game" was clear, severe and sure. Namely, staying outside the monetary union.

This recent experience in the EMU provides one lesson which could be applied to the case of the accession countries. Once they join the euro, their governments' incentives to implement reforms will diminish since internal lobbies would have greater leverage and would try to stop reforms since they imply costly decisions. Therefore, it is precisely before the accession takes place when governments in the candidate countries can find it most helpful to make use of the EMU institutions with the aim of convincing lobbies that such a process of reforms is a must. In this sense, one mechanism that has proved successful in stopping this kind of demands made by internal lobbies has been the actions of the European Commission[8].

5 Conclusions

This paper has explored the influence that the design of the central bank has on the government's incentives to carry out structural reforms and how the level of such reforms shapes the optimal inflation target of the central bank in a monetary union. This analysis is relevant in the context of the EMU where countries share a common monetary policy but decisions on structural reforms belong to the national level.

We have shown that the formation of a monetary union can be counterproductive for the

[8] For instance, France decided to allow a a greater degree of openess in its internal market of electricity just the day after a process had been initiated against this country for not abiding by a rule agreed in the European Union. In the same way, Italy ended seventy years of an active state intervention in industry because of the determination shown by the EU comissioner for competition, Karen van Miert, and its succesor, Mario Monti.

member countries if their economies present a similar level of rigidities and the monetary authorities have the social preferences. This reduction in social welfare will not occur if countries implement their structural reforms in a cooperative way. However, this scenario could only achieve a second-best. The first-best is attained if the central bank is designed so that it targets a level of inflation that differs from society's in a specific amount. This outcome is achieved even if decisions on reforms are not made in a cooperative fashion but, as it is the case in the EMU, belong to the national level.

Finally we have considered the case in which the union is enlarged by countries with more rigid economies than the initial members'. This study also applies to the EMU since new countries are expected to join the union before the end of this decade. We have shown that, in this scenario, the central bank must be made more conservative in order to prevent the accession from being counterproductive for the initial members. However, changing the monetary institution generates costs in terms of coordination and a loss of credibility. In this sense, an alternative solution that would avoid this unfavorable outcome for the initial members consists of the joining countries having implemented more structural reforms prior to the enlargement. In this respect, one important question that arises is how to find a commitment technology credible enough to persuade the accession countries to implement this costly reforms.

6 Appendix

Proof of Proposition 1

When countries do not share the same currency, we apply backward induction to solve the game in the same way used in section 3 (that led into (13)), with the only exception that in the last stage central banks act as Nash players. That is, each of them minimizes its own country's social loss (appearing in (2)), taking its counterpart's behavior as given. As a result, in this scenario country i's expected social loss is:

$$E\left(L_i^S\right) = \frac{\delta\left(\alpha^2+\lambda\right)\widehat{\phi}^2}{\lambda\left(1+\delta\right)+\alpha^2} + \frac{\lambda}{\left(\alpha^2+\lambda\right)}\sigma_\epsilon^2. \tag{30}$$

Therefore, the difference between country i's social loss with monetary union and without it is ((13) minus (30)):

$$\frac{\lambda\delta^2\alpha^4\widehat{\phi}^2}{(\delta\lambda+\lambda+\alpha^2)\left(2\lambda(1+\delta)+\alpha^2\right)^2}. \tag{31}$$

The sign of (31) is positive. Hence the formation of the monetary union is welfare reducing if the monetary authorities have the social preferences. ∎

Proof of Remark 3:

The solution to the problem appearing in (14) is:

$$\phi_i = \frac{\widehat{\phi}}{1+\frac{\delta\lambda}{\lambda+\alpha^2}}. \tag{32}$$

Substituting (32) in (6), (7) and (1) one finds the values for output and the inflationary bias when countries implement reforms in a cooperative fashion:

$$y_i = -\frac{\lambda\delta\widehat{\phi}}{\lambda(1+\delta)+\alpha^2} - \frac{\lambda\varepsilon}{\alpha^2+\lambda}, \tag{33}$$

$$\pi_i^e = \frac{\alpha\delta\widehat{\phi}}{\lambda(1+\delta)+\alpha^2}. \tag{34}$$

Working out the (three) respective differences between the values of reforms, output an inflation bias in the cooperative scenario and the corresponding ones obtained in the non-cooperative case, yields (substracting, respectively, expressions (9), (12) and (10) from equations (32), (33) and (34)):

$$\frac{\lambda\alpha^2\delta\widehat{\phi}}{(\lambda(1+\delta)+\alpha^2)(2\lambda(1+\delta)+\alpha^2)} > 0, \tag{35}$$

$$\frac{\lambda\alpha^2\delta\widehat{\phi}}{(\lambda(1+\delta)+\alpha^2)(2\lambda(1+\delta)+\alpha^2)} > 0, \tag{36}$$

$$-\frac{\delta\alpha^3\widehat{\phi}}{(\lambda(1+\delta)+\alpha^2)(2\lambda(1+\delta)+\alpha^2)} < 0. \tag{37}$$

Finally, given that it can be checked that the expression for country i's social loss in the cooperative regime coincides with (30), this scenario yields a higher level of welfare (since the difference between the social loss in the non-cooperative case and the one in the cooperative regime is given by the positive value appearing in (31)). ∎

Proof of Remark 4:

We apply backward induction to the game in which structural reforms are collectively determined. Therefore, we solve it in the same way as we did (in section 4) for the case where these reforms were decided at the national level with just one exception. That is, in the first stage a supranational authority solves (making use of (1), (2), (18) and (19)):

$$\underset{\{\phi_i,\phi_j\}}{Min} \qquad \sum_{i\neq j} E\left(\lambda\pi^2 + y_i^2 + \delta\phi_i^2\right)$$

$$s.a. \quad \begin{cases} y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi - \pi_i^e\right) - \varepsilon, \\ \pi_i^e = \pi_0 + \frac{\alpha\left(2\widehat{\phi}-\phi_i-\phi_j\right)}{2\lambda}, \\ \pi = \pi_0 + \frac{\alpha\left(2\widehat{\phi}-\phi_i-\phi_j\right)}{2\lambda} + \frac{\alpha\varepsilon}{(\alpha^2+\lambda)}, \end{cases}$$

which yields:

$$\phi_i = \frac{\lambda\alpha\pi_0 + \widehat{\phi}\left(\lambda + \alpha^2\right)}{\lambda\left(1+\delta\right) + \alpha^2}. \tag{38}$$

This reforms imply that expected and actual inflation are, respectively:

$$\pi^e = \frac{\pi_0\left(1+\delta\right)\lambda}{\lambda\left(1+\delta\right)+\alpha^2} + \frac{\widehat{\phi}\delta\alpha}{\lambda\left(1+\delta\right)+\alpha^2}, \tag{39}$$

$$\pi = \frac{\pi_0\left(1+\delta\right)\lambda}{\lambda\left(1+\delta\right)+\alpha^2} + \frac{\widehat{\phi}\delta\alpha}{\lambda\left(1+\delta\right)+\alpha^2} + \frac{\alpha\varepsilon}{\sigma+\alpha^2}. \tag{40}$$

Therefore, in stage zero, the inflation target of the central bank is obtained by solving the following problem:

$$\underset{\{\pi_0\}}{Min} \qquad \sum_{i=1}^{2} E\left(\lambda\pi^2 + y_i^2 + \delta\phi_i^2\right)$$

$$s.a. \quad \begin{cases} y_i = -\left(\widehat{\phi} - \phi_i\right) + \alpha\left(\pi - \pi_i^e\right) - \varepsilon, \\ \phi_i = \frac{\lambda\alpha\pi_0+\widehat{\phi}\left(\lambda+\alpha^2\right)}{\lambda(1+\delta)+\alpha^2}, \\ \pi^e = \frac{\pi_0(1+\delta)\lambda}{\lambda(1+\delta)+\alpha^2} + \frac{\widehat{\phi}\delta\alpha}{\lambda(1+\delta)+\alpha^2}, \\ \pi = \frac{\pi_0(1+\delta)\lambda}{\lambda(1+\delta)+\alpha^2} + \frac{\widehat{\phi}\delta\alpha}{\lambda(1+\delta)+\alpha^2} + \frac{\alpha\varepsilon}{\sigma+\alpha^2}, \end{cases}$$

whose solution is:

$$\pi_0 = -\frac{\delta\alpha\widehat{\phi}}{\lambda\left(1+\delta\right)}, \tag{41}$$

Notice that (41) coincides with (24). Now, substituting (41) into (38), we obtain the equilibrium value of reforms:

$$\phi = \frac{\widehat{\phi}}{1+\delta}. \tag{42}$$

Finally, from (42) one finds the values for expected inflation, actual inflation, output and expected social loss:

$$\pi^e = 0, \tag{43}$$

$$\pi = \frac{\alpha\varepsilon}{(\lambda+\alpha^2)}, \tag{44}$$

$$y = -\frac{\widehat{\phi}\delta}{(1+\delta)} - \frac{\lambda\varepsilon}{(\lambda+\alpha^2)}, \tag{45}$$

$$E\left(L^S\right) = \frac{\delta\widehat{\phi}^2}{1+\delta} + \frac{\lambda}{\lambda+\alpha^2}\sigma_\varepsilon^2, \tag{46}$$

which coincide respectively with the corresponding expressions (25) – (29)). ∎

Proof of Proposition 2:

Claim 1: The first-best is achieved when the common central bank is collectively designed:

Proof:

Following Persson and Tabellini (2000, p. 399) when the objective function is quadratic in the macroeconomic variables and the policy variable is determined after the realization of the shocks, the rule that achieves the first-best is a linear function of the realization of the shocks That is, the rule takes the following form:

$$\pi = a + b\varepsilon, \tag{47}$$

where a and b are two parameters to be determined.

On the other hand, when variables are determined before the realizations of the shocks, the optimum rule is not contingent on the shocks, that is, we need have:

$$\phi_i = c, \tag{48}$$

where c is the parameter to be found.

Now we determine the values of a, b, and c. First, plugging (47) and (48) into (2), and bearing in mind that $\pi^e = E(a+b\varepsilon) = a$, we have:

$$L^S = \lambda(a+b\varepsilon)^2 + \left(-\left(\widehat{\phi}-c\right) + \alpha(b\varepsilon) - \varepsilon\right)^2 + \delta c^2.$$

Taking expectations one obtains:

$$E\left(L^S\right) = \lambda a^2 + \lambda b^2 \sigma_\varepsilon^2 + \widehat{\phi}^2 - 2\widehat{\phi}c + c^2 + \alpha^2 b^2 \sigma_\varepsilon^2 - 2\alpha b \sigma_\varepsilon^2 + \sigma_\varepsilon^2 + \delta c^2.$$

The first order conditions are:

$$\begin{aligned}
\frac{\partial E\left(L^S\right)}{\partial a} &= 2\lambda a = 0 \\
\frac{\partial E\left(L^S\right)}{\partial b} &= 2\lambda b \sigma_\varepsilon^2 + 2\alpha^2 b \sigma_\varepsilon^2 - 2\alpha \sigma_\varepsilon^2 = 0 \\
\frac{\partial E\left(L^S\right)}{\partial c} &= -2\widehat{\phi} + 2c + 2c\widehat{\phi} = 0,
\end{aligned}$$

Solving simultaneously one finds:

$$\begin{aligned}
a &= 0, \\
b &= \frac{\alpha}{\lambda + \alpha^2}, \\
c &= \frac{\widehat{\phi}}{1+\delta}.
\end{aligned}$$

Thus, the first-best is achieved when the inflation and reforms are, respectively: $\pi = \frac{\alpha\varepsilon}{\lambda+\alpha^2}$ and $\phi_i = \frac{\widehat{\phi}}{1+\delta}$. These two expressions coincide with the ones obtained for these variables in the scenario in which the common central bank is designed ((27) and (25)).

Claim 2: Comparing the case in which the central bank has been designed with the regime where governments cooperate in the implementation of the structural reforms and the central bank has the social preferences, in the former scenario reforms, inflation and output reach lower level.

Proof:

Working out the (four) respective differences between the values of reforms, output, inflationary bias and expected social loss for the scenario where the central bank has been design and the corresponding values obtained in the case where the monetary authorities have the social preferences and there is cooperation in reforms yields (substracting, respectively, expressions

(32), (33), (34) and (30) from equations (42), (45), (43) and (46)):

$$-\frac{\delta\alpha^2\widehat{\phi}}{(1+\delta)(\delta\lambda+\lambda+\alpha^2)} < 0, \tag{49}$$

$$-\frac{\delta\alpha^2\widehat{\phi}}{(1+\delta)(\delta\lambda+\lambda+\alpha^2)} < 0, \tag{50}$$

$$-\frac{\alpha\delta\widehat{\phi}}{\delta\lambda+\lambda+\alpha^2} < 0, \tag{51}$$

$$-\frac{\delta^2\alpha^2\widehat{\phi}^2}{(1+\delta)(\delta\lambda+\lambda+\alpha^2)} < 0, \tag{52}$$

The signs of the previous four expressions prove claim 2. ∎

Proof of the Proposition 3

(a) The levels of reforms implemented after the accession takes place is obtained by solving the game as in the previous scenarios but keeping the inflation target at the level selected prior to the enlargement (expression (24)):

$$\phi_1 = \frac{1}{2}\frac{\alpha^2\widehat{\phi}_H\delta - \widehat{\phi}_L\left(-4\lambda(1+\delta)\delta+\delta\alpha^2-2\alpha^2\right)}{(1+\delta)(2\lambda(1+\delta)+\alpha^2)}, \tag{53}$$

$$\phi_2 = \frac{1}{2}\frac{\widehat{\phi}_H\left(4\lambda\delta+\delta\alpha^2+4\lambda+2\alpha^2\right)-\delta\widehat{\phi}_L\alpha^2}{2\lambda\delta^2+\alpha^2\delta+4\lambda\delta+2\lambda+\alpha^2}. \tag{54}$$

The difference between the level of country 1's reforms after and before enlargement ((53) minus (42)) is:

$$\frac{1}{2}\frac{\alpha^2\delta\left(\widehat{\phi}_H-\widehat{\phi}_L\right)}{(1+\delta)(2\lambda\delta+2\lambda+\alpha^2)} > 0.$$

The positive sign of this expression implies that country 1 (initial block) carries out more reforms after the accession occurs.

(b) The equilibrium values for country'1 expected inflation, actual inflation and output are, respectively:

$$\pi^e = \frac{\alpha\left(\widehat{\phi}_H-\widehat{\phi}_L\right)\delta}{2\lambda(1+\delta)+\alpha^2}, \tag{55}$$

$$\pi = \frac{\alpha\left(\widehat{\phi}_H-\widehat{\phi}_L\right)\delta}{2\lambda(1+\delta)+\alpha^2}+\frac{\alpha\varepsilon}{\lambda+\alpha^2}, \tag{56}$$

$$y_1 = -\frac{\left(\widehat{\phi}_L\left(4\lambda\delta+4\lambda+3\alpha^2\right)-\alpha^2\widehat{\phi}_H\right)\delta}{2(1+\delta)(2\lambda(1+\delta)+\alpha^2)}-\frac{\lambda\varepsilon}{\lambda+\alpha^2}. \tag{57}$$

Taking into account equations (53) – (57), the expected value of country 1's social loss after the enlargement differs from the one obtained prior to this event (expression (46)) in the following amount:

$$\frac{1}{4}\frac{\delta^2\left(\widehat{\phi}_H-\widehat{\phi}_L\right)^2\left(\alpha^2+4\lambda\left(1+\delta\right)\right)\alpha^2}{\left(2\lambda\left(1+\delta\right)+\alpha^2\right)^2\left(1+\delta\right)}.$$

Since this expression is positive, the enlargement makes country 1 (initial block) worse-off, provided that the central bank's inflation target remains unchanged. ∎

Proof of Proposition 4

Following the same procedure followed to obtain (24) , one finds that, when the new members (with more rigid economies) join in, the redesigned inflation target of the central bank is:

$$\pi_0=-\frac{\delta\alpha\left(\widehat{\phi}_L+\widehat{\phi}_H\right)}{2\left(1+\delta\right)\lambda}. \tag{58}$$

The difference between this value and the one appearing (24) is:

$$\frac{1}{2}\frac{\delta\alpha\left(\widehat{\phi}_L-\widehat{\phi}_H\right)}{\left(1+\delta\right)\lambda}<0.$$

Hence the central bank becomes more conservative after the enlargement. Taking account of (58), the inflationary bias is eliminated ($\pi^e=0$) and the expected social loss is:

$$E\left(L^S\right)=\frac{\delta\widehat{\phi}_L^2}{1+\delta}+\frac{\lambda}{\lambda+\alpha^2}\sigma_\varepsilon^2, \tag{59}$$

which coincides with the one appearing in (46). ∎

7 References

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