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Abstract

In a standard New-Keynesian sticky-price model of monetary policymaking, we show that formulating the policy objective of a monetary union in terms of a weighted average of objectives for inflation and output in each of the member countries, instead of union-wide aggregate inflation and output, can have an important impact on the effective weight each member country carries in policymaking. This has implications for how fluctuation costs are distributed among member countries, and whether or not monetary policy contributes to harmonize inflation and output across the union.

Keywords: Monetary policy; Monetary union; Policy objectives; Harmonization
JEL Codes: E52; E58

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Introduction

It is widely recognized that monetary policy in a monetary union cannot respond to the individual needs of each member country as well as outside a union. It is also well known that the welfare costs that arise because of this can be quite different for the member countries, depending on how heterogeneous they are, and the weight each carries in policymaking. However, an issue that has not received much attention is that the distribution of these costs across the member countries can depend on how one aggregates across these. In particular, the present study explores the implications of the union's policy objective being formulated in terms of union-wide aggregates, instead of as a weighted average of objectives for inflation and output in each of the member countries. We show that this choice can impact the effective weight each union member carries in policymaking, even when the two methods do not differ in terms of the weights officially assigned to each country.

We employ a simple New-Keynesian sticky-price model, of the type commonly used for analyzing monetary policy, both in the literature and at central banks, see for example Clarida, Gali and Gertler (1999 and 2001), McCallum and Nelson (2000) and Woodford (1999a, 1999b and 2000), to show that countries with a high degree of openness will have a larger impact on policy when the union's policy objective is formulated in terms of a weighted average of country-level objectives for inflation and output, instead of an objective in terms of union-wide aggregate inflation and output. While our model is too simple to capture all the channels through which

shocks are transmitted between countries, or to realistically study the exact distribution of fluctuation costs, its simplicity allows for an easy demonstration of our general point, that how one aggregates across union members affects the effective weight each carries in policymaking. The reason is that the policy objective is a quadratic function, so it makes a difference whether one aggregates across union members before or after inserting into it.

The official objective of the European Central Bank (ECB) is to keep the weighted average of the harmonized indices of consumer prices (HICP) of the member countries growing below two percent per year, where the weights correspond to each country's share of total consumption in the union (Svensson (1999)). This is an objective in terms of a union aggregate that according to our analysis could be assigning too little weight to union countries with a high degree of openness. Instead, we propose that the policy objective should be to keep inflation in each of the union countries below a certain rate each year, with the importance of obtaining the goal in each of the countries being determined by their relative size. This would force policymakers to pay more attention to the needs of small countries that differ significantly from the union average in terms of how their inflation and output behaves, more so the more they differ from the average. Because of this, policy would contribute to reduce the dispersion across union countries. In addition, it would yield a more equitable distribution of the welfare costs that arise from monetary policy having to be identical in all member countries.

Model

Our argument can be illustrated in a sticky-price model with J countries or regions. Assume that the economies of each of the countries are governed by the aggregate supply and demand equations,

$$\pi_{j,t} = \beta_j E_t \pi_{j,t+1} + \lambda_j y_{j,t} + u_{j,t},\ j = 1, ..., J \tag{1}$$

$$y_{j,t} = -\varphi_j \left(R_t - E_t \pi_{j,t+1}\right) + E_t y_{j,t+1} + n_{j,t},\ j = 1, ..., J \tag{2}$$

respectively, where $\pi_{j,t}$ is the inflation rate in country j at time t, $E_t \pi_{j,t+1}$ is the one-period-ahead forecast of inflation in country j at time t, $y_{j,t}$ is the output in country j at time t and $E_t y_{j,t+1}$ is the one-period-ahead forecast of output in country j at time t.[1] R_t is the nominal interest rate, which is the same across all the J union members. All variables are in terms of deviations from their flexible-price values. The shocks $u_{j,t}$ and $n_{j,t}$, which may be autocorrelated, and also correlated across countries, make inflation, output and the interest rate deviate from their flexible-price values. The policy problem is to mitigate these deviations. The parameters of the model, β_j, λ_j and φ_j, are permitted to differ across countries. The discount factor $\beta_j \in (0, 1)$ governs how expected future inflation affects present inflation. The degree to which there exists an inflation-output trade-off in the Phillips curve (1) depends on $\lambda_j > 0$, while $\varphi_j > 0$ determines the impact the expected real interest rate has on output. The equations are derived from fundamentals as-

[1] E_t is the mathematical expectation conditional on the information available at time t, which we assume includes all the parameter values and all the variables that have been realized at that time.

suming optimizing agents and menu costs, see Rotemberg (1982) and Calvo (1983) for the New-Keynesian Phillips curve (1), and Woodford (1995) and McCallum and Nelson (1999) for the dynamic IS-curve (2).

Contrary to the model studied by Benigno (2004), our framework does not explicitly include trade between countries. According to Clarida, Gali and Gertler (2001) this is a valid simplification because terms of trade deviations from flexible-price values will be proportional to output's deviation from flexible-price output. The model for an open economy is therefore identical to that of a closed one, except for the values of the parameters λ_j and φ_j, since the terms of trade enter through the output variable, affecting the related parameters.

Union Policy Objective

From an economic perspective, the objective of the union's monetary policy should be to maximize the welfare of the union members. Rotemberg and Woodford (1999) show that in an economy j, this is achieved at any time $t = 0$ by minimizing the loss function

$$E_0 \sum_{t=0}^{\infty} \beta_j^t \left(\pi_{j,t}^2 + \alpha_j y_{j,t}^2 + \theta_j R_{j,t}^2 \right) \tag{3}$$

with respect to $R_{j,0}$, since this will minimize the welfare costs of the distortions that arise due to price-stickiness. The coefficients α_j and θ_j are both positive and measure the aversion towards output and interest rate volatility, respectively. These are, as is discussed by Clarida, Gali and Gertler (2001),

sensitive to, among other things, the degree of openness of the economy, and can therefore differ across countries (see discussion below). Since there is no way for the monetary authority to credibly commit to a plan for future policy, we focus on discretionary policy.

A direct application of the above loss function (3) to the union as a whole, implies that the policy objective should be to minimize

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\pi_t^2 + \alpha y_t^2 + \theta R_t^2\right) \tag{4}$$

with respect to R_0, where β, α and θ are union-wide values, and

$$\pi_t = \sum_{j=1}^{J} p_j \pi_{j,t} \tag{5}$$

$$y_t = \sum_{j=1}^{J} p_j y_{j,t} \tag{6}$$

are union aggregate inflation and output, respectively, and p_j denotes the relative size of country j for $j = 1,..., J$, where $\sum_{j=1}^{J} p_j = 1$.[2] Substituting into the loss function above (4) yields

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\left(\sum_{j=1}^{J} p_j \pi_{j,t} \right)^2 + \alpha \left(\sum_{j=1}^{J} p_j y_{j,t} \right)^2 + \theta R_t^2 \right) \tag{7}$$

as the union-wide loss function.

The objective in terms of union aggregates (7) represents the welfare

[2]Output is measured in terms of deviations from flexible-price values, so union-wide output can be obtained by computing the weighted average of the country level values, just as inflation. For simplicity we assume that the same weights are used to aggregate inflation and output.

costs of fluctuations to the average union consumer. An alternative is to take a weighted average of the welfare of the representative consumer in each member country. When the weight assigned to country j is given by p_j, the objective would then be to minimize

$$E_0 \sum_{t=0}^{\infty} \sum_{j=1}^{J} p_j \beta_j^t \left(\pi_{j,t}^2 + \alpha_j y_{j,t}^2 + \theta_j R_t^2 \right) \tag{8}$$

with respect to R_0, assuming consumers are only directly affected by inflation and output in their own country.

The policy objective in terms of union aggregates (7) is invariant to a mean-preserving spread of inflation and output across member countries, since it would by definition leave aggregate inflation and output unchanged. However, because the objective in terms of average country-level welfare (8) is a weighted sum of the squared values of inflation and output in each country, a mean-preserving spread would raise its value. Hence, an objective in terms of union aggregates provides no incentives to conduct monetary policy so as to contribute toward reducing disparities in inflation and output across union members, while an objective in terms of the average of country-level welfare does.

Union Policy

The optimal discretionary policy when the objective is in terms of union aggregates (7) can, as is shown by Currie and Levine (1993), Clarida, Gali and Gertler (1999), Svensson and Woodford (2003) and Woodford (1999a),

be found by minimizing the Lagrangian

$$\begin{aligned}\pounds_A = &\sum_{t=0}^{\infty}\beta^t\left(\left(\sum_{j=1}^{J}p_j\pi_{j,t}\right)^2+\alpha\left(\sum_{j=1}^{J}p_jy_{j,t}\right)^2+\theta R_t^2\right)\\ &-\sum_{t=0}^{\infty}\sum_{j=1}^{J}\kappa_{j,t}\left(\beta_jE_t\pi_{j,t+1}+\lambda_jy_{j,t}+u_{j,t}-\pi_{j,t}\right)\\ &-\sum_{t=0}^{\infty}\sum_{j=1}^{J}\upsilon_{j,t}\left(-\varphi_j\left(R_t-E_t\pi_{j,t+1}\right)+E_ty_{j,t+1}+n_{j,t}-y_{j,t}\right)\end{aligned} \tag{9}$$

with respect to $\pi_{i,0}$, $y_{i,0}$ and R_0, for $i = 1,..., J$. Here, $\kappa_{j,t}$ and $\upsilon_{j,t}$ are Lagrangian multipliers associated with constraints (1) and (2), respectively, for country j at time t. The first-order conditions are

$$\frac{\partial\pounds_A}{\partial\pi_{i,0}} = 2\left(\sum_{j=1}^{J}p_j\pi_{j,0}\right)p_i+\kappa_{i,0}=0,\ i=1,...,J \tag{10}$$

$$\frac{\partial\pounds_A}{\partial y_{i,0}} = 2\alpha\left(\sum_{j=1}^{J}p_jy_{j,0}\right)p_i-\lambda_i\kappa_{i,0}+\upsilon_{i,0}=0,\ i=1,...,J \tag{11}$$

$$\frac{\partial\pounds_A}{\partial R_0} = 2\theta R_0+\sum_{j=1}^{J}\varphi_j\upsilon_{j,0}=0 \tag{12}$$

and solving this system for R_0 yields

$$R_0^A = \frac{1}{\theta}\sum_{i=1}^{J}p_i\varphi_i\lambda_i\sum_{j=1}^{J}p_j\pi_{j,0}+\frac{\alpha}{\theta}\sum_{i=1}^{J}p_i\varphi_i\sum_{j=1}^{J}p_jy_{j,0} \tag{13}$$

as the optimal policy.

When the union's objective is in terms of the average of country-level

welfare (8), the Lagrangian is

$$\begin{aligned}\pounds_B = &\sum_{t=0}^{\infty}\sum_{j=1}^{J} p_j\beta_j^t\left(\pi_{j,t}^2+\alpha_j y_{j,t}^2+\theta_j R_t^2\right)\\ &-\sum_{t=0}^{\infty}\sum_{j=1}^{J}\kappa_{j,t}\left(\beta_j E_t\pi_{j,t+1}+\lambda_j y_{j,t}+u_{j,t}-\pi_{j,t}\right)\\ &-\sum_{t=0}^{\infty}\sum_{j=1}^{J}\upsilon_{j,t}\left(-\varphi_j\left(R_t-E_t\pi_{j,t+1}\right)+E_t y_{j,t+1}+n_{j,t}-y_{j,t}\right)\end{aligned} \tag{14}$$

and the first-order conditions are

$$\frac{\partial\pounds_B}{\partial\pi_{i,0}} = 2p_i\pi_{i,0}+\kappa_{i,0}=0,\ i=1,...,J \tag{15}$$

$$\frac{\partial\pounds_B}{\partial y_{i,0}} = 2p_i\alpha_i y_{i,0}-\lambda_i\kappa_{i,0}+\upsilon_{i,0}=0,\ i=1,...,J \tag{16}$$

$$\frac{\partial\pounds_B}{\partial R_0} = 2R_0\sum_{j=1}^{J}p_j\theta_j+\sum_{j=1}^{J}\upsilon_{j,0}\varphi_j=0 \tag{17}$$

which yield

$$R_0^B = \left(\sum_{j=1}^{J}p_j\theta_j\right)^{-1}\sum_{j=1}^{J}p_j\varphi_j\left(\lambda_j\pi_{j,0}+\alpha_j y_{j,0}\right) \tag{18}$$

as the optimal discretionary policy.

Both the policy that minimizes the objective in terms of union aggregates (13) and the one that minimizes the average of the country-level objectives (18), respond to increases in output and inflation in a member country by raising the nominal interest rate. The two policies do, however, differ in how much the interest rate responds to conditions in each individual country.

With the policy based on union aggregates (13) we have

$$\frac{\frac{\partial R_0^A}{\partial \pi_{k,0}}}{\frac{\partial R_0^A}{\partial \pi_{l,0}}} = \frac{\frac{\partial R_0^A}{\partial y_{k,0}}}{\frac{\partial R_0^A}{\partial y_{l,0}}} = \frac{p_k}{p_l},\ k, l = 1, ..., J \tag{19}$$

for any two countries k and l, while we have

$$\frac{\frac{\partial R_0^B}{\partial \pi_{k,0}}}{\frac{\partial R^B}{\partial \pi_{l,0}}} = \frac{p_k \varphi_k \lambda_k}{p_l \varphi_l \lambda_l},\ k, l = 1, ..., J \tag{20}$$

$$\frac{\frac{\partial R_0^B}{\partial y_{k,0}}}{\frac{\partial R_0^B}{\partial y_{l,0}}} = \frac{p_k \varphi_k \alpha_k}{p_l \varphi_l \alpha_l},\ k, l = 1, ..., J \tag{21}$$

with the policy based on averaging member objectives (18). These ratios measure the relative weight carried by country k relative to country l in determining the policy instrument R_0. As expected, country k carries a smaller weight the lower p_k is, but in addition, when the economies are not identical ($\varphi_k \alpha_k \neq \varphi_l \alpha_l$ or $\varphi_k \lambda_k \neq \varphi_l \lambda_l$), the two policies effectively weight economic conditions in the two countries differently, even if the weights p_k and p_l are the same for both policies. The reason for this is that the policy objective (3) is a quadratic function, so it matters how one aggregates.

Clarida, Gali and Gertler (2001) show that the more open country j is, that is, the more it trades with other countries, the larger α_j and φ_j, and the smaller λ_j. Intuitively, this can be explained as follows. The weight output carries in the policy objective, measured by α_j, is higher because the terms of trade affect welfare, and since these enter through the output variable in our simple model, output must receive a larger weight the more open the

economy is. The effect a change in the real interest rate has on output, measured by φ_j, is larger the more an economy trades because a change in this rate affects the terms of trade, making the resulting movement in output larger. An increase in the real interest rate deteriorates the terms of trade, and therefore makes output decrease more the more open the economy is. The reason for a smaller λ_j is to adjust for net exports. The more open an economy is, the less domestic inflation is generated by supply increases, because a larger fraction of the goods are imported.

Furthermore, one can use Clarida, Gali and Gertler's (2001) framework to show that $\varphi_j \alpha_j$ and $\varphi_j \lambda_j$ will be larger the more open an economy is. The first is trivial, since we argued in the previous paragraph that both φ_j and α_j will be larger the higher the degree of openness. For the second, we have from Clarida, Gali and Gertler (2001) that

$$\varphi_j \lambda_j = \delta_j \left(1 + \frac{1 + \gamma_j \left(\sigma_j \eta_j - 1 \right) \left(2 - \gamma_j \right)}{\sigma_j} \phi_j \right) \tag{22}$$

where δ_j measures the sensitivity of domestic inflation to changes in the marginal costs of production in country j, σ_j is the coefficient of relative risk aversion in country j, η_j is the elasticity of substitution between domestically and foreign produced goods in country j, ϕ_j is the inverse of the labor supply elasticity in country j, and $\gamma_j \in (0, 1)$ is the fraction of goods consumed in country j that are of foreign production, a measure of the country's openness. Empirically, Clarida, Gali and Gertler (2001) argue, $\sigma_j \eta_j > 1$ is

generally satisfied, making

$$\frac{\partial \varphi_j \lambda_j}{\partial \gamma_j} = 2\delta_j \left(\sigma_j \eta_j - 1\right) \left(1 - \gamma_j\right) \frac{\phi_j}{\sigma_j} \tag{23}$$

strictly positive.[3]

Since $\varphi_j \alpha_j$ and $\varphi_j \lambda_j$ will, ceteris paribus, be larger the more open the economy of country j is, union countries with a high degree of openness will receive a lower effective weight in policymaking with an objective in terms of union aggregates (4) than with one in terms of the average of country-level objectives (8). For example, estimates of λ_j, the degree of price-stickiness in country j, by Benigno and Lopez-Salido (2006) for Germany, France, Italy, Spain and the Netherlands vary from .001 to .142 across the different countries. This implies that the relative weight put on a country's rate of inflation, which is arguably the main focus of the ECB, can vary by more than a factor of one hundred between the policy that minimizes the objective in terms of union aggregates (19) and the one that minimizes the average of country-level objectives (20).

Table 1 provides measures of the degree of economic openness in the European Monetary Union (EMU), illustrating the great disparities that exist across members, especially toward countries outside the EMU.[4] Bel-

[3]The degree of openness is not the only way in which union countries can differ that would impact the effective weights in policymaking through α_j, λ_j and φ_j. However, it is one of the more obvious and easily measured differences.

[4]Luxembourg, Monaco, San Marino, the Vatican City, Cyprus, Malta and Estonia were excluded from table 1, but the sum of their weights in policymaking is less than 1%. Trade statistics are averages for 1999-2009, except non-EMU trade numbers for Greece, Ireland, Portugal and Slovenia, which start in 2003, 2002, 2006 and 2005, respectively. All data for Greece is provisional. The statistics for HICP-inflation were computed over the period the country was a member of the EMU, including the weight, which is an average over those years

	All		Non-EMU		HICP-Inflation		
	Imp	Exp	Imp	Exp	Mean	Var	Weight
Austria	47.4	51.2	7.2	9.4	1.75	.82	3.1
Belgium	73.7	77.5	10.4	11.4	2.05	1.73	3.5
Finland	35.5	41.8			1.94	.99	1.6
France	26.7	26.7	3.4	4.2	1.70	.84	20.6
Germany	35.1	39.3	6.7	8.1	1.53	.73	29.6
Greece	34.9	22.6	4.3	4.6	3.28	.87	2.9
Ireland	74.2	87.5	21.1	21.2	2.96	3.70	1.3
Italy	25.8	26.2	2.9	3.9	2.26	.58	18.8
Netherlands	61.8	68.7	8.6	11.8	2.35	1.58	5.2
Portugal	37.9	29.0	3.2	4.4	2.57	2.11	2.1
Slovakia	78.9	75.2	15.1	16.0	2.00	3.10	.7
Slovenia	60.0	58.9	7.9	9.6	3.25	4.72	.4
Spain	30.5	26.6	3.5	4.7	2.89	1.71	11.2
EMU					2.00	.72	100

Table 1: Imports and exports as fractions of GDP and HICP-inflation statistics for EMU members, all in percentages, 1999-2009. Eurostat.

gium, Ireland, Slovakia, Slovenia and the Netherlands are the most open, while France, Greece, Italy and Spain are the least open. In addition, the table provides summary statistics for HICP-inflation, including the weight each country carries in aggregation, all computed over the years each has been a member of the EMU.[5] Inflation experiences have also varied across countries, both in level and volatility. For example, Greece has experienced an average rate two times greater than that of Germany, while Ireland has experienced a variance six times greater than that of Italy. As one would expect, the countries with the largest weights in policymaking, Germany, France and Italy, are among the ones that have enjoyed the lowest and most

[5] More precisely, the data for each country goes back to whenever its previous national currency became officially pegged to the Euro, which was January 1999 for all countries except: June 2000 for Greece, July 2006 for Slovenia and July 2008 for Slovakia.

stable inflation.

With a policy objective in terms of country-level aggregates, the more open economies, Belgium, Ireland, Slovakia, Slovenia and the Netherlands, would have received a larger weight in policymaking than with the current objective based on union aggregates. With the exception of Portugal and Spain, these are also the countries that have experienced the most inflation volatility. France, Greece, Italy and Spain would have received a lower weight, and with the exception of Spain, these are also among those to have experienced the least inflation volatility.

Conclusions

Assuming that the average of country-level welfare more closely measures overall union welfare than the welfare of the average union member when countries are asymmetric, we find that using union aggregates to formulate the union's policy objectives makes the countries with the more open economies receive too little weight. While this result is specific to our model, it is useful in illustrating the more general point that when union members are asymmetric, it can make a difference whether the policy objective is in terms of union aggregates or an average of country-level objectives. This choice can affect the effective weight each union member carries in policymaking, and thus how fluctuation costs are distributed among them. An exact evaluation of the welfare implications in each country from policymakers focusing on one policy objective versus the other would require specifying the parameter values, initial conditions and shocks for all countries, and is

beyond the scope of the present study. Besides, such an exercise would require a more complete and detailed model in order to yield realistic estimates. However, it seems reasonable to infer that having a smaller impact on union policy will generally make a country worse off, when the union members' economies, and the shocks affecting these, are asymmetric. Intuitively, it is also clear that focusing on an average of country-level objectives would make monetary policy contribute toward making these variables more homogeneous across union members, thus helping to synchronize their business cycles. The reason is that such an objective punishes heterogeneity, while an objective in terms of union aggregates does not.

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