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Abstract

We consider the political economy of a monetary union where member governments attempt to influence the policy of the common central bank. Modeling this as a common agency with incentive contracts, we show that if incentives are all that matters for the bank, the equilibrium implements a weighted average of the countries' most preferred policy. We then argue that making the bank inflation averse and/or attentive towards the countries' economic developments is undesirable in this context.

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1 Introduction

Countries forming a monetary union will only in unlikely circumstances meet the Mundellian criterions for an Optimum Currency Area. From time to time, the countries' views on the appropriate common monetary policy will therefore inevitably differ. A government with national priorities facing a cyclical downturn in its country would obviously prefer a monetary expansion, while governments in countries without recessionary tendencies would clearly oppose this. In such a scenario, it is likely that governments act in order to influence the decisions of the common central bank. The important question is then how this "politicization" of monetary policy affects the whole union. It is the purpose of this paper to shed light on this question.

We consider a setting where the relationship between the governments of the countries of monetary union and their common central banker is modelled as one of "multiprincipal" or "common" agency. Member countries differ with respect to the shocks hitting their economies, the way shocks are transmitted, as well as in terms of the governments' preferences over macroeconomic aggregates. We allow such a variety of sources of conflicts over preferred policies in our model. We then assume that governments attempt to induce the central bank to follow their wishes, using the metaphor of incentive contracts; see Persson and Tabellini (1993) and Walsh (1995).[1] Such incentives *could* be pecuniary, but as noted by Persson and Tabellini (1993) one should not take the contract approach as literally describing remuneration for the central bank. Also, Rogoff (1985) labels similar incentive mechanisms as broad "systems of rewards of punishments," and Walsh (1995) describes the contracts approach as "a useful fiction for deriving the optimal incentive structure." In the context of the game within a monetary union one can indeed envisage that the incentives represent political pressures on the common central bank.

An important, almost defining, aspect of "politicization" is the difficulty of achieving cooperation and implementing a collusive solution. Each separate influence group remains free to pursue its aims. Therefore a politicized common agency should result in a noncooperative or Nash equilibrium of the strategies of each of the principals.[2] Two dimensions of politicization can be distinguished in the model. The first is *ex ante* politicization.

[1] For multi-country models applying the contracts approach to central banking, see, e.g., Persson and Tabellini (1996) or Jensen (2000). None of these papers, however, consider a monetary union.

[2] In the context of domestic politics, Wilson (1989) emphasized this noncooperative aspect of a politicized bureaucratic agency, and Dixit (1996) has analyzed some of its implications.

Here, the countries act noncooperatively, but each commits to its incentive schedule before shocks are realized, and the result is the Nash equilibrium of their schedules. The second is *ex post* politicization, or lack of commitment, where each country remains free to renegotiate the contract with the central banker after shocks are realized.

The danger of *ex post* politicization or non-credibility of commitment exists even within a single country, and the incentive schemes of Walsh (1995) (or delegation schemes of Rogoff, 1995) have been criticized for this reason.[3] However, in this paper we concentrate on the question of *ex ante* politicization in isolation and take commitment for granted. We comment on the properties of *ex post* politicization in the conclusion.

The consequences of noncooperative politicization for monetary policymaking turn out to depend crucially on the institutions under which the central bank operates. Of course, if the bank is constitutionally required to aim exclusively at union-wide price stability and this mandate is fully effective in practice, then whatever incentives the governments may offer will have no impact. The surprising aspect of our results, however, is that politicization, and even that of the noncooperative form, may not be so bad for the union as the mere semantics suggest.

In fact, we show that when the institutional setting is one where *all* that matters for the central bank's decision are the incentives offered by governments, then the equilibrium monetary policy is a very natural weighted average of the most preferred policies of the individual countries. Hence, when politicization is "maximal," policy outcomes turn out to be Pareto optimal. The reason is that it is optimal for each government to offer a schedule that resembles its own welfare function (up to a constant as well as a term acknowledging the rationality of expectations in the model). This is reminiscent of the "globally truthful" schedules of the common agency equilibrium of Grossman and Helpman (1994). Then, a central bank optimizing a weighted sum over all governments' schedules implements efficient monetary policy.

Moreover, we find that if the system is a mixture, where the central bank is operating under a mandate for price stability or a requirement of considering union-wide economic developments, but the incentives offered by governments have some effect de facto, then monetary policy becomes inefficient. In the case where the de jure system is a mandate for price stability, monetary policy leads to inefficiently stable inflation. In the case where the bank is required to care for a weighted sum of union members' welfare functions *per se*,

[3]See, e.g., McCallum (1995) and Jensen (1997) for discussions of this issue.

it turns out that equilibrium monetary policy will exhibit a systematic deflationary bias. This is because governments, who try to offer incentives resulting in its preferred inflation rate, in this situation will offer biased incentives. When the central bank cares for all countries' welfare in addition to incentive schedules, each government, acting unilaterally, is induced to counteract the central bank's "additional" preference for other countries' preferred inflation rates. This results in a systematic noncooperative inefficiency. In an example where welfare functions give rise to a standard Barro and Gordon (1983) inflation bias, each government will try to counteract the bias by offering anti-inflationary incentives. In a noncooperative equilibrium, however, all governments end up providing too strong incentives, and a deflation bias will be the result in equilibrium.

In sum, our results suggest that politicization of monetary policy in a monetary union may actually be desirable, and that institutional settings aiming at partially mitigating such politicization can be counterproductive. These implications are in stark contrast with conventional wisdom inherited from recent literature. The newly established European Central Bank's constitution is intended to avoid politicization entirely, but to the extent that this is impractical, our analysis offers useful lessons for the design of effective incentives.

The remainder of the paper is organized as follows. In Section 2, we set up a simple log-linearized multi-country model of a monetary union. The purpose is to show that relevant economic aggregates can be cast as functions of actual and expected inflation. This insight is used in the main part of the paper, Section 3, where we consider the equilibrium of the game of common agency with general welfare functions indeed defined over actual and expected inflation. In Subsection 3.1, we then consider a linear-quadratic example to clarify the costs and benefits of politicization of the common monetary policy. Section 4 concludes.

2 The Effects of Monetary Policy

We consider a simple structural multi-country model in the spirit of, e.g., Canzoneri and Henderson (1988), Giavazzi and Giovannini (1989), but amended to cover the case of a monetary union as recently done by Lane (2000). For simplicity, we confine the analysis to a two-country version, but a generalization to more countries is relatively straightforward. The countries are called home and foreign, all variables are log-deviations from steady state, and variables pertaining to the foreign country are distinguished by an asterisk.

First, Cobb-Douglas production functions give the outputs of each country's imperfectly substitutable goods, y and y^*, respectively, as functions of employment levels ℓ and ℓ^*:

$$y = \alpha\,\ell + s, \qquad y^* = \alpha^*\,\ell^* + s^*\ , \tag{1}$$

where α, α^* are parameters between 0 and 1, and s, s^* are supply shocks, with $\mathbf{E}\,[s] = \mathbf{E}\,[s^*] = 0$, where $\mathbf{E}\,[.]$ is the unconditional expectations operator. Employment decisions are made after the shocks are realized; therefore the profit-maximization conditions are

$$w - p = -(1-\alpha)\,\ell + s, \qquad w^* - p^* = -(1-\alpha^*)\,\ell^* + s^*\ , \tag{2}$$

where w, w^* are the nominal wages and p, p^* the producer price levels. Wages are set before the shocks are realized, given rational expectations p^e, p^{*e} of the prices. Specifically, we assume

$$w - p^e = 0, \qquad w^* - p^{*e} = 0\ . \tag{3}$$

This can result if wages are set with a target of zero (log) real wage or zero (log) employment level.[4]

Subtracting equation (2) from (3) and rearranging, we have the equations of derived demand for labor,

$$\ell = \frac{1}{1-\alpha}\,(p - p^e + s), \qquad \ell^* = \frac{1}{1-\alpha^*}\,(p^* - p^{*e} + s^*)\ , \tag{4}$$

and finally the output supply equations

$$y = \gamma\,(p - p^e) + (1+\gamma)\,s, \qquad y^* = \gamma^*\,(p^* - p^{*e}) + (1+\gamma^*)\,s^*\ , \tag{5}$$

where $\gamma = \alpha/(1-\alpha)$ and $\gamma^* = \alpha^*/(1-\alpha^*)$.

On the demand side, we assume that consumers everywhere have identical homothetic preferences with an elasticity of substitution σ between the two countries's goods. Hence, one can write the world goods market equilibrium as

$$y - y^* = \sigma\,(p^* - p) + d\ , \tag{6}$$

where d is a shock expressing a demand shift toward the home country good, with $\mathbf{E}[d] = 0$.

[4] Of course the zero is just a normalization. Any other constant target would merely make the algebra more messy.

Combining (5) and (6), we get

$$\gamma\,(p-p^e)+(1+\gamma)\,s-\gamma^*\,(p^*-p^{*e})-(1+\gamma^*)\,s^*=\sigma\,(p^*-p)+d\ . \tag{7}$$

Finally, the common money market equilibrium is approximated by a Cambridge-type equation

$$M=\omega\,(p+y)+(1-\omega)\,(p^*+y^*)\ , \tag{8}$$

where M is the union-wide money supply, and where ω is the share of the home country GDP in the union GDP. The common central bank chooses M, after all the shocks have been realized.[5]

To solve the system, begin by taking expectations in equations (7) and (8). Using the rationality of price expectations, we have $0=\sigma\,(p^{*e}-p^e)$ and $M^e=\omega\,p+(1-\omega)\,p^{*e}$. These expressions yield a very simple solution for the price expectations, namely

$$p^e=p^{*e}=M^e\ . \tag{9}$$

Next turn to the realizations. Using equation (9) and rearranging terms, we can write equations (7) and (8) in the form

$$(\gamma+\sigma)\,(p-M^e)-(\gamma^*+\sigma)\,(p^*-M^e)=d-(1+\gamma)\,s+(1+\gamma^*)\,s^*\ ,$$

$$\begin{aligned}&\omega\,(1+\gamma)\,(p-M^e)+(1-\omega)\,(1+\gamma^*)\,(p^*-M^e)\\ =\ &(M-M^e)-\omega\,(1+\gamma)\,s-(1-\omega)\,(1+\gamma^*)\,s^*\ .\end{aligned}$$

These yield the solutions

$$\begin{aligned}p-M^e &= \delta\,(M-M^e)+\frac{(1-\omega)\,(1+\gamma^*)}{\Delta}\,d\\ &\quad-\frac{1+\gamma^*-\omega(1-\sigma)}{\Delta}(1+\gamma)s+\frac{(1-\omega)(1-\sigma)}{\Delta}(1+\gamma^*)\,s^*\ , &(10)\\ p^*-M^e &= \delta^*\,(M-M^e)-\frac{\omega\,(1+\gamma)}{\Delta}\,d\\ &\quad+\frac{\omega(1-\sigma)}{\Delta}\,(1+\gamma)s-\frac{1+\gamma-(1-\omega)(1-\sigma)}{\Delta}\,(1+\gamma^*)\,s^*\ , &(11)\end{aligned}$$

[5] Many economists argue that modern monetary policy is conducted with the short-term nominal interest rate as the instrument. This can be modeled in the same way with the same results as the model used here. We have retained the money supply model for its simplicity; the interest rate version is available for interested readers from the authors.

where

$$\Delta = \omega\,(1+\gamma)(\gamma^* + \sigma) + (1-\omega)\,(1+\gamma^*)(\gamma + \sigma)$$

and

$$\delta = (\gamma^* + \sigma)/\Delta, \qquad \delta^* = (\gamma + \sigma)/\Delta \ .$$

Note that the stochastic shocks affect the prices and therefore various real magnitudes. This creates the temptation for the countries to seek ex post policy adjustments (surprise inflation) to secure better outcomes.

We can define a union-wide price index π as a weighted average of p and p^* with the ω weights (or some other weights; here we retain for simplicity the ω weights). Then we will find

$$\begin{aligned} \pi &= M^e + \omega\delta\,(M - M^e) + (1-\omega)\delta^*\,(M - M^e) \\ &\quad + \frac{\omega(1-\omega)(\gamma^* - \gamma)}{\Delta}\, d - \frac{\omega(\gamma^* + \sigma)}{\Delta}\, s - \frac{(1-\omega)(\gamma + \sigma)}{\Delta}\, s^* \ , \qquad (12) \\ \pi^e &= M^e \ . \qquad (13) \end{aligned}$$

Therefore we can formally regard the common central bank as choosing π as its policy variable instead of M.

Having obtained the solutions for prices and price expectations in terms of M and M^e, or equivalently, π and π^e, we can express all the other economically relevant magnitudes — outputs, employment levels, the real exchange rate, etc. — in terms of these policy variables.[6] This completes the solution.[7]

3 The Equilibrium of Monetary Policy

Using the characteristics of the above solution of the economic equilibrium, we now formulate the political game where the member governments attempt to influence the monetary policy of the common central bank (CCB). Here we consider the general case of a monetary union of $n > 1$ countries, because the general algebra is no more complex than that

[6] The solution for the relative price (real exchange rate) is

$$p^* - p = \frac{\gamma - \gamma^*}{\Delta}\,(M - M^e) - \frac{\omega(1+\gamma) + (1-\omega)(1+\gamma^*)}{\Delta}\, d + \frac{(1+\gamma)(1+\gamma^*)}{\Delta}\,(s - s^*).$$

[7] Note that in the above calculations, all of the other parameters we have introduced can also be stochastic shocks. However, they are required to be realized before expectations are formed.

of the two-country case. Our notation and the general structure mostly follows Persson and Tabellini (1993)'s one-country model, and the model is a considerable generalization of Dixit (2000 b).

As we saw from the structural model in the previous section, the central bank can be regarded as choosing the inflation rate π for the union, after the realization of two types of stochastic shocks, represented by vectors θ and ϵ. Therefore the central bank's policy is a function $\pi(\theta, \epsilon)$. The inflation expectations π^e of the private sector are formed rationally, after θ is realized but before ϵ is realized; therefore the expectations are a function $\pi^e(\theta)$. Let $\phi(\theta, \epsilon)$ denote the joint probability density function of the shocks, $f(\theta)$ the marginal density function of θ, and $g(\epsilon|\theta)$ the conditional density function of ϵ. We will denote unconditional expectations by $\mathbf{E}[.]$, expectations with respect to the distribution of ϵ conditioned on θ by $\mathbf{E}_\epsilon[.|\theta]$, and expectations with respect to the marginal distribution of θ by $\mathbf{E}_\theta[.]$. Note that $\mathbf{E}[.] = \mathbf{E}_\theta[\mathbf{E}_\epsilon[.|\theta]]$. Now the condition for rationality of expectations can be written as

$$\pi^e(\theta) = \mathbf{E}_\epsilon[\pi(\theta, \epsilon)|\theta] \equiv \int \pi(\theta, \epsilon)\, g(\epsilon|\theta)\, d\epsilon \ . \tag{14}$$

for each θ.

As shown in the structural model of the previous section, all economically relevant magnitudes can be expressed in terms of π and π^e. Therefore, the preferences of the government of country i can be written as a function

$$U_i(\pi, \pi^e; \theta, \epsilon) \ . \tag{15}$$

Persson and Tabellini (1983) use instead a function of the form $W_i(\pi, \pi - \pi^e; \theta, \epsilon)$. The two are mathematically equivalent, and we assume $U_i(\pi, \pi^e; \theta, \epsilon) = W_i(\pi, \pi - \pi^e; \theta, \epsilon)$; our specification (15) merely simplifies the algebra in the present context. Concerning the properties of U_i we follow Persson and Tabellini (1983) and present the main assumption in terms of W_i: $\partial W_i / \partial [\pi - \pi^e] \geq 0$, with strict inequality for at least some θ,ϵ. This assumption captures the usual notion of benefits of inflation surprises due to, e.g., output gains.

For future reference it is of relevance to characterize country i's preferred policy. This characterization can be obtained by forming the Lagrangian

$$\mathcal{L} = \mathbf{E}\left[U_i\left(\pi\left(\theta, \epsilon\right), \pi^e\left(\theta\right); \theta, \epsilon\right)\right] + \mathbf{E}_\theta\left[\lambda_i(\theta)\ \left(\pi^e(\theta) - \ \mathbf{E}_\epsilon[\pi(\theta, \epsilon)|\theta]\right)\right] \ ,$$

where $\lambda_i(\theta)$ is the multiplier on (14). The first-order conditions are $\partial U_i/\partial\pi = \lambda_i(\theta)$ and $\partial \mathbf{E}_\epsilon [U_i|\theta]/\partial\pi^e = -\lambda_i(\theta)$, respectively, where U_i is, of course, evaluated at $\pi = \pi(\theta,\epsilon)$, and $\pi^e = \pi^e(\theta)$. These conditions are combined to eliminate the multiplier so as to characterize optimal commitment policy from the perspective of country i:

$$\partial U_i/\partial\pi = -\partial \mathbf{E}_\epsilon [U_i|\theta]/\partial\pi^e \ . \tag{16}$$

This reflects that $\mathbf{E}_\epsilon [\partial U_i/\partial\pi + \partial U_i/\partial\pi^e|\theta] = 0$, i.e., in the preferred equilibrium, the expected gain of marginally higher inflation and inflation expectations is zero for any realization of θ. Inflation is, in the absence of ϵ-shocks, therefore at its optimal rate. I.e., excessive inflation, which would otherwise prevail under discretion due to the assumption about gains from surprise inflation, is absent. (Therefore, in the preferred equilibrium, there will be no inflation bias of the Barro and Gordon, 1983, type.) Note, however, that (16) allows responses towards the shocks ϵ over which the policymaker has an informational advantage.

Although the member governments have delegated the conduct of monetary policy to the CCB, they stand to benefit differently for various realizations of shocks; hence, from the perspective of any country i, (16) is unlikely to be implemented. In particular, some or perhaps even all members facing adverse supply shocks may want to create some surprise inflation to increase the employment and output levels. As mentioned in the Introduction, each country offer incentives, or a contract a la Persson and Tabellini (1993) and Walsh (1995), to the common central bank, in an attempt to attain its preferred policy (note, however, that we do *not* restrict the contracts to be linear in inflation). The contracts are committed to before expectations are formed but delivered after the shocks are realized. Therefore each country commits to a state-contingent schedule $k_i(\theta,\epsilon)+T_i(\pi,\theta,\epsilon)$. Countries offer these incentives noncooperatively, so we seek a Nash equilibrium in schedules.

In contrast with Dixit (2000 b), where the CCB is assumed only to care about the schedules, we now assume that the CCB preferences are more general. The objective of the CCB is given by

$$U^{CCB} = A\sum_{i=1}^{n} a_i U_i + H(\pi) + B\sum_{i=1}^{n} p_i \left\{k_i(\theta,\epsilon) + T_i(\pi,\theta,\epsilon)\right\} \ .$$

with $A, B \geq 0$ and $a_i, p_i > 0$. The first term of U^{CCB} reflects a weighted average of the union members' objective functions. This could be present because some members on the governing board of the central bank bring with them their national preferences, or because the officials of the bank want to please the country governments because of implicit career incentives or for other reasons. Alternatively it could represent a legal requirement in the central bank's charter instructing it to pay attention to the overall economic developments in the monetary union. The third term is a weighted average of the explicit incentives. The weights a_i and p_i can be given a number of interpretations. The a_i s could reflect the size of the countries, and the p_i s could reflect countries' different abilities of influencing the decisions of the CCB (which may not necessarily be equal to size). The second term is included to allow for the case where the CCB has an innate preference for price stability, i.e., to reflect a degree of conservativeness of the CCB (again, it could also represent an explicit legal mandate for paying particular attention to price stability). The specification of U^{CCB} should be therefore be sufficiently general to cover a variety of interpretations.

When deciding on $T_i(\pi, \theta, \epsilon)$, each country knows that the CCB chooses π to maximize U^{CCB}. I.e., the following first-order condition holds:

$$A \sum_{i=1}^{n} a_i \frac{\partial U_i}{\partial \pi} + H'(\pi) + B \sum_{i=1}^{n} p_i \frac{\partial T_i}{\partial \pi} = 0 \; . \tag{17}$$

Country i maximizes $\mathbf{E}\left[U_i - c_i \left\{k_i(\theta, \epsilon) + T_i(\pi, \theta, \epsilon)\right\}\right]$, where $c_i > 0$ is some parameter weighting macroeconomic outcomes versus transfers. For example, a low value of c_i could characterize a country for whom offering incentives to the CCB is relatively painless; hence, U_i can have high priority when choosing the incentive schedule. This is a useful generalization because critics of Walsh (1995) have pointed that monetary payments may be trivial in a government's budget and yet matter a lot to the central bankers, and even non-monetary incentives may not weigh equally in the two parties' calculations. Note that in the special case of $c_i = p_i = B = 1$, all $i = 1, 2, ..., n$, $A = 0$, $H(\pi) \equiv 0$, and quadratic U_i, the model reduces to that of Dixit (2000 b).

Each country's maximization is subject to several constraints. First, the countries recognize that the common central bank will choose its π according to (17). This is kept implicit, and in the Lagrangian below, the π is assumed to be such a function of all the countries' incentive schemes. The countries also recognize that expectations will be formed rationally as defined by (14). However, it is mathematically complex to substitute out for the expectations using this equation. Therefore we use the simpler and mathematically equivalent approach of regarding each country as if it chooses the expectations, subject to the constraint (14). Finally, countries recognize the CCB's participation constraint, $\mathbf{E}\left[U^{CCB}\right] \geq u_0$, where u_0 is some outside opportunity utility.

Consider now the decision of, say, country 1. Its Lagrangian is

$$\begin{aligned}\mathcal{L}_1 &= \mathbf{E}\left[U_1\left(\pi,\pi^e\left(\theta\right);\theta,\epsilon\right)-c_1\left\{k_1(\theta,\epsilon)+T_1(\pi,\theta,\epsilon)\right\}\right]+\mathbf{E}_\theta\left[\lambda_1(\theta)\left(\pi^e(\theta)-\ \mathbf{E}_\epsilon[\pi(\theta,\epsilon)|\theta]\right)\right] \\ &\quad +\mu_1\mathbf{E}\left[A\sum_{i=1}^n a_iU_i\left(\pi,\pi^e\left(\theta\right);\theta,\epsilon\right)+H(\pi)+B\ \sum_{i=1}^n p_i\left\{k_i(\theta,\epsilon)+T_i(\pi,\theta,\epsilon)\right\}-u_0\right]\ ,\end{aligned}$$

where $\lambda_1(\theta)$ and μ_1 are the multipliers on the rational expectations constraint and participation constraint, respectively. The country's choice variables are $\pi^e(\theta)$, cf. above, and the functions $k_1(\theta,\epsilon)$ and $T_1(\pi,\theta,\epsilon)$, taking as given the other countries' choice variables and functions. As evident from (17), k_1 plays no role for the determination of π (assuming that the participation constraint holds). What is more, the Lagrangian depends on only the expectation $\mathbf{E}[k_1]$, not the full function $k_1\left(\theta,\epsilon\right)$. Therefore we can regard $\mathbf{E}\left[k_1\right]$ as country 1's choice variable. The first-order condition for it is

$$-c_1+\mu_1 p_1 B=0,\qquad \text{or,}\qquad \mu_1=\frac{c_1}{Bp_1}\ .$$

Using this, the Lagrangian can be rewritten as

$$\begin{aligned}\mathcal{L}_1 &= \mathbf{E}\left[U_1\right]+\mathbf{E}_\theta\left[\lambda_1\left(\pi^e-\ \mathbf{E}_\epsilon\left[\pi|\theta\right]\right)\right] \\ &\quad +\frac{c_1}{Bp_1}\mathbf{E}\left[A\sum_{i=1}^n a_iU_i+H+B\sum_{i=2}^n p_i\left\{k_i+T_i\right\}-u_0\right]\ ,\end{aligned}$$

where the function arguments have been omitted for brevity. Observe that, as in Dixit (2000 b), the country's own incentive schedules have cancelled out. Any marginal change in $T_1\left(.,\theta,\epsilon\right)$, however, will cause a marginal change in $\pi\left(\theta,\epsilon\right)$, which will alter the country's Lagrangian by

$$\begin{aligned}d\mathcal{L}_1 &= \left[\frac{\partial U_1}{\partial\pi}-\lambda_1+\frac{c_1}{Bp_1}\left\{A\sum_{i=1}^n a_i\frac{\partial U_i}{\partial\pi}+H'(\pi)+B\ \sum_{i=2}^n p_i\frac{\partial T_i}{\partial\pi}\right\}\right]\phi\left(\theta,\epsilon\right)\ d\pi\left(\theta,\epsilon\right) \\ &= \left[\frac{\partial U_1}{\partial\pi}-\lambda_1-c_1\frac{\partial T_1}{\partial\pi}\right]\phi\left(\theta,\epsilon\right)\ d\pi\left(\theta,\epsilon\right)\ ,\end{aligned}$$

where the last line follows from applying (17).

The optimal choice of T_1 must therefore satisfy

$$\frac{\partial T_1}{\partial\pi}=\frac{1}{c_1}\left[\frac{\partial U_1}{\partial\pi}-\lambda_1(\theta)\right]\ .$$

A simple function satisfying this requirement is

$$T_1\left(\pi,\theta,\epsilon\right)=\frac{1}{c_1}\left[U_1\left(\pi,\pi^e(\theta);\theta,\epsilon\right)-\lambda_1(\theta)\,\pi\right]\ . \tag{18}$$

Next, the first-order condition concerning the choice of π^e is

$$\mathbf{E}_\epsilon \left[\frac{\partial U_1}{\partial \pi^e} \bigg| \theta \right] + \lambda_1(\theta) + \frac{c_1}{Bp_1} \mathbf{E}_\epsilon \left[A \sum_{i=1}^{n} a_i \frac{\partial U^i}{\partial \pi^e} \bigg| \theta \right] = 0 \ , \tag{19}$$

and provides the solution for $\lambda_1(\theta)$. Similar conditions apply for all countries.

The solution (18) for the countries' equilibrium incentive schedules has a useful interpretation. If $c_1 = 1$ and if $\lambda_1(\theta)$ were zero, then (18) would simplify to just $T_1(\pi, \theta, \epsilon) = U_1(\pi, \pi^e(\theta); \theta, \epsilon)$. Remember that we have separated out the constant term in the incentive schedules as $k_1(\theta, \epsilon)$. Thus each country's schedule (for each realization of the shocks) differs from its own utility function only by a constant. In other words, the schedules become the "globally truthful" schedules of the common agency equilibrium in Grossman and Helpman (1994). Our equilibrium is a generalization of theirs in two senses. First, the factors c_i allows the transfers to figure differently in the principals' and the agent's objective functions. Second, the multiplier $\lambda_1(\theta)$ captures the added effect of the rational expectations constraint, which was not relevant in the Grossman-Helpman analysis, but becomes important in macroeconomic applications.

Using solutions like (18) for all countries in the CCB's first-order condition (17), we have

$$A \sum_{i=1}^{n} a_i \frac{\partial U_i}{\partial \pi} + H'(\pi) + B \sum_{i=1}^{n} \frac{p_i}{c_i} \frac{\partial U_i}{\partial \pi} - B \sum_{i=1}^{n} \frac{p_i}{c_i} \lambda_i = 0 \ . \tag{20}$$

This shows that the bank's policy choice π in each state will be guided by a weighted sum of its own objective (the first two terms on the left hand side), the countries' objectives (the third term) and an effect coming from the rational expectations constraint (the last term). This in principle completes the solution. Of course an explicit solution cannot be written down for the general model with arbitrary functions U_i; we will exhibit one for a special example below.

A crucial insight, however, follows in an important special case. Consider the situation where the CCB only pays attention to transfers, i.e., the case of $A = 0$ and $H(\pi) \equiv 0$. Then by use of (19), (20) reduces to

$$\sum_{i=1}^{n} \frac{p_i}{c_i} \frac{\partial U_i}{\partial \pi} = \sum_{i=1}^{n} \frac{p_i}{c_i} \mathbf{E}_\epsilon \left[\frac{\partial U_i}{\partial \pi^e} \bigg| \theta \right] . \tag{21}$$

This is a weighted average of the conditions (16) characterizing each country's preferred policy. So, in the simple case of symmetric countries, $U_i = U$, $p_i = p$ and $c_i = c$, all i, then (21) collapses into (16), and all countries attain their most preferred policy. It is thus interesting that in a Nash equilibrium, where countries attempt to influence the common monetary policy with only selfish objectives, and where the CCB *responds only to these attempts*, then policy will become an average of preferred policies. However, in the more general case of $A > 0$ and $H'(\pi) \neq 0$ inspection of (20) reveals that this will not be the case. To investigate clearly in what direction the common policy is distorted, we turn to a simplification of the objective functions so as to obtain closed form solutions.

3.1 A linear-quadratic example

Here we take the country objective functions to be of the linear-quadratic form:

$$U_i = b_i \left(\pi - v_i - \pi^e\right) - \frac{1}{2}\left(\pi - v_i - \widehat{\pi}_i\right)^2 \ , \tag{22}$$

where $\widehat{\pi}_i$ is the most-preferred inflation rate of country i under normal circumstances (for example because it wants to use an unindexed tax system to raise some revenues), v_i is a mean-zero, country-specific shock that makes it want a higher inflation rate for that realization,[8] and b_i is a supply shock that alters its trade-off between the benefits of surprise inflation and the costs of higher inflation in favor of the former. We assume that $\mathbf{E}[b_i] = \beta_i > 0$. The shocks v_i and b_i are realized after expectations are formed, so in conformity with the notation of the previous section we define the shock vector $\epsilon = (v_i, b_i | i = 1, 2, ..., n)$. We can interpret the other parameters of the model as shocks as well, which, however, are realized before expectations are formed. Hence, we define the vector $\theta = (\widehat{\pi}_i, \beta_i | i = 1, 2, ..., n)$.

For future reference, we note that from the perspective of any country i, the optimal commitment rule of monetary policy follows from (16), when U_i is given by (22), as

$$\pi^{(i)} = \widehat{\pi}_i + v_i + \left(b_i - \beta_i\right) \ . \tag{23}$$

This rule secures that π on average equals the preferred rate, while allowing for temporary expansions (contractions) whenever b_i is above (below) its mean, as well as neutralizing the effects of v_i shocks.

We model the CCB's innate inflation aversion by specifying $H(\pi) = -\left(\varphi/2\right)\pi^2$, $\varphi \geq 0$. Then the steps of the argument of the general theory above can be carried

[8] One could interpret v_i as a shock causing deviations from purchasing power parity, i.e., causing a deviation in country i's inflation rate from the union-wide rate.

out explicitly. I.e., (18) and (19) when U_i is given by (22) yields following quadratic equilibrium incentive schedule for country 1:

$$T_1(\pi, \theta, \epsilon) = \frac{1}{c_1}\left\{b_1(\pi - v_1 - \pi^e) - \frac{1}{2}(\pi - v_1 - \widehat{\pi}_1)^2 - \left(\beta_1 + \frac{c_1 A}{B p_1}\sum_{i=1}^{n} a_i \beta_i\right)\pi\right\}. \quad (24)$$

As similar functions apply for other countries, (17) results in the following solution for $\pi(\theta, \epsilon)$:

$$\pi(\theta, \epsilon) = \frac{\sum_{i=1}^{n}(A a_i + B\ p_i/c_i)\ \pi^{(i)}}{\varphi + \sum_{i=1}^{n}(A a_i + B\ p_i/c_i)} - \frac{(n-1)\,A\sum_{i=1}^{n} a_i \beta_i}{\varphi + \sum_{i=1}^{n}(A a_i + B\ p_i/c_i)}. \quad (25)$$

The first part of this expression is a very simple weighted average of the central bank's own most preferred inflation rate, namely 0, which gets weight proportional to φ, and the individual countries' optimal rules given by (23), which get weights proportional to $(A a_i + B\, p_i/c_i)$. When $\varphi > 0$, the resulting inflation rate is therefore *less* than a weighted average of each country's preferred policy. If, on the other hand, $\varphi = 0$, i.e., if the CCB has no independent objective for price stability (which seems unlikely both from a legislative and practical point of view), *and* if $A = 0$ such that the second term of (25) disappear, then $\pi(\theta, \epsilon)$ becomes a weighted average of each country's preferred policy. This is analogous to what Dixit (2000 b) finds, with the only difference being the presence of weights, which depend on the various parameters. The way the weights are functions of the parameters is very intuitive.

The second part of (25) is more intricate. It is of relevance when $A > 0$, i.e., when the CCB's own objective directly takes into account the countries' objectives. Then, equilibrium inflation involves a *deflation bias*. This rather surprising feature arises for the following reason. When deciding unilaterally on transfers, country 1 acknowledges that implementing strong incentives for low inflation expectations raises all countries' U_i. This raises the CCB's utility and thus relaxes the participation constraint. This is valuable for country 1 as $\mu_1 > 0$. (It can in principle take advantage of it by lowering its $\mathbf{E}[k_1]$.) As this argument applies for all countries, the anti-inflationary incentives offered will be inefficiently strong. Another way of explaining the result is that each country — taking other countries' schedules as given — attempt unilaterally to offer incentives to counteract the CCB's incentives for creating surprise inflation in *all* countries when $A > 0$. In equilibrium total incentives therefore become too strong, and stronger the larger is the union.

To sum up, including additional objectives for the CCB changes the results of Dixit (2000 b) in two ways. If $\varphi > 0$, inflation becomes too stable and too low on average (given that $\widehat{\pi}_i > 0$, $i = 1, 2, ..., n$), when compared to (23). The intuition for this result, is that the (contract) costs of providing the central bank with the needed incentives for creating more inflation variability outweigh the macroeconomic gains. This can be seen by considering the limit where authorities are indifferent towards transfer payments, i.e., $c_i \rightarrow 0$, all $i = 1, 2, ..., n$ (a case resulting in $\mu_i \rightarrow 0$ so that the deflation bias also vanishes). Only in that case will the resulting policy rule be a weighted average of countries' preferred policy rules. The weights will be functions of countries' ability to influence the central bank. Formally:

$$\lim_{\{c_i\}_{i=1}^{n} \rightarrow 0} \pi(\theta, \epsilon) = \frac{\sum_{i=1}^{n} p_i \ \pi^{(i)}}{\sum_{i=1}^{n} p_i}.$$

Moreover, if $A > 0$ monetary policy will feature a deflation bias.

Hence, only in the case where the CCB is *exclusively* subject to noncooperatively ex ante politicization, modelled here by use of the contracts metaphor, will policy be an average of most preferred policies. Any other legal mandates on the CCB reflecting either $\varphi > 0$ or $A > 0$ are counterproductive within this context.

4 Concluding Comments

We constructed a simple common agency model of ex ante politicization in a monetary union, when the common central bank is partially responsive to incetives offered noncooperatively by member governments. We found that if the central bank cared solely for these incentives, then the Nash equilibrium implemented a weighted average of the countries' objective functions, and was therefore a Pareto efficient outcome. Institutions where de jure mandates of price stability or requirements to include the countries' welfare directly in the bank's objectives interact with politicized incentives were counterproductive, and led to too low and stable inflation in relation to the average of the member countries' most preferred policies.

As a by-product, our paper offers some methodological contributions. We extend the contracts paradigm of monetary policy to the multi-country case, allowing fully non-linear state-contingent contracts. We use the Grossman-Helpman common agency framework, but extend it in two ways that are particularly useful in the context of macroeconomics and political economy. We incorporate the rational expectations constraint, and find that the "globally truthful" schedules must be modified to incorporate the shadow value of this constraint. We also allow the incentive payments to have different weights in the objective functions of the principals and the agent, as is likely when incentives are non-monetary.

We assume that the incentive schedules offered by the countries constitute binding commitments, that is, we do not consider ex post politicization. The contracts metaphor has been criticized for this reason; see McCallum (1995). However, just as a country may renege on its contract, it may also renege on delegation of policy. Ultimately, the credibility of such institutions hinges on the reputations of the parties; this is persuasively argued by Lohmann (1998). Therefore an appropriate model of ex post politicization should be a repeated game. Dixit (2000 a) considers repeated interactions where governments may undermine the commitment of the central bank's policy rule, but does not consider the gradual incentive schemes that were the focus of this paper. A repeated common agency model is clearly outside the scope of this paper, but should be a good topic for future research.

We follow Grossman and Helpman (1994) in assuming a common agency without information asymmetries. In fact countries' most-preferred policies, and the weight of incentive payments in their objective functions, are likely to be private information. The sizes of shocks may also be asymmetrically known. Incorporating these aspects into the model is also a promising item on the research agenda in this area.

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