Financial Heterogeneity in a Monetary Union

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Abstract

This paper addresses the issue of macroeconomic policies in a financially heterogeneous monetary union. Optimized policy rules are used, under various budgetary policy scenarios, in a two-country DSGE model. The results indicate that a Euro-wide monetary policy strategy based on national information does not offset the costs associated with the abandonment of national monetary policy. Decentralized budgetary policies need to be more proactive in countries which are structurally more sensitive to shocks. For independent common monetary policy, cooperation between governments is comparable to a coalition, causing losses for every member. Welfare improvement at the union level only results from reducing public expenditure divergences.

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I. Introduction

Despite an initial common financial shock, European Monetary Union (EMU) members have not been identically affected by the subprime mortgage crisis. In this respect, this crisis reasserts the structural heterogeneity of the EMU.[1] Recent studies indicate that the European financial system, in particular, remains far from integrated. Specifically, the banking market appears to be the most heterogeneous financing market;[2] price differentials remain high compared to other monetary unions, and home biases in the lending to and borrowing of small non-financial corporations and households are persistent.[3] According to the seminal models provided by Carlstrom and Fuerst (1997), Kiyotaki and Moore (1997), and Bernanke *et al*. (1999), the financial accelerator can explain these price differentials.[4]

However, the subprime mortgage crisis has also demonstrated that banks constitute key actors for the transmission of financial shocks. In this respect, several recent contributions[5] have highlighted the importance of the *bank capital channel*: through adjustments of their balance sheet structures, banks act as amplifiers for the transmission of shocks to the real economy. Following this literature, the question of banks' financing is as problematic as the question of external financing for entrepreneurs. Because of an agency problem between banks and their creditors, the former bear an external financial premium which is negatively related to their capital ratio. The resulting counter-cyclical external financing premium is ultimately passed on to entrepreneurs, through credit conditions.

Considering the main factors underlying the bank capital channel, an empirical study by Badarau-Semenescu and Levieuge (2010) indicates that European countries are ought to be more (Germany, Italy, Netherland) or less (Finland, France, Spain) sensitive to this mechanism. The reasons for this rely on structural, institutional, and behavioural differences. This concerns, for instance, differences regarding concentration in the banking market, the importance of bank loans' substitutes, the existence of long-term relationships between firms and banks, dependency on banking credit, bank capitalization, and liquidity. The bank capital channel thus constitutes an interesting way to model the effects of financial heterogeneity in the euro area. From this perspective, Badarau and Levieuge (2011) provide a DSGE model of a financially-asymmetric monetary union and show that: *1)* symmetric shocks induce cyclical divergences

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[1] The heterogeneity of the EMU is discussed in Jondeau and Sahuc (2008), MacDonald and Wojcik (2008), Sekkat and Malek Mansour (2005), Angeloni and Ehrmann (2007), Ekinci *et al*. (2007), Hofmann and Remsperger (2005), and Lane (2006).

[2] See Baele et al. (2004) and ECB (2008) for instance.

[3] See Angeloni *et al*. (2003).

[4] Empirical evaluations of the financial accelerator mechanism are provided by Gomes *et al*. (2003) and Christensen and Dib (2008).

[5] See Blum and Hellwig (1995), Chen (2001), Sunirand (2003), Gerali et al. (2010), and Levieuge (2009). National characteristics in banks' (and firms') financial structures in European countries are documented, for instance, in Chatelain *et al*. (2003) and Ehrmann *et al*. (2003). In addition, Gertler and Kiyotaki (2010) analyze the case of a capital quality shock to explain the role of financial intermediaries in the propagation of the recent crisis.

inside the union, and *2*) a common monetary policy worsens these cyclical divergences.

Given the role of banks in propagating shocks, namely, financial shocks which have become recurrent in recent decades, the heterogeneity of banking markets raises the question of what are the appropriate macroeconomic policies in such a context. Certainly, avoiding major financial crises requires adequate micro and macro-prudential measures. The reduction of financial heterogeneity also demands a convergence of structural policies. However, both require sufficient time and strength of will to be implemented. It is thus worth investigating what would be the most suitable mixture of the two main policy tools for the EMU : common monetary policy led by an independent central bank and budgetary policies conducted by national governments. Since 2008, the lack of coordination of economic stimulus plans inside the euro area, and the ways in which EMU-members could cooperate to help both the most affected countries and the union as a whole have been the subject of intense debate. Discussions are also on going regarding the appropriate design of monetary policy.

Recent literature analyzing the mix between monetary and fiscal policy in an asymmetric monetary union is quite scarce. Van Aarle *et al*. (2002, 2004) study fiscal and monetary policy rules in a two-country monetary union model with standard structural asymmetries. However, their analysis is not based on a micro-founded model, and they do not address the issue of optimal monetary policy. Interactions between monetary and fiscal policy in a monetary union have also been analyzed in dynamic stochastic general-equilibrium models. Gali and Monacelli (2008) and Ferrero (2009), for example, study optimal policies compared to simple policy rules in a monetary union in which all the policy agents care about union-wide variables. Grimm and Ried (2007) use a two-country model with a central bank maximizing union-wide welfare and two fiscal authorities minimizing comparable, but slightly different country-wide losses. Heterogeneity is introduced by the presence of inflation and output divergences due to specific productivity shocks and to the diverging conduct of national fiscal policies (concerned with national output and inflation targets). Comparing the welfare losses in static games for the three authorities, they conclude that cooperation between all the authorities is the best-performing scenario.

While *full* cooperation between national governments and the supranational central bank is the best solution, the literature is quite ambivalent about the situation of *partial* cooperation, in which there is no cooperation between monetary and fiscal policies only between national fiscal policies. Indeed, such a cooperative game between a subset of players is comparable to a coalition, which leads to welfare losses for all the players[6]. In this respect, the institutional organization of the euro area corresponds to the monetary leadership scenario rather than to overall cooperation.

The aim of this paper is to extend this literature by analyzing the effects of various policy-

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[6] See Rogoff (1985), Van Aarle *et al*. (2002), Villieu (2008), Dixit (2001), Dixit and Lambertini (2003), and Lambertini *et al*. (2007).

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mix scenarios in such an institutional context, in the presence of financial heterogeneity and financial shocks. In this respect, our work is close to Faia (2002) and Gilchrist *et al*. (2002). However, while they only focus on the appropriate monetary policy in a currency union, the original contribution of our paper is to further provide an evaluation of different policy-mix strategies in such a context.

To this end, we proceed with some policy experiments based on the DSGE model proposed by Badarau and Levieuge (2011) for a monetary union composed of two countries with distinct banking structures and national budgetary policies. As the leader of this game, the common central bank can choose to target the average inflation rate in the union or to target inflation divergences within the union. As discussed in De Grauwe and Piskorski (2001), Angelini et al. (2002), Gros and Hefeker (2002), De Grauwe and Sénégas (2006), Brissimis and Skotida (2008), and Badarau-Semenescu *et al*. (2009) this second scenario, which corresponds to a standard national information based monetary policy strategy, can be viewed as a solution to counteract the effects of structural heterogeneity.

As for budgetary policies, national governments are allowed to strongly cooperate or to conduct non-cooperative policies after committing to a simple coordination mechanism within the union, as stipulated by the Treaty of Lisbon. Whatever the underlying scenario, the Central Bank follows an optimized Taylor rule, while the national governments follow optimized balanced-budget rules allowing for temporary deficits. The novelty of our work with respect to this literature is to address the question of the optimal policy mix in a micro-founded financially heterogeneous monetary union by distinguishing 1) between full and partial cooperation among governments, and 2) between monetary strategies based on national or aggregate information. No previous reference combines these features simultaneously. However, they are important, on the one hand, to properly characterize the context of the euro area, and on the other hand, to draw plausible and robust normative conclusions for economic policy.

We first find that a Euro-wide monetary policy strategy based on national information does not offset the costs associated with the abandonment of national monetary policy. Next, we find that decentralized budgetary policies need to be more proactive in countries that are structurally more sensitive to shocks. However, when monetary policy is conducted independent of budgetary policies, cooperation between national governments is comparable to a coalition causing losses for every member. Such a cooperative strategy is welfare-improving at the union-wide level only in that it reduces public expenditure divergences.

The reminder of this paper is organized as follows. Section II resumes the baseline DGSE model with financial heterogeneity on which the policy experiments are based. Section III is devoted to the analysis of centralized vs. national information oriented monetary policy. Section IV comprises the analysis of cooperative *vs*. non-cooperative budgetary policies, while section V discusses policy mix. The last section formulates some concluding remarks.

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II. The Model

The model we are using in this work is provided by Badarau and Levieuge (2011). It describes a two-country monetary union with heterogeneous national banking structures. We simply improve this model by considering that governments are active and try to stabilize national variables. This allows us to introduce discussion on budgetary policy and to define different policy-mix scenarios.

As depicted in Appendix 1, six categories of national agents optimize their decisions in this model: households, entrepreneurs (wholesale producers), retailers, capital producers, banks, and the government. Households supply labor and own the retail firms. They receive wages from entrepreneurs and profits from retailers, and use them for consumption and savings. Because the model consists of a two-country monetary union, domestic households simultaneously consume domestic goods and goods produced in the other country of the union. They also pay lump-sum taxes to the government, which are necessary to finance public expenditures. Entrepreneurs use labor and capital as inputs (partially financed by debt) to produce wholesale final goods in perfectly competitive markets. Retailers buy wholesale goods from the producers. They slightly differentiate them (with no costs) and retail them in a monopolistic competition market. CES aggregates of retail products are bought by households and also by capital producers, who transform retail goods into capital (used by the entrepreneurs in the production process). Banks collect funds from national households to finance investment projects by lending to the national entrepreneurs. The national banking sectors have a particular place in the model as they are embedded in the structural heterogeneity. The strength of the bank capital channel is indeed supposed to be different in the two countries.

At the union level, a common Central Bank is responsible for the conduct of monetary policy. As in the euro area, the main task of the Central Bank is to maintain price stability, while the national governments should insure the stability of national aggregates.

A. The general equilibrium

Each country is inhabited by a continuum of infinitely-lived households represented by the unit interval. These agents choose consumption (C) and leisure (L) and determine their working time ($H = 1$-L) remunerated at real rate W. Their one period utility function is:

$$U(C_t, H_t) = \frac{\sigma_c}{\sigma_c - 1}(C_t)^{\frac{\sigma_c - 1}{\sigma_c}} - \frac{\sigma_h}{\sigma_h + 1}(H_t)^{\frac{\sigma_h + 1}{\sigma_h}} \tag{1}$$

with intertemporal elasticity of substitution in consumption σ_c, and elasticity of the disutility

associated with labor σ_h.

Consumption is a composite index which depends on the consumption of domestically produced goods and goods produced in the other country of the union. The origin of goods is indexed by 1 and 2, while C and C^* denote aggregate consumption in the first and the second country of the union, respectively. $\gamma \in [0,1]$ represents the relative preference for consumption of domestically produced goods in each country.

$$C = \frac{C_1^\gamma C_2^{1-\gamma}}{\gamma^\gamma (1-\gamma)^{1-\gamma}} ; \quad C^* = \frac{(C_1^*)^{1-\gamma}(C_2^*)^\gamma}{\gamma^\gamma (1-\gamma)^{1-\gamma}} \tag{2}$$

Price indexes for the two countries are respectively: $P = P_1^\gamma P_2^{1-\gamma}$ and $P^* = P_2^\gamma P_1^{1-\gamma}$, and the law of one price is supposed to hold.

Households choose a sequence of consumption, labor, bank securities (A_t) remunerated with a real interest rate r_t^A, and other possible financial investments (D_t) at the real risk-free interest rate r_t^f, which maximizes an intertemporal utility function, based on (1), subject to the following budget constraint:

$$P_t C_t + P_t D_t + A_t \leq P_t W_t H_t + A_{t-1} R_t^A + P_t D_{t-1} R_t^f - T_t + \Pi_t \tag{3}$$

Under constraint (3), $R_t^A = 1 + r_t^A$ and $R_t^f = 1 + r_t^f$ denote the gross real returns of the two alternative financial investments for households, T_t represents lump-sum taxes and Π_t is the dividends received from the ownership of retail firms. A symmetric constraint applies to the second country of the union. The first order conditions associated with C_t, D_t, A_t, and H_t for the two countries are shown in Table 1.

Table 1. First order conditions for households' optimization

Country 1	Country 2
$\lambda_t = P_t^{-1} C_t^{-\frac{1}{\sigma_c}}$	$\lambda_t^* = (P_t^*)^{-1}(C_t^*)^{-\frac{1}{\sigma_c}}$
$0 = \lambda_t - \beta R_{t+1}^f E_t[\lambda_{t+1}] E_t[P_{t+1}/P_t]$	$0 = \lambda_t^* - \beta R_{t+1}^{f*} E_t[\lambda_{t+1}^*] E_t[P_{t+1}^*/P_t^*]$
$0 = \lambda_t - \beta R_{t+1}^A E_t[\lambda_{t+1}]$	$0 = \lambda_t^* - \beta R_{t+1}^{A*} E_t[\lambda_{t+1}^*]$
$H_t = (\lambda_t P_t W_t)^{\sigma_h}$	$H_t^* = (\lambda_t^* P_t^* W_t^*)^{\sigma_h}$

(Note) λ_t and λ_t^* respectively denote the Lagrange multipliers associated to the budget constraint (3) in the two countries of the union.

At the optimum, the households do not prefer one financial investment over the other. The labor supply is given by the last condition in table 1, and the nominal interest rate is the same throughout the union (chosen by the common Central Bank):

$\left(R_{t+1}^{f}\right)E_{t}\left[P_{t+1}/P_{t}\right]=\left(R_{t+1}^{f*}\right)E_{t}\left[P_{t+1}^{*}/P_{t}^{*}\right]$. As in Gali and Monacelli (2009), this allows us to write:

$$C_t = C_t^* \left(\Theta_t\right)^{\sigma_c} \tag{4}$$

where $\Theta_t = P_t^*/P_t$ is an expression of the bilateral terms of trade.

Wholesale producers combine capital (K_t) and labor (L_t) with a Cobb-Douglas constant return to scale technology:

$$Y_t = a_t K_t^{\alpha} L_t^{1-\alpha} \quad \text{and} \quad Y_t^* = a_t^* \left(K_t^*\right)^{\alpha} \left(L_t^*\right)^{1-\alpha} \tag{5}$$

with a_t is an exogenous productivity factor that follows a standard autoregressive process in the model: $a_t = \rho_a a_{t-1} + \varepsilon_a$, where ε_a defines a productivity shock, with zero mean and unit variance. The labor input in (5) is a composite index of households labor (H_t) and entrepreneurial labor $\left(H_t^E\right)$: $L_t = H_t^{\Omega}\left(H_t^E\right)^{1-\Omega}$. The entrepreneurs supplement their income by supplying their own labor force, remunerated at rate W^E. Note that the total entrepreneurial labor is normalized to unity. In each country, investment (I_t) is supposed to concern domestically produced goods. The accumulation of physical capital is introduced by the following equation, with δ as the depreciation rate:

$$K_{t+1} = (1-\delta)K_t + I_t \tag{6}$$

The stock of capital is renewed each period. To produce wholesale final goods for period $t+1$, the entrepreneur buys, at the end of period t, capital K_{t+1} at price Q_t. Because an entrepreneur cannot entirely self-finance his project, he uses his own net wealth (NE_t), and borrows the remainder (B_t) from a representative bank. In turn, the representative bank uses its own accumulated capital (NB_t) and other complementary funds raised from households (A_t) to lend B_t to a representative firm.

It is also assumed that there are some internal capital-adjustment costs $\Phi(.)$ borne by the *capital producers*, who buy I_t units of final goods and transform them into physical capital which they afterwards sell to entrepreneurs.

$$\Phi\left(I_t, K_t\right) = \frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t, \text{ for } \phi > 0 \tag{7}$$

Denoting by $\rho_t = P_{1,t}^{\omega}/P_{1,t}$ the relative price of wholesale goods produced in country 1 and by Q_t the Lagrange multiplier associated with the process of capital accumulation, and given the term of trade $P_1/P_2 = P_t^*/P_t = \Theta_t$, the profit maximization program of domestic entrepreneurs gives the first order conditions (relative to H_t, H_t^E, I_t, and K_{t+1} respectively), reported in Table 2.

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Table 2. First order conditions for wholesale producers' optimization

Country 1

$$\rho_t(\Theta_t)^{1-\gamma}\Omega(1-\alpha)\frac{Y_t}{H_t}=W_t \;\; ; \;\; \rho_t(\Theta_t)^{1-\gamma}(1-\Omega)(1-\alpha)\frac{Y_t}{H_t^E}=W_t^E \;\; ; \;\; Q_t=1+\frac{\partial\Phi(\cdot)}{\partial I_t} \;\; ;$$

$$E_t[R_{t+1}^K]=\frac{1}{Q_t}E_t\left[\rho_{t+1}(\Theta_{t+1})^{1-\gamma}\alpha\frac{Y_{t+1}}{K_{t+1}}-\frac{\phi}{2}\left(\delta^2-\left(\frac{I_{t+1}}{K_{t+1}}\right)^2\right)+(1-\delta)Q_{t+1}\right]$$

(Note) For the second country of the union the first order conditions are symmetric, except for the exponent of Θ_t, which becomes $(\gamma\text{-}1)$ instead of $(1\text{-}\gamma)$.

As in Levieuge (2009), the profit maximization of capital producers is internalized in this program. The first two conditions define the demand for labor. The third one gives the Tobin's Q ratio. The last relation represents the expected gross return on holding a unit of capital from t to $t+1$: at the optimum, the entrepreneurs' demand for capital insures equality between the expected marginal return on capital and the expected marginal cost of external financing. This cost is derived from the external financial premium the firms have to bear as a consequence of an asymmetric information situation between them and their bank creditors. Moreover, not only do entrepreneurs have private information about the risk and return of their projects, but banks also have private information about the risk and realized return of their activities. It is then analogously assumed that debt contracts between banks and households (as ultimate creditors) occur in an asymmetric information context. Following the demonstration by Badarau and Levieuge (2011), the expressions for the external financial premium borne by banks on the one hand and by firms on the other hand, are given in Table 3.

Table 3. Financial market equilibrium in member countries

Country 1

$$S_t^B=\Psi_B\left[k_{t+1}^B\right], \text{ where } S_t^B=\frac{R_{t+1}^B}{R_{t+1}^f}, \frac{\partial\Psi_B(\cdot)}{\partial k_{t+1}^B}>0 \text{ and with } k_{t+1}^B=\frac{B_t}{NB_t}$$

$$S_t^E=\Psi_E\left[k_{t+1}^E\right], \text{ where } S_t^E=E_t\left[\frac{R_{t+1}^K}{R_{t+1}^f}\right], \frac{\partial\Psi_E(\cdot)}{\partial k_{t+1}^E}>0 \text{ and } k_{t+1}^E=\frac{Q_tK_{t+1}}{NE_t+NB_t}$$

$$NE_t=\gamma^E\left[VE_t+W_t^E\right], \text{ with } VE_t=Q_{t-1}R_t^KK_t-S_{t-1}^ER_t^fB_{t-1}$$

$$NB_t=\gamma^BVB_t+T_t^B, \text{ with } VB_t=R_t^KB_{t-1}-S_{t-1}^BR_t^fA_{t-1}.$$

(Note) All relations are identical for the second country of the union.

The external finance premium for banks S_t^B is, in logarithmic form, is the difference

between the non-default net return on the bank's loan portfolio required by the household $(r_{t+1}^B = R_{t+1}^B - 1)$ and the risk-free interest rate $(r_{t+1}^f = R_{t+1}^f - 1)$. As described in Table *3*, S_t^B only depends on the banks' financial leverage, defined by the ratio of loans (B_t) over accumulated capital (NB_t).

For entrepreneurs, the external finance premium S_t^E is, in logarithmic form, the difference between the net return on the entrepreneur's physical capital required by the bank $(r_{t+1}^K = R_{t+1}^K - 1)$ and the risk-free rate $(r_{t+1}^f = R_{t+1}^f - 1)$. As we can see in Table 3, it depends not only on the entrepreneur's accumulated net wealth (NE_t), but also on the accumulated capital of the bank (NB_t). Thus, the lending interest rate required by a poorly capitalized bank ought to be higher than that charged by a healthier one. This implies that entrepreneurs internalize the banks' external financing costs. In line with the bank capital channel mechanism, a deterioration of the banks' balance sheet implies a tightening of its lending conditions to entrepreneurs.

The entrepreneur's net worth (NE_t) comes from his accumulated benefits (VE_t) and, to a lesser extent, the wage he receives (W_t^E) in offering his labor force.[7] The coefficient γ^E in table 3 corresponds to the survival probability of the entrepreneur. The remaining net wealth of the constant proportion $(1 - \gamma^E)$ of entrepreneurs leaving the market each period is entirely used to consume final goods (CE_t): $CE_t = (1 - \gamma^E)[VE_t + WE_t] = \frac{1 - \gamma^E}{\gamma^E} NE_t$. Finally, the value of the firm $(VE_t = Q_{t-1} R_t^K K_t - S_{t-1}^E R_t^f B_{t-1})$ is given by the gross return on capital, after the repayment of debt and of associated interest.

In a similar way, the internal bank capital (NB_t) comes mainly from the accumulated benefits of intermediation activity $(VB_t = R_t^K B_{t-1} - S_{t-1}^B R_t^f A_{t-1})$. Furthermore, it is assumed that a proportion $(1 - \gamma^B)$ of banks leave the market each period, and then transfer a small part (t^B) of their internal capital to new banks[8] (for an aggregated amount T_t^B). Their remaining capital is devoted to final goods consumption: $CB_t = (1 - \gamma^B)(1 - t^B) VB_t = \frac{(1 - \gamma^B)(1 - t^B)}{\gamma^B(1 - t^B) + t^B} NB_t$

Retailers are represented by firms, held by households, that purchase wholesale goods and differentiated final goods. Following Calvo (1983), it is assumed that a retailer changes his price each period with probability $1 - \varsigma$. Subsequently, retailer pricing behavior leads to the following 'new Phillips curves' in the two countries of the union:

$$\hat{\pi}_{1,t} = \beta E_t\left[\hat{\pi}_{1,t+1}\right] + \kappa \hat{\rho}_t \text{ and } \hat{\pi}_{2,t} = \beta E_t\left[\hat{\pi}_{2,t+1}\right] + \kappa \hat{\rho}_t^* \tag{8}$$

where $\pi_{1,t} = \log(P_{1,t}/P_{1,t-1})$ and $\pi_{2,t} = \log(P_{2,t}/P_{2,t-1})$ give the inflation rates calculated for the domestically priced goods of the two countries, $\kappa = \frac{(1 - \varsigma)(1 - \varsigma\beta)}{\varsigma}$ and ρ_t, ρ_t^* are, respectively, the real marginal cost for a representative retailer in each country. $\hat{x}_t$ defines, for all x_t, the

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[7] This assumption allows the entrepreneurs to borrow immediately; otherwise, they would face an unrealistically high external finance premium.

[8] In line with other financial accelerator models, this assumption makes it possible for new banks to benefit from internal capital, which is essential for access to external financing. Without initial wealth, newcomers would suffer a prohibitive external financial premium.

deviation of variable x_t from its steady-state value.

The national *goods and labor markets equilibrium* conditions imply:[9]

$$Y_t = \Theta_t^{(1-\gamma)/(2\gamma-1)} C_t \left[\gamma + (1-\gamma)\Theta_t^{1-\sigma_c} \right] + CE_t + CB_t + I_t + G_t \tag{9}$$

$$Y_t^* = (\Theta_t)^{\gamma/(1-2\gamma)+\sigma_c} C_t^* \left[(1-\gamma) + \Theta_t^{1-\sigma_c} \gamma \right] + CE_t^* + CB_t^* + I_t^* + G_t^* \tag{9'}$$

and respectively:

$$\left(H_t \right)^{\frac{\sigma_h+1}{\sigma_h}} = (C_t)^{-\frac{1}{\sigma_c}} \rho_t (\Theta_t)^{1-\gamma} \Omega(1-\alpha) Y_t \tag{10}$$

$$\left(H_t^* \right)^{\frac{\sigma_h+1}{\sigma_h}} = \left(C_t^* \right)^{-\frac{1}{\sigma_c}} \rho_t^* (\Theta_t)^{\gamma-1} \Omega(1-\alpha) Y_t^* \tag{10'}$$

Finally, in addition to technological shocks, already considered in equations (5), *financial shocks* are also introduced in the model. In previous equations, Q_t represents the fundamental value of physical capital, given by the present value of dividends to be obtained by the wholesale firms' shareholders. We now allow for the possibility that the market value of capital, denoted hereafter by Q_t^m, differs temporarily from its fundamental value Q_t, because of a temporary financial shock (ε_{qt}):

$$Q_t^m = Q_t + \varepsilon_{qt} \tag{11}$$

with ε_{qt} being a random variable of zero average and 0.2 standard deviation. If a shock arises in t, it affects market value Q_t^m of the capital only during this period; afterwards, equality between Q_t^m and Q_t still holds[10].

Hence, in the case of a financial shock, the fundamental return on the physical capital given in table 2 becomes an *abnormal return* on capital given by:

$$R_t^{Km} = \left[\rho_t (\Theta_t)^{1-\gamma} \alpha \frac{Y_t}{K_t} - \frac{\phi}{2} \left(\delta^2 - \left(\frac{I_t}{K_t} \right)^2 \right) + (1-\delta) Q_t^m \right] / Q_{t-1} \tag{12}$$

Therefore, Q_t^m replaces Q_t in the equations in Table 3, defining the dynamics of entrepreneurs' net worth, banks' net worth, and the subsequent external finance premiums, respectively. So, when $Q_t^m > Q_t$, the entrepreneurs' and banks' net values increase without any fundamental justification. The seeming improvement of their balance sheets allows them to obtain better conditions for external financing, stimulating national investment and output (and inversely in case of adverse financial shock).

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[9] Total consumption in the economy includes households' consumption and the consumption of the entrepreneurs and banks that have failed in the previous period (CE and CB respectively).

[10] Then, financial shock corresponds to a one-period shock, whereas Bernanke and Gertler (1999) and Levieuge (2009) simulate an exogenous multi-period bubble. The aim here is not to reproduce the effects of a long-lasting financial bubble, but simply to adequately insert financial shocks into the model.

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The model is closed by monetary and budgetary rules that are discussed in detail in the following sections.

B. Model parameterization

Calibration for the parameters and main macroeconomic ratios at their steady-state is detailed in Appendix 2, and is made according to references found in the literature for the euro area. Ratios such as capital/GDP, investment/GDP, and total consumption/GDP are all compatible with the estimations revealed by Fagan *et al*. (2001). Moreover, it is realistically supposed that banks have a lower default probability than entrepreneurs, and that the ratio *B/NB* belongs to the interval $[5,10]$.[11] Finally, we realistically obtain that, in the steady state, the probability of a bank leaving the credit market is lower than that of entrepreneurs. Additionally, an audit is more costly for households than for banks, which justifies the presence of the latter in the economy. The banking system is embedded in the structural financial heterogeneity, as it is assumed that the two countries differ in two aspects: *(i) in the ratio of loans to internal capital for banks at the steady-state, and (ii) in the sensitivity coefficient of the banks' external finance premium to their financial leverage*. Considering both criteria, country 1 becomes more sensitive to shocks than country 2.

Badarau and Levieuge (2011) analyze in detail how such financial heterogeneity accentuates cyclical divergences. This raises the question of how a monetary, budgetary, and policy mix can mitigate the asymmetric effects of common shocks. To this end, alternative strategies for the Central Bank and for the governments will be analyzed, through the optimization of their respective policy rules, in the following sections.

III. Centralized vs. National information in Monetary Policy

We consider an independent common Central Bank, like the European Central Bank, whose policy is responsible for union-wide price stability and which does not cooperate with the national governments (in accordance with Article 130 of the Treaty on the European Union). This common Central Bank is supposed to conduct its monetary policy following an interest rate rule given by:

$$\hat{r}_t^n = \beta_0 \hat{r}_{t-1}^n + (1 - \beta_0)\beta_1 \hat{\pi}_t^{MU} + \varepsilon_{r_t} \tag{13}$$

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[11] Numerical values are in line with those used by Sunirand (2003) and Levieuge (2009) for the euro area.

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where $\hat{\pi}_t^{MU} = \frac{1}{2}(\hat{\pi}_t + \hat{\pi}_t^*)$ is the union-wide inflation deviation from the target, and β_1 is the corresponding reaction coefficient. β_0 is the smoothing coefficient of the nominal interest rate. ε_{r_t} represents a monetary policy shock of zero average and a standard deviation equal to 1.

As a common monetary policy induces a stabilization bias in a heterogeneous monetary union, worsening cyclical divergences (see Badarau and Levieuge, 2011), two configurations are alternatively considered for the optimization of β_1 and β_0. First, in the *centralized strategy*, the Central Bank solely stabilizes the average inflation of the union, and is not concerned with national divergences. The loss function to be minimized is:[12]

$$L^{CB} = \mathrm{var}(\hat{\pi}^{MU}) + \lambda_r \, \mathrm{var}(\Delta\hat{r}^n) \tag{14}$$

where $\mathrm{var}(\hat{x})$ defines the second order moment of the variable $\hat{x}$, and $\Delta\hat{r}_t^n = \hat{r}_t^n - \hat{r}_{t-1}^n$. λ_r is the relative importance given by the monetary authority to interest rate smoothing.

Second, a *monetary strategy based on national information* responds to the situation in which the Central Bank is simultaneously concerned with union-wide inflation stabilization and with the stabilization of inflation differentials inside the union (see Badarau-Semenescu *et al.*, 2009). It thus becomes an *inflation-divergences oriented monetary strategy*. The loss function of the Central Bank becomes:

$$L^{CB} = \mathrm{var}(\hat{\pi}^{MU}) + \mathrm{var}(\hat{\bar{\pi}}^{MU}) + \lambda_r \, \mathrm{var}(\Delta\hat{r}^n), \text{ for } \hat{\bar{\pi}}^{MU} = \frac{\hat{\pi}_t - \hat{\pi}_t^*}{2} \tag{15}$$

Monetary decisions are supposed to be independent of the governments' behavior. Optimization is made in the presence of stochastic and symmetric technological and financial shocks, whose variances are given in section II.

The results reveal that the coefficient β_1 is optimally higher in the centralized strategy ($\beta_1 = 1.45704$) compared to the national information based strategy[13] ($\beta_1 = 1.43749$). As expected, centralized monetary policy is more reactive to symmetric shocks than a policy taking the specific situation of each member country into account.[14] Therefore, faced with symmetric shocks, a centralized monetary strategy dominates the strategy based on national information, being able to insure better macroeconomic stability in the union. This is clearly supported by the computation and comparison of expected social losses (see Table 7) in section V below.

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[12] The central bank loss function could be derived from the intertemporal utility function of the representative agent, as in Woodford (2003). Nevertheless, this is in fact not a result, but a hypothesis. The representative agent cannot be the central bankers once the central bank is independent. Moreover, a vast and persuasive literature indicates that the central bankers' preferences depend on institutional and political matters, and not only on structural ones. See for instance the survey by Hayo and Hefeker (2008). It is not less rigorous to directly infer from the actual conduct of the ECB its preferences. From this viewpoint, it can reasonably be asserted (*de facto* and *de jure*) that inflation stability is its single objective.

[13] In line with Sauer and Sturm (2007), Fourçans and Vranceanu (2007), and Licheron (2009), β_0 is equal to 0.96.

[14] For asymmetric shocks, the situation reverses. As found in Badarau-Semenescu *et al*. (2009) for instance, shocks are better stabilized under a monetary policy that attempts to reduce inflation divergences than under a centralized monetary policy.

IV. Cooperative vs. Non-cooperative Budgetary Policy

Decentralized budgetary policies are conducted by the national governments. They use lump-sum taxes to finance public expenditures and they respect a balanced-budget condition allowing for temporary deficits or surpluses, in the spirit of Annicchiarico *et al.* (2006).[15] Governments are concerned with national output and inflation stabilization, whereas they are not directly concerned with output growth and price changes in other parts of the union unless they decide to cooperate. In order to balance the diverging effects of the common monetary policy, the output target for budgetary policy corresponds, as usual, to national potential output, while the inflation target is the one announced by the common central bank, corresponding to its steady state value. To insure the stability of national aggregates, governments use conventional balanced-budget rules extended to incorporate cyclical components (see, for instance, Muscatelli *et al.*, 2004, Annicchiarico *et al.*, 2006, and Grimm and Ried, 2007).

$$\hat{g}_t = \rho_g \, \hat{g}_{t-1} + \rho_\pi \, \hat{\pi}_t + \rho_y \, \hat{y}_t + \varepsilon_{g_t} \tag{16}$$

$$\hat{g}_t^* = \rho_g^* \, \hat{g}_{t-1}^* + \rho_\pi^* \, \hat{\pi}_t^* + \rho_y^* \, \hat{y}_t^* + \varepsilon_{g_t}^* \tag{16'}$$

where $\hat{g}_t, \hat{g}_t^*$ denote the deviation of the fiscal balance from its steady state in each country, a positive value corresponding to a fiscal deficit, and ρ_g, ρ_g^* are coefficients for budgetary policy inertia. ρ_π, ρ_π^* represent the reaction coefficients of budgetary policy to national inflation deviation from the steady-state. ρ_y, ρ_y^* stand for the reaction to the output-gap ($\hat{y}_t$ is the log-deviation of the output from the steady-state). $\varepsilon_{g_t}, \varepsilon_{g_t}^*$ are random shocks with zero mean and a unit standard deviation.

While Ballabriga and Martinez-Mongay (2002), for instance, consider inertia as a constraint stemming mainly from the political difficulty of changing past spending commitments, we follow Vogel *et al.* (2006) and consider here ρ_g, ρ_g^* as control variables, in the sense that annual budget laws define policy guidelines that are gradually implemented. Thus, the coefficients ρ_g, ρ_y and ρ_π have to be optimally found so as to minimize national loss functions.

Two configurations are considered. In the *non-cooperative budgetary policy regime*, which refers to the autonomous conduct of national policies, each government optimizes a national loss function (17), considering as exogenous the public expenditures of the other country:[16]

$$L^G = \lambda_\pi^G \operatorname{var}(\hat{\pi}) + \lambda_y^G \operatorname{var}(\hat{y}) + \lambda_g^G \operatorname{var}(\hat{g}) \tag{17}$$

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[15] In fact, taxes are maintained at the steady state level in our model (which corresponds to a balanced budget in normal periods). The cyclical changes in governments' spending explain why temporary deficits or surpluses are possible.

[16] Such a form of the governments' loss functions is also considered in Villieu (2008) and Von Hagen and Mundschenk (2003), for instance. See Van Aarle *et al.* (2002, 2004), Leitemo (2004), Vogel *et al.* (2006), or Andersen (2005) to explain the presence of a public deficit stabilization objective in the governments' loss functions.

λ_π^G, λ_y^G, and λ_g^G define the national preferences for inflation, output, and public expenditure stabilization, respectively.

In the *cooperative budgetary policy regime*, both governments are endowed with a unique cooperative loss function, calculated as the average of the national loss functions:

$$L^{Coop} = \frac{1}{2}\left(L^G + L^{G*}\right) \tag{18}$$

Note that, according to the new Treaty of Lisbon, national governments benefit from autonomy in the conduct of their budgetary policies. However, they are supposed to respect a global orientation for their budgetary policy defined at the union-wide level. Such a global orientation, which remains unclear in the treaty, is interpreted hereafter as a commitment on the part of national governments to follow symmetric stabilization objectives in their budgetary policy. This implies in our model that λ_π^G, λ_y^G, and λ_g^G in (17) are identical for the two countries. This institutional framework can be seen as a *particular coordination mechanism* that covers not only the cooperative, but also the non-cooperative budgetary regime.

Finally, the following sequential game applies to the design of the monetary and budgetary policies design. The Central Bank first chooses its strategy by taking as given the governments' policies.[17] The national governments observe the monetary policy orientation and define their policies afterwards[18]

Under the *centralized optimal monetary policy*, the optimization of the budgetary rules is summarized in Table 4 for the non-cooperative budgetary regime and in table 5 for the cooperative budgetary regime.[19] The robustness of the results is controlled by considering in each case three sets of governmental loss functions parameters ($\lambda_\pi^G, \lambda_y^G, \lambda_g^G$).

Table 4. Non-cooperative budgetary rules coefficients with centralized monetary policy

Governmental loss functions coefficients	Country 1	Country 2
$\lambda_\pi^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$\rho_g = 0.2189$ $\rho_y = -0.2022$ $\rho_\pi = -1.0861$	$\rho_g^* = 0.1477$ $\rho_y^* = -0.1727$ $\rho_\pi^* = -0.7125$
$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$\rho_g = 0.2368$ $\rho_y = -0.1355$ $\rho_\pi = -0.7648$	$\rho_g^* = 0.1720$ $\rho_y^* = -0.1155$ $\rho_\pi^* = -0.5162$
$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$\rho_g = 0.2175$ $\rho_y = -0.6526$ $\rho_\pi = -3.6283$	$\rho_g^* = 0.1623$ $\rho_y^* = -0.5476$ $\rho_\pi^* = -2.3157$

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[17] See also Benassy (2003).

[18] This sequential solving is usual and logical in the euro area context. See Andersen (2005) for instance.

[19] Results with an inflation-divergences oriented monetary policy are qualitatively similar. The tables of results corresponding to this scenario are available on request.

For the non-cooperative regime (Table 4), the corresponding Cournot-Nash solutions clearly indicate that, whatever the governmental loss functions parameters are, the coefficients for inflation and output stabilization are, as expected, negative under the optimal budgetary rules.[20] Moreover, in absolute value, these coefficients are systematically lower in country 2 than in country 1. As country 1 is more sensitive to shocks, it requires more stabilization by budgetary policy. This means that, with a simple non-cooperative budgetary regime, national governments could play an active role in mitigating asymmetries in the transmission of shocks due to structural heterogeneity.

In contrast with these results, optimal cooperative budgetary rules are not consistent with the stabilization needs of member countries, as can be seen in Table 5. For example, the coefficient associated with the inflation gap in the budgetary rule of country 2 is positive, corresponding to a definitely destabilizing policy.

Table 5. Cooperative budgetary rule coefficients with centralized monetary policy

Governmental loss functions coefficients	Country 1	Country 2
$\lambda_\pi^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$\rho_g = 0.1779$ $\rho_y = -0.1901$ $\rho_\pi = -0.5985$	$\rho_g^* = 0.6051$ $\rho_y^* = -0.0632$ $\rho_\pi^* = 0.2576$
$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$\rho_g = 0.2079$ $\rho_y = -0.1237$ $\rho_\pi = -0.4442$	$\rho_g^* = 0.5625$ $\rho_y^* = -0.0459$ $\rho_\pi^* = 0.2049$
$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$\rho_g = 0.1929$ $\rho_y = -0.5955$ $\rho_\pi = -0.6366$	$\rho_g^* = 0.9225$ $\rho_y^* = -0.0445$ $\rho_\pi^* = 0.048$

At first glance this result seems counter-intuitive. However, in line with De Grauwe et Senegas (2004) and Badarau-Semenescu et al. (2009), the cooperative loss function L^{Coop} can be alternatively written:

$$L^{Coop} = \lambda_\pi^G \, \mathrm{var}\left(\hat{\pi}^{UM}\right) + \lambda_y^G \, \mathrm{var}\left(\hat{y}^{UM}\right) + \lambda_g^G \, \mathrm{var}\left(\hat{g}^{UM}\right) + \lambda_\pi^G \, \mathrm{var}\left(\hat{\bar{\pi}}^{UM}\right) + \lambda_y^G \, \mathrm{var}\left(\hat{\bar{y}}^{UM}\right) + \lambda_g^G \, \mathrm{var}\left(\hat{\bar{g}}^{UM}\right) \quad (19)$$

In other words, the cooperative loss function implicitly leads the governments to comply with centralized objectives of stabilization, but also to combat national divergences. One way to fulfill the objective of cyclical convergence consists of each country making an effort to reach the average performance of the union. This explains the positive sign of the national

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[20] Indeed, when the output gap is positive and/or inflation is higher than its steady-state value, governments should be more restrictive, namely they should reduce public expenditures, in order to stabilize national variables. The opposite policy is expected when the output gap is negative or inflation is too low.

inflation stabilization in the budgetary rule of country 2 (which is supposed to be less affected by shocks). Most important, the need for responding to divergences in inflation, output, and public expenditures finally makes the individual stabilizations less satisfying than in the non-cooperative regime. Figure 1 illustrates this point, in the case of a restrictive and symmetric monetary shock.

Figure 1. National responses to a restrictive monetary shock

Cooperative budgetary regime

Non-cooperative budgetary regime
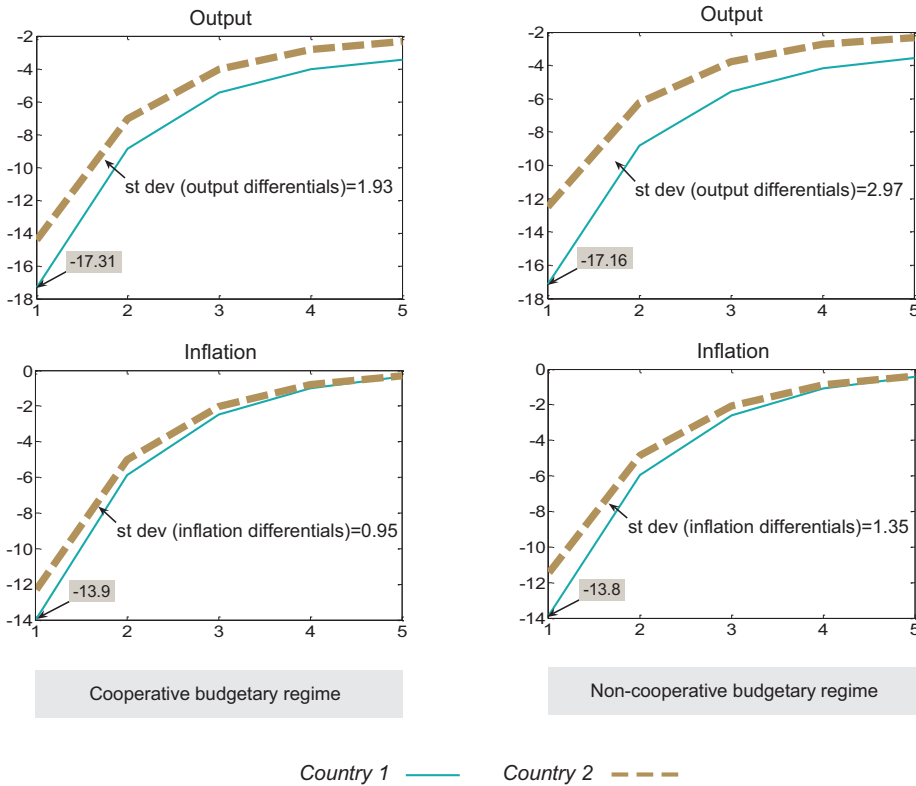
Country 1 ——— *Country 2* – – –

(Note) $\lambda_\pi = 1; \lambda_y = 1.5; \lambda_g = 0.5$

As the government in country 2 responds to macroeconomic divergences in the union, its policy is, as a whole not, expansionist enough to duly stabilize its national output (divergences are otherwise exacerbated). More precisely, the reaction to inflation divergences implies a reduction of public expenditures in country 2, whereas public expenditures increase in country 1 (cf. ρ_π and ρ_π^* coefficients in Table 5). In the same way, the reduction of output divergences implies a lower increase of public spending in country 2 compared to country 1 (see ρ_y and ρ_y^* coefficients in Table 5). Certainly, given the accommodative budgetary policy of country 1, this reduction of government spending divergences would require an increase in public expenditure in country 2. However, this objective is offset by the need to reduce inflation and output divergences.

Consequently, the global effect of these mixed assignments leads to (excessively) moderate public expenditures in country 2. Country 1, in turn, cannot implement a stimulus scheme as ambitious as it would in the non-cooperative regime. It would otherwise be penalized by a growing public expenditures gap. This situation is unsatisfactory for all the members of the monetary union. Further demonstration is provided in Table 6, where the stabilization performances of a cooperative vs. non-cooperative regime are compared, following negative monetary and financial shocks. It is clear that compared to the non-cooperative regime, the cooperative regime allows for better stabilization of the divergences between member countries, but inferior stabilization of national variables (the decline in output is particularly higher).

This situation of counterproductive cooperation echoes some results found in the literature[21] and is reaffirmed here in the specific context of a heterogeneous monetary union with a fully independent central bank and a coordination framework. This situation typically matches the euro area. In a situation in which the central bank conducts monetary policy regardless of national budgetary policies, cooperation between a subset of players (i.e. the governments) is comparable to a coalition in the global economy, which leads to welfare losses for all the players.

Table 6. Stabilization performance of a cooperative/non-cooperative regime with shocks

Financial shock		**Monetary shock**	
Country 1:		*Country 1:*	
y_1: 1.02	π_1: 1.02	y_1: 1.003	π_1: 1.002
Country 2:		*Country 2:*	
y_2: 1.06	π_2: 1.05	y_2: 1.15	π_2: 1.07
Inflation and output differentials:		*Inflation and output differentials:*	
$\bar{y}^{UM}$: 0.98	$\bar{\pi}^{UM}$: 0.98	$\bar{y}^{UM}$: 0.65	$\bar{\pi}^{UM}$: 0.70

(Note) The numerical values give the ratios between the standard deviation of the variable x in the cooperative compared to the non-cooperative regime during the first 5 periods following the shock: $\sigma_x^{Coop} / \sigma_x^{NCoop}$, for $x \in \left\{ y_1, y_2, \pi_1, \pi_2, \bar{y}^{UM}, \bar{\pi}^{UM} \right\}$.

V. Policy-mix Analysis

In this section, we analyze the qualitative properties of four alternative policy mixes (centralized/inflation-divergences oriented monetary policy with cooperative/non-cooperative

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[21] See Rogoff (1985), Dixit (2001), Dixit and Lambertini (2003), Van Aarle *et al.* (2002), and Lambertini *et al.* (2007).

budgetary policies), evaluated with respect to a usual union-wide social loss function, computed as the average of national social loss functions:

$$EL_S = \frac{1}{2}\left[\lambda_y^S \operatorname{var}(\hat{y}) + \lambda_\pi^S \operatorname{var}(\hat{\pi}) + \lambda_g^S \operatorname{var}(\hat{g}) + \lambda_y^S \operatorname{var}(\hat{y}^*) + \lambda_p^S \operatorname{var}(\hat{\pi}^*) + \lambda_g^S \operatorname{var}(\hat{g}^*)\right] \quad (20)$$

$\lambda_y^S, \lambda_\pi^S, \lambda_g^S$ are symmetric preferences for the stabilization of output, inflation, and public expenditures in the national social loss functions.

Two cases are considered. First, it is assumed that governments, which represent the majority views of their respective societies, share the same preferences as the agents for inflation and output stabilization: $\lambda_x^S = \lambda_x^G$, *for* $x \in \{y, \pi\}$. Second, we make the assumption that the two societies are essentially concerned about inflation and output stabilization and less concerned about public expenditure stabilization (see, in extremis, $\lambda_g^S = 0$). This latter assumption requires a proof and as we shall see, comparing the two cases will allow for a better understanding of the results.

Evaluations of these different policy mixes are reported in Table 7. The first column reports the coefficients of the social loss function.[22] The second column compares the corresponding expected losses derived from alternative budgetary regimes. These results are independent of monetary policy design. The third column compares the expected losses issued from alternative monetary strategies for the central bank, independently of budgetary regime. The last column clearly shows that, whatever the social and governments' stabilization preferences, the expected loss induced by a centralized monetary policy is systematically lower than the loss resulting from a monetary policy based on national targets and then designated to fight inflation divergences in the union.

Table 7. Expected social loss comparison for alternative policy mixes

Loss functions coefficients		$EL_S^{NCoop} / EL_S^{Coop}$ (whatever the monetary regime)	EL_S^C / EL_S^{C+Div} (whatever the budgetary regime)
$\lambda_\pi^S = \lambda_\pi^G$ $\lambda_y^S = \lambda_y^G$ $\lambda_g^S = \lambda_g^G$	$\lambda_\pi^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$EL_S^{NCoop} = 1.054 EL_S^{Coop}$	$EL_S^C = 0.972 EL_S^{C+Div}$
	$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$EL_S^{NCoop} = 1.039 EL_S^{Coop}$	$EL_S^C = 0.972 EL_S^{C+Div}$
	$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$EL_S^{NCoop} = 1.12 EL_S^{Coop}$	$EL_S^C = 0.973 EL_S^{C+Div}$
$\lambda_\pi^S = \lambda_\pi^G$ $\lambda_y^S = \lambda_y^G$ $\lambda_g^S = 0$	$\lambda_\pi^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$EL_S^{NCoop} = 0.979 EL_S^{Coop}$	$EL_S^C = 0.973 EL_S^{C+Div}$
	$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$EL_S^{NCoop} = 0.986 EL_S^{Coop}$	$EL_S^C = 0.973 EL_S^{C+Div}$
	$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$EL_S^{NCoop} = 0.902 EL_S^{Coop}$	$EL_S^C = 0.974 EL_S^{C+Div}$

(Note) EL_S^C = expected social loss with a centralized monetary policy; EL_S^{C+Div} = expected social loss with monetary policy based on national information; EL_S^{NCoop} = expected social loss in a non-cooperative budgetary regime; EL_S^{Coop} = expected social loss in a cooperative budgetary regime.

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[22] The results are robust and qualitatively similar for any set of preference parameters.

The results are more balanced concerning budgetary regimes. Under the assumption of identical social and governmental stabilizing preferences within the union, the results favor the cooperative regime over the non-cooperative one. However, the computation of alternative social loss functions solely defined in terms of inflation and output stabilization ($\lambda_g^S = 0$) reasserts the superiority of the non-cooperative regime, as obtained in the previous section. Thus, comparing the cases in which $\lambda_g^S \neq 0$ and $\lambda_g^S = 0$, it appears that the relative benefit of the cooperative regime only comes from the stabilization of public expenditure divergences inside the union.

VI. Concluding Remarks

This paper addresses the issue of policy mix in a heterogeneous monetary union hit by financial shocks. The analysis relies on a two-country DSGE model with financial heterogeneity, in which one country is more sensitive to adverse financial shocks than the other. This model shows how financial heterogeneity can accentuate the cyclical divergences inside a monetary union, and indicates that the conduct of a common monetary policy worsens national divergences. This motivates the investigation of several budgetary and monetary policy scenarios. Several conclusions can be drawn from simulations based on optimized policy rules.

First, it appears that a centralized monetary policy, seeking to stabilize the union-wide inflation rate, dominates a strategy that is concerned with the stabilization of inflation divergences inside the union. This conclusion holds whatever the budgetary regime (cooperative or non-cooperative) is, thus supporting, for instance, the current orientation of European Central Bank (ECB) policy.

Second, decentralized budgetary policies need to be more proactive in countries that are structurally more sensitive to shocks, especially those in which the bank capital channel is stronger. In this case, budgetary policies can contribute to mitigating the effects of adverse shocks. A solution could come from a non-cooperative budgetary regime in the union, endowed with an implicit coordination mechanism that implies similar objective functions in the member countries. This is an interpretation of the global common orientation promoted by the new Treaty of Lisbon.

Third, a cooperative budgetary regime can be counterproductive when monetary policy is conducted regardless of the governments' behavior. Indeed, cooperation between a subset of players is comparable to a coalition, which leads to welfare losses for all the players. So cooperation between solely the governments of a monetary union is not a panacea in the case of structural heterogeneity.

Finally, at the union level, a cooperative regime seems to be preferable only because it allows for better stabilization of public deficit divergences. This result has at least two

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consequences. First, if the agents in a monetary union care about inflation and output divergences, but are not concerned with public spending divergences, then a non-cooperative regime is preferable. Second, in the case of cooperation, a virtuous country is sufficient to impose budgetary discipline on the union.

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Appendices

Appendix 1: The main structure of the model for each member country

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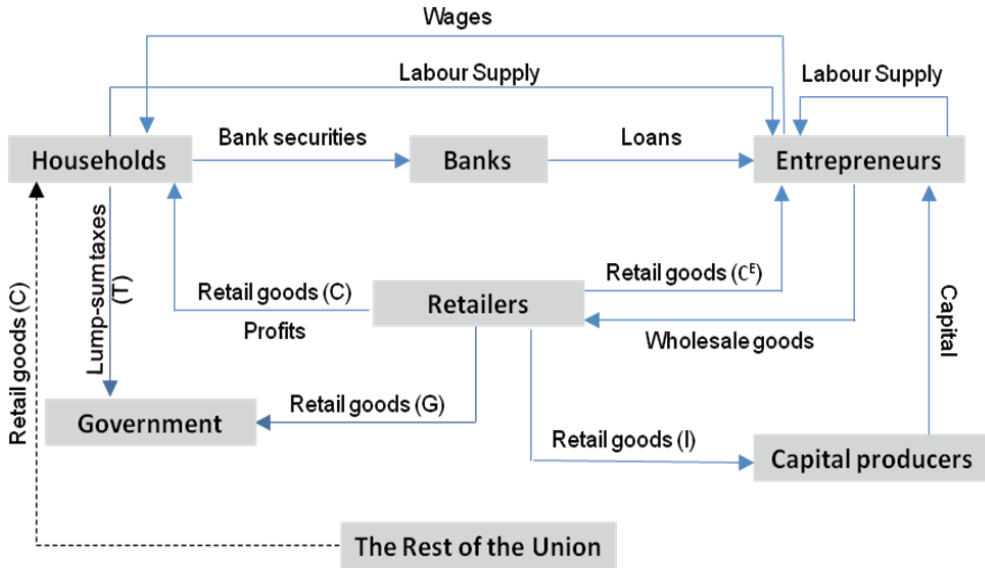
Appendix 2: Baseline calibration of the DSGE model

Description	Parameter	Value country 1	Value country 2
Intertemporal elasticity of substitution	σ_c	0.75	0.75
Elasticity of labor disutility	σ_h	0.32	0.32
Subjective discount factor	β	0.99	0.99
Portion of retailers with unchanged prices on the period	ς	0.75	0.75
Capital contribution to GDP	α	0.35	0.35
Portion of entrepreneurial labor in total labor	$1-\Omega$	0.01	0.01
Portion of households labor in total labor	Ω	0.99	0.99
Depreciation rate for capital	δ	0.03	0.03
Internal capital adjustment costs parameter	ϕ	10	10
Portion of inside capital transfers to surviving banks	t^B	0.001	0.001
Banks external finance premium elasticity	ψ_B^s	**0.002**	**0.001**
Entrepreneur external finance premium elasticity	ψ_E^s	0.025	0.025
Portion of foreign goods in national consumption	$1-\gamma$	0.2	0.2
Smoothing coefficient in the monetary rule	β_0	0.9	
Inflation stabilizing coefficient in the monetary rule	β_1	1.1	
Steady State: Exogenous fixed values			
Real marginal cost	$\widehat{c}$	1/1.1	1/1.1
Bank loans/internal capital ratio	B/NB	**6.67**	**5**
Entrepreneur net wealth/capital ratio	NE/K	0.4	0.4
Public expenditures/GDP ratio	G/Y	0.16	0.16
Entrepreneur probability of default	$F(\overline{\omega}^E)$	0.03	0.03
Bank probability of default	$F(\overline{\omega}^B)$	0.007	0.007
Average external finance premium for entrepreneurs (annual basis)	r^K-r^f	0.02	0.02
Auditing cost for banks	μ^B	0.018	0.077
Auditing cost for households	μ^A	0.807	0.545
Variance for ω distribution	σ	0.2531	0.2531
ω threshold value for banks	$\overline{\omega}^B$	0.52	0.52
ω threshold value for entrepreneurs	$\overline{\omega}^E$	0.6016	0.6016
Bank probability to leave the market	$1-\gamma^B$	0.01	0.01
Entrepreneur probability to leave the market	$1-\gamma^E$	0.017	0.017
Capital/GDP ratio	K/Y	7.0549	7.0549
Investment/GDP ratio	I/Y	0.2116	0.2116
Bank consumption expenses/GDP	CB/Y	0.006	0.008
Entrepreneur consumption expenses/GDP	CE/Y	0.048	0.048
Household consumption expenses/GDP	C/Y	0.5735	0.5501
Total consumption expenses/GDP	$(C+CE+CB/Y)$	0.628	0.628