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► **To cite this version:**

Florina-Cristina Badarau, Grégory Levieuge. Which policy-mix to mitigate the effects of financial heterogeneity in a monetary union?. 2011. hal-00641995

HAL Id: hal-00641995

<https://hal.science/hal-00641995>

Preprint submitted on 17 Nov 2011

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Which policy-mix to mitigate the effects of financial heterogeneity in a monetary union?

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LAREFI Working Paper CR11-EFI/09

2011

<http://lare-efi.u-bordeaux4.fr>

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Abstract:

This paper aims to study a suitable policy-mix for a monetary union like the euro area, in a context of financial heterogeneity. It relies on a DSGE model with empirically-justified heterogeneous bank capital channel, with financial shocks, in addition to monetary, budgetary and technological ones. The analysis leads to the following conclusions. A centralized monetary policy appears to be more advantageous for the union than an alternative inflation-divergences oriented policy. Besides, national budgetary policies can mitigate cyclical divergences. Nevertheless, the exam of various policy-mixes indicates that the superiority of a cooperative budgetary regime only relies on the fact that it allows a better stabilization of public spending divergences in the Union. On the other hand, national variables are less stabilized under this regime. These results are finally discussed in light of the subprime mortgage crisis context.

Key words: euro area, financial heterogeneity, monetary/budgetary policy rules, DSGE model.

JEL classification: E44, E58, E63, C61

1 Introduction

The European Monetary Union members have not been identically affected by the subprime mortgage crisis, whose origin was however a common financial shock. In this respect, this crisis reasserts the structural heterogeneity of the EMU¹. More precisely, recent studies² indicate that the European financial system in particular remains far from being integrated. The banking markets precisely appear as the most heterogeneous financing market; price differentials remain high compared to other monetary unions, and home biases in lending to and borrowing of small non-financial corporations and households are persistent.³ Credit conditions thus depend on national firms' and banks' financial structures.⁴

Next, the subprime mortgage crisis also demonstrated that banks constitute key actors for the transmission of financial shocks. In that sense, several recent contributions⁵ have highlighted the importance of the *bank capital channel*, according to which, through the 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 firms. Because of an agency problem between banks and their creditors, the formers bear an external financial premium which is negatively related to their capital ratio (and so is counter-cyclical). This external financing premium is ultimately passed on to the credit conditions to firms.

Considering simultaneously the main factors underlying the bank capital channel, a preliminary empirical study by *Badarau-Semenescu & Levieuge (2010)* indicates that European countries are ought to be more (Germany, Italy, Netherland) or less (Finland, France, Spain) sensitive to this mechanism. So this channel constitutes an interesting way to model the effects of the financial heterogeneity in the euro area. In this perspective, *Badarau & Levieuge (2011)* provide a DSGE model of financially-asymmetric monetary union and show 1) how symmetric shocks produce cyclical divergences inside the union, and 2) that a common monetary policy worsens cyclical divergences in this context.

So, given the role of banks in propagating shocks (namely financial which have become recurrent in the last decades), the heterogeneity of banking markets raises the question of the appropriate macroeconomic policies in such a context. Certainly, avoiding huge financial crisis requires adequate micro and macro-prudential measures (*Levieuge, 2009*). The reduction of financial heterogeneity also demands a convergence of structural policies. But both need time and strength of will to be implemented. It is thus worth examining the suitable

¹ The heterogeneity of the EMU is analyzed in detail in *Jondeau & Sahuc (2008)*, *Sekkat & Malek Mansour (2005)*, *Angeloni & Ehrmann (2007)*, *Ekinici & al. (2007)*, *Hofmann & Remsperger (2005)*, and *Lane (2006)*.

² See *Baale & al. (2004)* and *ECB (2008)* for instance.

³ According to *Angeloni & al. (2003)*, the asymmetric information between lenders and borrowers in the European credit markets could partly explain these price differentials.

⁴ National specificities in the firms' and banks' financial structures are documented for instance in *Chatelain & al. (2003)* or *Ehrmann & al. (2003)*. See *Alves (2008)* for theoretical implications.

⁵ See *Blum & Hellwig (1995)*, *Chen (2001)*, *Sunirand (2003)*, *Van den Heuven (2006)*, *Gerali & al. (2008)*, *Levieuge (2009)*. To this respect *Gertler & Kiyotaky (2009)* analyze the case of a capital quality shock to explain the role of financial intermediaries in the propagation of the recent crisis

mixing of the two main existing EMU policy tools: the common monetary policy led by an independent Central Bank and the budgetary policies conducted by national governments. Since 2008, intensive debates have concerned the lack of coordination of economic stimulus plans inside the euro area, and the way the EMU-members could help the most affected countries. Discussions also exist about the appropriate design of monetary policy⁶. The aim of the present article is to study some policy-mix arrangements likely to mitigate the effects of financial asymmetries in a monetary union possibly hit by financial shocks.

To this end, we proceed to some policy experiments based on the Dynamic Stochastic General Equilibrium (DSGE) model provided by *Badarau & Leveuge (2011)*, for a monetary union gathering two countries with distinct banking structures and national budgetary policies.⁷ The present paper differs from the existing literature as it considers: (i) a bank capital channel, (ii) financial heterogeneity, (iii) financial shocks and, (iv) the evaluation of various policy-mixes, in the institutional context depicted by the Treaty of Lisbon.

It is found that a centralized monetary policy, seeking to stabilize the union-wide inflation rate, dominates a strategy that is simultaneously concerned by the stabilization of inflation divergences in the union. This is true whatever the budgetary regime (cooperative or non-cooperative), supporting the current orientation of the European Central Bank (ECB) policy for the euro area. Besides, national budgetary policies constitute relevant instruments (although insufficient) to fight the asymmetric transmission of shocks in a monetary union with financial heterogeneities. Nevertheless, the analysis of different policy-mixes shows that a cooperative regime is costly at national level. Its superiority only relies on the fact that it allows a better stabilization of public spending divergences.

The reminder of this paper is organized as follows. The second section resumes the baseline model with financial heterogeneity. The third section briefly discusses the role of the centralized monetary policy to amplify cyclical divergences in such an asymmetric union. The capacity of different macroeconomic policies to mitigate the effects of financial structural heterogeneity is then analyzed in the fourth section of the paper. The last section formulates some concluding remarks.

2 The baseline model

The model, based on *Bernanke & al. (1999)*, describes a two-country monetary union with heterogeneous national banking structures. It is very close to the model recently provided by *Badarau & Leveuge (2011)*, with an extension considering the potential stabilizing role of national governments in a monetary union. The main structure of each member country is depicted in *appendix A*. Six categories of national agents optimize their decisions in the model: households, entrepreneurs, retailers, capital producers, banks and a government.

⁶ To this respect, the monetary policy tightening decided by ECB in summer 2008 for instance had been widely commented.

⁷ Previous examples of monetary policy analysis in two-country models with different financial systems are provided by *Faia (2002)* or *Gilchrist & al. (2002)*. The last one is more close to our model, because it addresses the question of the monetary policy conduct in a monetary union. The authors settle for introducing asymmetric firms' balance sheet channels within the union and analyze the transmission of technological shocks. We extend their study considering the effects of a bank capital channel and evaluating different policy-mix strategies in an asymmetric union.

Households supply labour 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, necessary to finance the public expenditures. Entrepreneurs (firms) use labor and capital as input (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 in capital (used by the entrepreneurs, in the production process). The role of banks is twofold in the model: on one hand, they participate as lenders to the national firms investment projects. On the other hand, they collect funds from households, so as to insure the firms financing. The national banking sectors have a particular place in the model, being considered heterogeneous among countries. At the union level, a common Central Bank is responsible for the conduct of the monetary policy. As for the euro area, the main task of the Central Bank is to maintain the price stability, while the national governments should insure the stability of national aggregates.

2.1 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 the working time ($H = 1 - L$) remunerated at a real rate W . The one period utility function is given by:

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

σ_c the consumption intertemporal elasticity of substitution, and σ_h the elasticity of the disutility associated to labour.

Consumption is a composite index which depends on the consumption of goods domestically produced 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 domestic produced goods, in each country.

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

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, labour, bank securities (A_t) and other possible financial investment (D_t) at the real risk-free interest rate, which maximizes an intertemporal utility function, based on (1), subject to the following budget constraint:

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

In (3), $R_t^A = 1 + r_t^A$ and $R_t^f = 1 + r_t^f$ denote respectively the gross real returns of the two alternative financial investments for households, T_t represents lump sum taxes and Π_t are the

dividends received from the ownership of retail firms. Symmetric constraint applies in the second country of the union.

The first order conditions associated to C_t, D_t, A_t and H_t for the two countries appear in the table 1. At the optimum, there is no arbitrage for households among the different financial investments. The labor supply is given by the last condition in table 1, and the nominal interest rate is the same inside the union (chosen by the common central bank):

$$(R_{t+1}^f)E_t \left[\frac{P_{t+1}}{P_t} \right] = (R_{t+1}^{f*})E_t \left[\frac{P_{t+1}^*}{P_t^*} \right].$$
 Under nonrestrictive assumptions similar to Gali &

Monacelli (2009), this allows us to write:

$$C_t = C_t^* (\Theta_t)^{\sigma_c} \quad (4) \text{ where}$$

$\Theta_t = \frac{P_t^*}{P_t}$ is an expression of the bilateral terms of trade.

Table 1. First order conditions for the households' optimization

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

Wholesale producers combine labour and capital with a Cobb-Douglas constant return to scale technology:

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

a_t 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 labour input in (5) is a composite index of households labour (H_t) and

entrepreneurial labour (H_t^F): $L_t = H_t^\Omega (H_t^F)^{1-\Omega}$. As indicated previously, entrepreneurs

supplement their income by supplying their labour force, remunerated at a rate W^F . Note that the total entrepreneurial labour is normalized to unity. In each country, the investment (I_t) is supposed to concern domestic produced goods. The accumulation of physical capital is introduced by the following equation, with δ the depreciation rate:

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

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

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

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

Table 2. First order conditions for firms' optimization

Country 1^(*)
$\rho_t (\Theta_t)^{1-\gamma} \Omega (1-\alpha) \frac{Y_t}{H_t} = W_t; \rho_t (\Theta_t)^{1-\gamma} (1-\Omega) (1-\alpha) \frac{Y_t}{H_t^F} = W_t^F; Q_t = 1 + \frac{\partial \Phi(\cdot)}{\partial I_t};$ $E_t [R_{t+1}^K] = \frac{1}{Q_t} E_t \left[\rho_{t+1} (\Theta_{t+1})^{1-\gamma} \alpha \frac{Y_{t+1}}{K_{t+1}} - \frac{\phi}{2} \left(\delta^2 - \left(\frac{I_{t+1}}{K_{t+1}} \right)^2 \right) + (1-\delta) Q_{t+1} \right]$

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

As in Leveuge (2009) the profit maximization of capital producers is internalized in this program. The first two conditions define the labour demands. The third gives the Tobin's Q ratio. The last relation represents the expected gross return to holding a unity of capital from t to $t+1$.

It is assumed that the debt contracts between households and banks on one hand, and between banks and firms in the other hand, occur in an asymmetric information context. Entrepreneurs have private information about the risk and the return of their projects, and banks have private information about the risk and the realized return of their activity. It is shown in Badarau & Leveuge (2011) that, in these conditions, banks and firms have to bear a financial premium in their external financing. In these conditions, the last relation in table 2 indicates that, at the optimum, the firms' demand for capital insures the equality between the expected marginal cost for the external financing and the expected marginal return on capital. The main relations which describe the financial market equilibrium for the member countries are depicted in table 3.

Table 3. Financial market equilibrium in the member countries

Country 1^(*)
$S_t^B = \Psi_B [k_{t+1}^B], \text{ where } S_t^B = \frac{R_{t+1}^B}{R_{t+1}^f}, \frac{\partial \Psi_B(\cdot)}{\partial k_{t+1}^B} > 0 \text{ and with } k_{t+1}^B = \frac{B_t}{NB_t}$
$S_t^F = \Psi_F [k_{t+1}^F], \text{ where } S_t^F = E_t \left[\frac{R_{t+1}^K}{R_{t+1}^f} \right], \frac{\partial \Psi_F(\cdot)}{\partial k_{t+1}^F} > 0 \text{ and } k_{t+1}^F = \frac{Q_t K_{t+1}}{NF_t + NB_t}$
$NF_t = \gamma^F [VF_t + WF_t], \text{ with } VF_t = Q_{t-1} R_t^K K_t - S_{t-1}^F R_t^f B_{t-1}$
$NB_t = \gamma^B VB_t + T_t^B, \text{ with } VB_t = R_t^K B_{t-1} - S_{t-1}^B R_t^f A_{t-1}$

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

The external finance premium for banks, the logarithmic form of S_t^B , is the difference between the non-default net return on the bank's loans 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 the *table 3*, it only depends on the banks' financial leverage, defined by the ratio accumulated inside capital (NB_t) on loans (B_t).

For firms, the external finance premium (the logarithmic form of S_t^F) is the difference between the net return on the firm's physical capital required by the bank ($r_{t+1}^K = R_{t+1}^K - 1$) and the risk-free rate ($r_{t+1}^f = R_{t+1}^f - 1$). In *table 3*, it does not only depend on the firm's accumulated net wealth (NF_t), but also on the accumulated inside capital of the bank (NB_t). Thus, the lending interest rate required by a bad-capitalized bank is ought to be higher than that charged by a healthier one. This implies that entrepreneurs internalize the banks' external financing costs. A deterioration of the banks' balance sheet finally implies a tightening of the lending conditions to firms, which is precisely the bank capital channel manifestation. The firm's net worth (NF_t) mainly comes from the accumulated benefits, i.d. the accumulated value of the firm (VF_t). It is also assumed that the entrepreneur offers its labour force⁸ and perceives a wage (WF_t), which increases the firm's net wealth. The coefficient γ^F in *table 3* corresponds to the survival probability of the firm, assuming that a constant proportion ($1 - \gamma^F$) of firms leave the market each period. When living the market, the remaining net wealth is entirely used to consume final goods (CF_t):

$CF_t = (1 - \gamma^F)[VF_t + WF_t] = \frac{1 - \gamma^F}{\gamma^F} NF_t$. Besides, the value of the firm (VF_t) is given by the gross return on capital, after the repayment of the debt and of the associated interests.

In a similar way, the bank inside capital (NB_t) comes mainly from the accumulated benefits of the intermediation activity, i.d. the intrinsic value of the bank (VB_t). Besides, it is assumed that a proportion ($1 - \gamma^B$) of banks leaves the market each period, transferring a small part (t^B) of their inside capital to new banks⁹ (for an aggregated amount T_t^B). The outgoing banks, once their transfers to newcomers done, consume in final goods their remaining capital: $CB_t = (1 - \gamma^B)(1 - t^B)VB_t = \frac{(1 - \gamma^B)(1 - t^B)}{\gamma^B(1 - t^B) + t^B} NB_t$.

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

⁸ This assumption just allows the wholesale producers to borrow immediately; otherwise, they should face an unrealistic high external finance premium.

⁹ In line with other financial accelerator models, this assumption gives the possibility to new banks to benefit from initial capital, which is essential for the access to external financing. Without initial wealth, newcomers would suffer prohibitive external financial premium.

$\hat{\pi}_{1,t} = \beta E_t [\hat{\pi}_{1,t+1}] + \kappa \hat{p}_t$ and $\hat{\pi}_{2,t} = \beta E_t [\hat{\pi}_{2,t+1}] + \kappa \hat{p}_t^*$ (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 in the domestically priced goods for the two countries, $\kappa = \frac{(1-\zeta)(1-\zeta\beta)}{\zeta}$ 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 deviation of a variable x_t from its steady-state value.

The national goods and labour markets equilibrium conditions imply:

$$Y_t = \Theta_t^{\frac{1-\gamma}{2\gamma-1}} C_t [\gamma + (1-\gamma)\Theta_t^{1-\sigma_c}] + I_t + G_t + CF_t + CB_t \quad (9)$$

$$Y_t^* = (\Theta_t)^{\frac{\gamma}{1-2\gamma+\sigma_c}} C_t^* [(1-\gamma) + \Theta_t^{1-\sigma_c} \gamma] + I_t^* + G_t^* + CF_t^* + CB_t^* \quad (9')$$

and respectively:

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

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

National governments are responsible for the budgetary policy. They use lump-sum taxes to finance public expenditures. To insure the stability of national aggregates, governments use conventional active budgetary policy rules (see for instance Muscatelli & al. (2004)):

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + \rho_\pi \hat{\pi}_t + \rho_y \hat{y}_t + \varepsilon_{g_t} \quad (11)$$

$$\hat{g}_t^* = \rho_g^* \hat{g}_{t-1}^* + \rho_\pi^* \hat{\pi}_t^* + \rho_y^* \hat{y}_t^* + \varepsilon_{g_t}^* \quad (11') \text{ where}$$

$\rho_g, \rho_g^* < 1$, and $\rho_\pi, \rho_\pi^* < 0$ represent the reaction coefficients of the budgetary policy to national inflation deviation from the steady-state, $\rho_y, \rho_y^* < 0$ are the coefficients of reaction to the output-gap deviation from the steady-state. $\varepsilon_{g_t}, \varepsilon_{g_t}^*$ are random shocks with zero mean and unit standard deviation.

Finally, the *common Central Bank* conducts the monetary policy following a standard monetary policy rule (with respect to the union-wide inflation):

$$\hat{r}_t^n = \beta_0 \hat{r}_{t-1}^n + (1-\beta_0) \beta_1 \hat{\pi}_t^{UM} + \varepsilon_{r_t} \quad (12)$$

where $\hat{\pi}_t^{UM} = \frac{1}{2}(\hat{\pi}_t + \hat{\pi}_t^*)$. The $\beta_1 > 0$ coefficient corresponds to the reaction of the monetary policy to the union-wide inflation deviation from its steady-state level. $\beta_0 \in [0;1[$ is the smoothing coefficient of the nominal interest rate. ε_{r_t} represents a monetary policy shock of zero average and standard deviation equal to 1.

In addition to technological, budgetary and monetary shocks that are introduced in equations (5), (11) and (12), *financial shocks* are also considered in the model. In previous equations, Q_t represents the fundamental value of the firms' physical capital, given by the actualized amount of dividends to be obtained by the firms' shareholders. We now allow for the

possibility that the market value of the capital, denoted hereafter by Q_t^m , differs temporarily from its fundamental value Q_t , because of a temporary financial shocks (ε_{q_t}):

$$Q_t^m = Q_t + \varepsilon_{q_t} \quad (13)$$

with ε_{q_t} a random variable of zero average. If the shock arises in t , it affects the market value Q_t^m of the capital only at this period; afterwards, starting from the $t+1$ period, the equality between Q_t^m and Q_t holds again¹⁰. Hence, in case of financial shock, the fundamental return on the physical capital given in *Table 2* becomes an *abnormal return* on capital given by:

$$R_t^{Km} = \frac{\rho_t (\Theta_t)^{1-\gamma} \alpha \frac{Y_t}{K_t} - \frac{\phi}{2} \left(\delta^2 - \left(\frac{I_t}{K_t} \right)^2 \right) + (1-\delta)Q_t^m}{Q_{t-1}} \quad (14)$$

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

2.2 The model parameterization

The calibration for the parameters and the variables (or ratios) at their steady-state is detailed in *appendix B*, and is made according to the references found in the literature for the euro area. Ratios such as capital/GDP, investment/GDP or total consumption/GDP are all compatible with the estimations revealed by Fagan & Al. (2001). Moreover, it is realistically supposed that banks have a lower default probability than firms, and that the ratio $\frac{NB}{B}$ belongs to the interval $[0.1, 0.2]$.¹¹ Finally, the probability for a bank to leave the credit market is lower than for firms, and as already evoked, the audit is more costly for households than for banks. *Structural financial heterogeneity* is introduced among countries in the national banking system, at two levels: (i) in the *ratio inside capital on loans for banks* at the steady-state, and (ii) in the *sensitivity coefficient of the banks' external finance premium to their financial leverage*. Country 1 is thus assumed to be more sensitive to shocks than country 2.

3. The role of common monetary policy to amplify national divergences

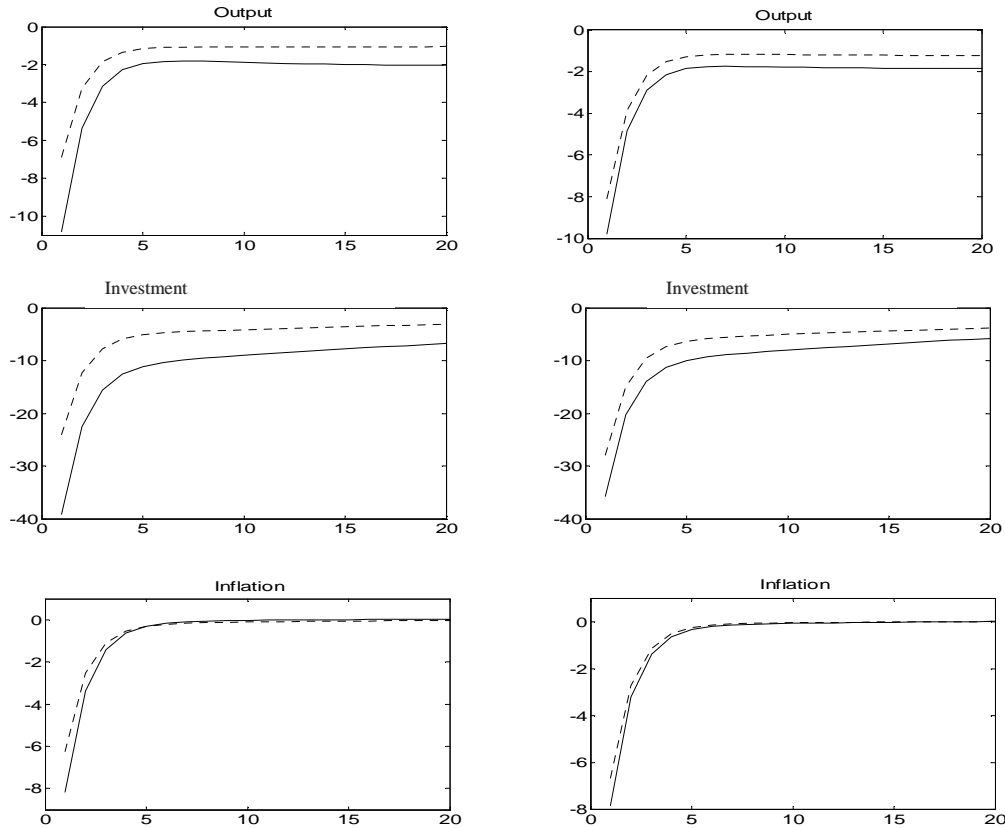
As in *Badarau & Leveuge (2011)*, the conduct of a single monetary policy for the (financially asymmetric) union as a whole worsens the cyclical divergences. *Figure 1*

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

¹¹ See, for example, the numerical values used by Sunirand (2003) and Leveuge (2009) for the euro area.

comparatively depicts the dynamics of countries 1 and 2 after a symmetric monetary shock, when they form a monetary union or not.

Figure 1. Macroeconomic divergences with common vs national monetary policies



We compare the behavior of the	<p>Common monetary policy</p> <p>--- Country 2: weak bank capital channel</p> <p>— Country 1: high bank capital channel</p>	output over time	<p>National monetary policy</p> <p>--- Country 2: weak bank capital channel</p> <p>— Country 1: high bank capital channel</p>
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country were supposed to conduct autonomously its monetary policy, the output response in the country 1 would be only 20% higher than in country 2. In other words, a common monetary policy in an asymmetric union implies a *stabilization bias* comparatively to national policies. Since a single monetary policy seeks to stabilize the average inflation in the whole area, country 2 will benefit from an even lower real interest rate than under a national monetary policy, while country 1 is affected by an even higher real interest rate than under a national policy. This real interest rate differential, which is favorable to the least sensitive country, explains the increased divergences inside the union. A single monetary policy that only reacts to average variables of an asymmetric union worsens the cyclical divergences among member countries.

In this respect, we wonder in the following section whether the consideration of national information for the conduct of monetary policy is likely to mitigate cyclical disparities, and whether national budgetary policies could represent useful tools to reduce divergences.

4. Macroeconomic policies to mitigate the effects of financial heterogeneity

This section aims to study the suitable macroeconomic policy-mix for a monetary union in a context of financial heterogeneity, as described by empirical evidence mentioned in the introduction, in a situation in which financial shocks are not insignificant.

On the one hand, we consider an independent common Central Bank, like the European Central Bank, whose policy is responsible for the union-wide price stability and which does not cooperate with the national governments (in accordance with the *Article 130* of the *Treaty*). On the other hand, decentralized budgetary policies are conducted by the national governments. Alternative strategies for the Central Bank (centralized *or* based on national information) and for the governments (budgetary cooperation *or* autonomous conduct of national budgetary policies) are analyzed following a sequential game. The Central Bank chooses first its strategy. National governments define afterwards their policies.¹² Simple monetary and budgetary rules are optimized and evaluated in terms of welfare gains, under each configuration.

As indicated in (12), the *monetary policy rule* links the short-term nominal interest rate to the union-wide inflation. Two configurations are alternatively considered for the optimization of β_0 and β_1 . Firstly, in the *centralized strategy*, the Central Bank just stabilizes the average inflation for the union, and is not concerned by national divergences. The loss function to be minimized is:¹³

$$L^{BC} = \text{var}(\hat{\pi}^{UM}) + \lambda_r \text{var}(\Delta \hat{r}^n) \quad (15) \text{ where}$$

$\text{var}(\hat{x})$ defines the second order moment for 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 policy to the interest rate smoothing.

Secondly, a *monetary strategy based on national information* responds to the situation in which the Central Bank is simultaneously concerned by the union-wide inflation stabilization and by the stabilization of the inflation differentials inside the union (see *Badarau-Semenescu & al., 2009*). The loss function of the Central Bank becomes:

$$L^{BC} = \text{var}(\hat{\pi}^{UM}) + \text{var}(\hat{\pi}^{UM}) + \lambda_r \text{var}(\Delta \hat{r}^n), \text{ for } \hat{\pi}_t^{UM} = \frac{\hat{\pi}_t - \hat{\pi}_t^*}{2} \quad (16)$$

Governments' decisions take the form of *active budgetary rules* (11) and (11'), whose coefficient ρ_g , ρ_y and ρ_π have to be optimally chosen so as to minimize the national loss functions. Two configurations are considered again. In the *non-cooperative budgetary policy regime*, which refers to an autonomous conduct of national policies, each government optimize a national loss function (17), considering as exogenous the public expenditures of the other country.¹⁴

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

¹² This sequential solving is usual and logical in the euro area context. See Andersen (2005) for instance.

¹³ Following Woodford (2003), the Central Bank loss function could be derived from the intertemporal utility function of the representative agent. Nevertheless, this is in effect not a result, but a hypothesis; Woodford assumes that the objective function of the Central Bank perfectly matches the objectives of the collectivity. This returns to neglect the vast and persuasive literature which 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 & Hefeker (2008)*. So it is not less rigorous to directly refer to the actual conduct of the ECB to deduce its preferences. From this viewpoint, it can reasonably be asserted (*de facto* and *de jure*) that inflation stability is its single objective. With respect to empirical evidence, a penalty with regard to the interest rate volatility is also added in its objective function in order to reproduce the interest rate smoothing.

¹⁴ Such form of governments' loss functions is also considered in *Villieu (2008)*. See *Van Aarle & al. (2002)*, *Leitemo (2004)*, *Vogel & al. (2006)* or *Andersen (2005)* for explanations about to the presence of a public expenditures stabilization objective in the budgetary policy loss functions.

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

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

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

Note that, according to the new Treaty of Lisbon, entered into force on 1st December 2009, national governments benefit from autonomy in the conduct of their budgetary policies. However, they are supposed to respect a global orientation for the budgetary policy defined at the union-wide level. Such global orientation, which is still unclear in the treaty, is interpreted hereafter as a commitment of national governments to follow symmetric stabilization objectives for 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 an *implicit coordination mechanism* that covers not only the cooperative, but also the non-cooperative budgetary regime.

4.1 Some optimization results

First, we optimize the behavior of the common central bank. The context corresponds to the presence of both symmetric technological and financial shocks in the union, and the monetary decisions are supposed independent on the governments' behavior. The optimal coefficient β_1 appears higher in the centralized strategy ($\beta_1 = 1.45704$) compared to the national information based strategy¹⁵ ($\beta_1 = 1.43749$). As expected, the centralized monetary policy is thus more reactive to symmetric shocks than a policy taking into account the specific situation of member countries.¹⁶

Second, given the optimal policy of the central bank, governments' optimize their behavior either in a non-cooperative or in a cooperative regime. Considering the *centralized optimal monetary policy* as given, the optimization of the budgetary rules is summarized in *table 4* for the non-cooperative budgetary regime, and in *table 5* for a cooperative budgetary regime, respectively.¹⁷ To verify the results robustness, different scenarios were defined each time for the governmental loss functions coefficients: λ_π^G , λ_y^G , λ_g^G .

For the non-cooperative regime (*table 4*), the corresponding Cournot-Nash solutions clearly indicate that, whichever coefficients for the governmental loss functions, the coefficients for inflation and output stabilization are (as expected) negative in the budgetary rules. Moreover, taken in absolute value, these coefficients are systematically lower in country 2 than in

¹⁵ In line with *Sauer & Sturm (2007)*, *Fourçans & Vranceanu (2007)* et *Licheron (2009)*, β_0 is equal to 0.96.

¹⁶ For asymmetric shocks, the situation reverses. As in *Badarau-Semenescu & al. (2009)*, they are better stabilized under a monetary policy who tries to reduce inflation divergences, than under a centralized monetary policy.

¹⁷ Results with an inflation-divergences oriented monetary policy are qualitatively similar (see tables in *appendix C*).

country 1. Precisely, in the calibration, country 1 was supposed to be more sensitive to shocks. It thus needs more stabilization by the budgetary policy, and it is exactly what the government does. 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 the structural heterogeneity of the union.*

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

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

In contrast with these results, optimal cooperative budgetary rules are not consistent with the stabilization needs of member countries in *table 5*. For example, the coefficient associated to the inflation gap in the budgetary rule of country 2 is positive, corresponding to a definitely destabilizing effect of the government optimal actions in this country.

Table 5. Cooperative budgetary rules coefficients with centralized monetary policy

Governmental loss functions coefficients	Country 1	Country 2
$\lambda_{\pi}^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$\rho_g = 0.1779$	$\rho_g^* = 0.6051$
	$\rho_y = -0.1901$	$\rho_y^* = -0.0632$
	$\rho_{\pi} = -0.5985$	$\rho_{\pi}^* = 0.2576$
$\lambda_{\pi}^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$\rho_g = 0.2079$	$\rho_g^* = 0.5625$
	$\rho_y = -0.1237$	$\rho_y^* = -0.0459$
	$\rho_{\pi} = -0.4442$	$\rho_{\pi}^* = 0.2049$
$\lambda_{\pi}^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$\rho_g = 0.1929$	$\rho_g^* = 0.9225$
	$\rho_y = -0.5955$	$\rho_y^* = -0.0445$
	$\rho_{\pi} = -1.6366$	$\rho_{\pi}^* = 0.048$

At first glance this result seems counter-intuitive. But, following *Badarau-Semenescu & al. (2009)*, it is easy to show that the cooperative loss function L^{Coop} can be alternatively written:

$$L^{Coop} = \lambda_{\pi}^G \text{var}(\hat{\pi}^{UM}) + \lambda_y^G \text{var}(\hat{y}^{UM}) + \lambda_g^G \text{var}(\hat{g}^{UM}) + \lambda_{\pi}^G \text{var}(\hat{\pi}^{UM}) + \lambda_y^G \text{var}(\hat{y}^{UM}) + \lambda_g^G \text{var}(\hat{g}^{UM}) \quad (19)$$

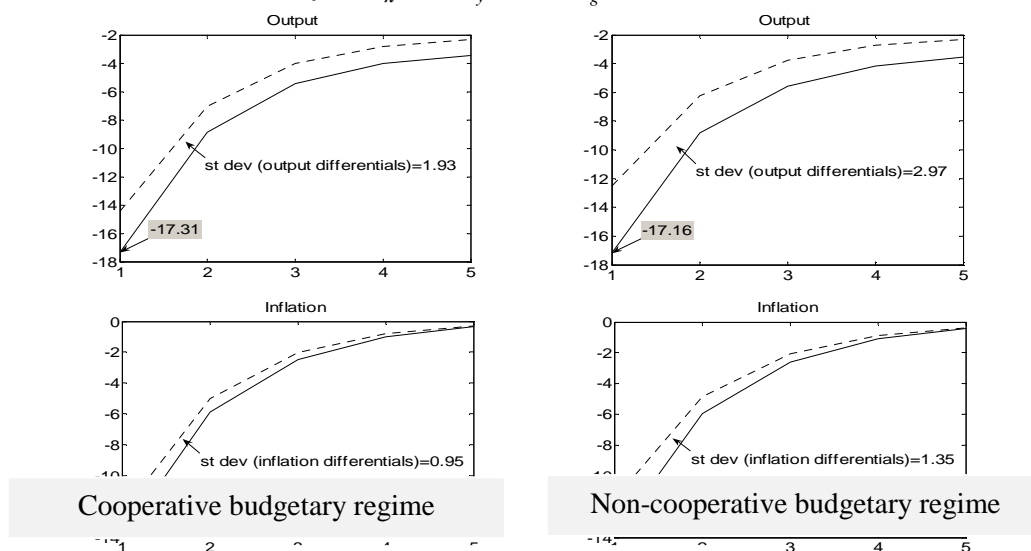
This function implicitly incorporates centralized stabilization objectives and national divergences stabilization objectives. Since all governments accept to fight divergences in the union, one possible solution is that each economy makes an effort to reach the average performance of the union. This explains the positive sign of the national inflation stabilization in the budgetary rule of country 2 (which is supposed to be less affected by shocks). Consequently, the cooperative budgetary regime is not necessarily suitable in an asymmetric monetary union. 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 2 illustrates this point, in case of restrictive and symmetric monetary shock. As the government in country 2 takes care of macroeconomic divergences in the union, its policy is not expansionist enough to duly stabilize its national output (otherwise it risks to exacerbate the divergences). Precisely, reaction to inflation divergences implies a reduction of public expenditures in country 2 simultaneously to an increase in country 1 (cf.

ρ_{π} and ρ_{π}^* coefficients in table 5). Moreover, the reduction of output divergences implies a lower increase of public spending in country 2 relatively to country 1 (see ρ_y and ρ_y^* coefficients in table 5).

All in all, the cooperative regime allows a better stabilization of the divergences between the member countries, but national variables are then less stabilized than under a non-cooperative regime (the decline in output in particular is higher under a cooperative regime).

Figure 2. National responses to a restrictive monetary shock
(for $\lambda_{\pi} = 1; \lambda_y = 1.5; \lambda_g = 0.5$)



Certainly, the budgetary response of Country 1 to a restrictive monetary shock asks for an increase of national expenditures to compensate the reaction to inflation divergences. Consequently, as the global effect of these mixed forces finally leads to (excessively) moderate public expenditures (at the national level) in country 2, the country 1 in turn can not plan to implement an ambitious stimulus scheme. Otherwise, it would be penalized by a growing public expenditures gap. In other words, in country 1, the lower stabilization of the national variables is explained by the reaction of the budgetary

policy to government spending divergences. This reduces the amount of public expenditures in the cooperative regime, compared to the non-cooperative one, with consequently less stabilizing effect on the economy.

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

Financial shock	Monetary shock
<i>Country 1:</i> $y_1 : 1.02$ $\pi_1 : 1.02$	<i>Country 1:</i> $y_1 : 1.003$ $\pi_1 : 1.002$
<i>Country 2:</i> $y_2 : 1.06$ $\pi_2 : 1.05$	<i>Country 2:</i> $y_2 : 1.15$ $\pi_2 : 1.07$
<i>Inflation and output differentials:</i> $\bar{y}^{UM} : 0.98$ $\bar{\pi}^{UM} : 0.98$	<i>Inflation and output differentials:</i> $\bar{y}^{UM} : 0.65$ $\bar{\pi}^{UM} : 0.70$

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

All in all, the cooperative regime allows for a better stabilization of divergences in the union compared to the non-cooperative one, but, since it would be done to the detriment of the national variables stabilization, it is not really acceptable for member countries. *Table 6* clearly depicts this fact, not only for the previous monetary shock, but also for a financial shock.

4.2 Policy-mix analysis

In this paragraph, we analyze the qualitative properties of four alternative policy-mixes (*centralized / inflation-divergences oriented* monetary policy with *cooperative / non-cooperative* budgetary policies), evaluated with respect to a union-wide social loss function, computed as the average of national social loss functions:

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

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

Two cases are considered. On the one hand, it is assumed that governments share the same preferences as the society for inflation and output stabilization: $\lambda_x^S = \lambda_x^G$, for $x \in \{y, \pi\}$. On the other hand, since the national aggregates are not correctly stabilized under the cooperative regime (see *table 6*), we wonder what happens if the social stabilization preferences deviate from the governmental ones. We reasonably consider that the society is essentially concerned about inflation and output stabilization and less concerned about the public expenditures stabilization (see, in extremis, $\lambda_g^S = 0$).

The evaluations for these different policy-mixes are reported in *Table 7*. Three sets of social loss function's coefficients are considered and reported in the first column. The second column compares the expected losses issued from alternative budgetary regimes, independently of the monetary policy design. The third column compares the expected losses issued from alternative monetary strategies for the Central Bank, independently of the budgetary regime.

Table 7. Expected social loss comparison for alternative policy-mixes

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

* 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.

The last column clearly shows that, whichever the social and governments' stabilization preferences, the expected loss of a centralized monetary policy is systematically lower than in the alternative case, where the Central Bank fights inflation divergences in the union. This indicates that a change in the monetary policy design, in favour of inflation divergences, is not suitable¹⁸. Concerning budgetary regimes, under the assumption of identical social and governmental stabilizing preferences in the union, the results favour the cooperative regime over the non-cooperative one. But the relative benefit of the cooperative regime comes only from the stabilization of public expenditures and the decrease of their divergences inside the union ($\lambda_g^S \neq 0$). Indeed, the computation of the alternative social loss function solely defined in terms of inflation and output stabilization ($\lambda_g^S = 0$) reasserts the superiority of the non-cooperative regime with implicit coordination mechanism¹⁹, as indicated in figure 2.

5 Conclusions

Considering the well-documented financial heterogeneity of the euro area, paying attention to the bank capital channel (which has generated great interest for several years), and to financial shocks (which are now recurrent), this paper aims to study the suitable

¹⁸ As discussed in *Badarau-Semenescu & al. (2009)* such modification would be beneficial only if it is supported by simultaneous consideration of output divergences in the union.

¹⁹ So, the case in which $\lambda_g^S = 0$ is useful to demonstrate that the superiority of the cooperative regime is mainly due to a better stabilization of public spending divergences.

policy-mix in such a context. The analysis relies on a dynamic stochastic general equilibrium model, calibrated in reference to previous studies for the euro area. This model generates conventional dynamics, and particularly shows that the conduct of a single monetary policy for an asymmetric union as a whole seriously worsens national divergences.

The normative conclusions are the following. Firstly, it appears that a centralized monetary policy dominates a strategy based on inflation divergences in the Union, whatever the budgetary regime. This conclusion confirms previous results in the literature, according to which the aversion of the common Central Bank to national divergences could be beneficial only if it focuses simultaneously on inflation **and** output (what is not the case for the ECB). Secondly, decentralized budgetary policies need to be more proactive in countries that are structurally more sensitive to shocks (those where the bank capital channel is stronger). In that case, budgetary policies can contribute to mitigate the effects of adverse shocks. Thirdly, a cooperative budgetary regime (defined as the average of the national objective functions) can be counterproductive. Indeed, each country has then to make a step toward a common target (partly defined as a combination of inflation, output and public spending divergences, besides their own national targets) in order to respect the objective of macroeconomic convergence this regime implicitly implies. If structural heterogeneity is important, this returns to be unsatisfactory for any country: national variables are less duly stabilized than under a non-cooperative regime (notwithstanding with an implicit coordination mechanism implying similar objective functions in the member countries, what is an interpretation of the global common orientation promoted by the new Treaty of Lisbon). Finally, the cooperative regime is preferable only because it allows a better stabilization of public spending divergences.

Typically, in the context of diverging responses by European economies following the subprime mortgage crisis, a cooperative budgetary regime would have implied an insufficient reaction of national governments, with regards to what their own situation had required. Caring about inflation divergences between the members, the less affected countries like France for instance would have had to refrain from ambitious stimulus plan (compared to what should be nationally required). Otherwise, they would have been responsible for worsening macroeconomic divergences, what is inconsistent with “cooperation”. In the same way, the most affected countries, like Italy for example, would have been constrained to circumscribe their economic stimulus plan, in order to limit the

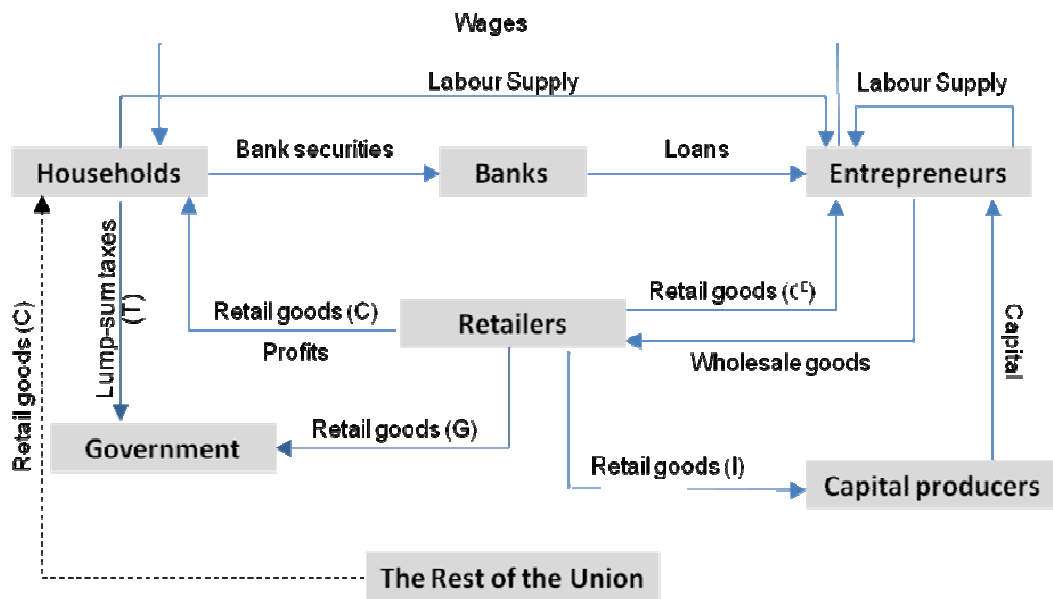
public spending divergences. All in all, European countries would not have benefited from a cooperative budgetary regime, whatever their sensitivity to the financial shock.

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Appendix A. The main structure of the model for each member country



Appendix B. 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 labour disutility	σ_h	0.32	0.32
Subjective discount factor	β	0.99	0.99
Part of retailers with unchanged prices on the period	ζ	0.75	0.75
Capital contribution to GDP	α	0.35	0.35
Part of entrepreneurial labour in total labour	$1 - \Omega$	0.01	0.01
Part of households labour in total labour	Ω	0.99	0.99
Depreciation rate for capital	δ	0.03	0.03
Internal capital adjustment costs parameter	ϕ	10	10
Part of inside capital transfers to survival banks	t^B	0.001	0.001
Banks external finance premium elasticity	ψ_B^S	0.002	0.001
Firms external finance premium elasticity	ψ_F^S	0.025	0.025
Part 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	ρ	1/1.1	1/1.1
Banks inside capital/ loans ratio	NB / B	0.15	0.2
Firms net wealth/ capital ratio	NF / K	0.4	0.4
Public expenditures/GDP ratio	G / PIB	0.16	0.16
Firms probability of default	$F(\bar{\omega}^F)$	0.03	0.03
Banks probability of default	$F(\bar{\omega}^B)$	0.007	0.007
Average external finance premium for firms (in annual basis)	$r^K - r^f$	0.02	0.02
Steady State: Calculated values			
Auditing cost for banks	μ^B	0.018	0.077
Auditing cost for households	μ^A	0.807	0.545
Variance for the ω distribution	σ	0.2531	0.2531
ω threshold value for banks	$\bar{\omega}^B$	0.52	0.52
ω threshold value for firms	$\bar{\omega}^F$	0.6016	0.6016
Banks probability to leave the market	$1 - \gamma^B$	0.01	0.01
Firms probability to leave the market	$1 - \gamma^F$	0.017	0.017
Capital/GDP ratio	K / Y	7.0549	7.0549
Investment/ GDP ratio	I / Y	0.2116	0.2116
Banks consumption expenses/GDP	CB / Y	0.006	0.008
Firms consumption expenses/GDP	CF / Y	0.048	0.048
Households consumption expenses/GDP	C / Y	0.5735	0.5501
Total consumption expenses/GDP	$(C+CF+CB)/Y$	0.628	0.628

Appendix C. Budgetary policies optimization under inflation divergences-oriented monetary policy

Table C.1 Optimal coefficients for non-cooperative budgetary policy rules

Governmental loss functions coefficients	Country 1	Country 2
$\lambda_{\pi}^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$\rho_g = 0.2204$	$\rho_g^* = 0.1483$
	$\rho_y = -0.2035$	$\rho_y^* = -0.1740$
	$\rho_{\pi} = -1.0849$	$\rho_{\pi}^* = -0.7107$
$\lambda_{\pi}^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$\rho_g = 0.2382$	$\rho_g^* = 0.1727$
	$\rho_y = -0.1364$	$\rho_y^* = -0.1164$
	$\rho_{\pi} = -0.7639$	$\rho_{\pi}^* = -0.5149$
$\lambda_{\pi}^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$\rho_g = 0.2191$	$\rho_g^* = 0.1631$
	$\rho_y = -0.6578$	$\rho_y^* = -0.5522$
	$\rho_{\pi} = -3.6250$	$\rho_{\pi}^* = -2.3106$

Table C.2 Optimal coefficients for cooperative budgetary policy rules

Governmental loss functions coefficients	Country 1	Country 2
$\lambda_{\pi}^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$\rho_g = 0.1810$	$\rho_g^* = 0.5964$
	$\rho_y = -0.1915$	$\rho_y^* = -0.0654$
	$\rho_{\pi} = -0.5978$	$\rho_{\pi}^* = 0.2608$
$\lambda_{\pi}^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$\rho_g = 0.2110$	$\rho_g^* = 0.5355$
	$\rho_y = -0.1246$	$\rho_y^* = -0.0476$
	$\rho_{\pi} = -0.4436$	$\rho_{\pi}^* = 0.2075$
$\lambda_{\pi}^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$\rho_g = 0.1974$	$\rho_g^* = 0.9098$
	$\rho_y = -0.5996$	$\rho_y^* = -0.0519$
	$\rho_{\pi} = -1.6349$	$\rho_{\pi}^* = 0.0553$