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

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Abstract

The credit market constitutes a predominant source of financing in the European economies. Its heterogeneity, confirmed by recent studies, represents an important feature of the euro area. Based on these empirical findings, the objective of the paper is twofold: 1) it analyzes the implications of the financial heterogeneity in a monetary union, and 2) examines the pertinence of some possible policy-mix solutions to reduce the cyclical divergences induced by financial heterogeneity. If a centralized monetary policy appears to be more advantageous for the union than an alternative inflation-divergences oriented policy, the national budgetary policies represent the main instruments to mitigate cyclical divergences. To this end, they must be correctly coordinated inside the union. Such a coordination mechanism is emphasized, coming from the governments' commitment to a common strategy for the budgetary policy conduct, in line with the conditions proposed by the new Treaty of Lisbon for the euro area.

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

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1 Introduction

The structural heterogeneity of the European Monetary Union is largely documented and commented[1]. Its effects have given rise to numerous debates for at least two decades. Despite the attempts of convergence made by the national governments, recent studies[2] conclude that the financial system is far from being integrated in Europe. More precisely, among the five main financial markets usually analyzed (money, government bond, corporate bond, banking credit and equity market), the banking markets are the most heterogeneous. Indeed, 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]. According to *Angeloni & al. (2003)*, the asymmetric information between lenders and borrowers in the European credit markets could partly explain these price differentials. Credit conditions would thus depend on the national firms' and banks' financial structures[4].

Such a financial heterogeneity implies that a symmetric shock will have asymmetric effects in the member countries, what a common monetary policy can not deal with. This is true in particular for financial shocks, which have become recurrent over the last two decades (the EMS crisis, the spillovers of the Asian financial crisis, the "dot-com bubble" boom and burst, the subprime mortgage crisis). As shown during the subprime mortgage crisis, banks constitute nowadays key actors for the transmission of financial shocks. Several recent contributions[5] have highlighted the importance of the *bank capital channel*, according to which the banks' balance sheet structures may act as an amplifier for the transmission of shocks to the real economy[6]. According to this literature, the question of the 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 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

[1] See for instance *Jondeau & Sahuc (2008), Sekkat & Malek Mansour (2005), Angeloni & Ehrmann (2007), Ekinci & al. (2007), Hofmann & Remsperger (2005), Lane (2006).*
[2] See *Baele & al. (2004)* and *ECB (2008)*.
[3] Compared to the credit market, the money market is found to be the most integrated being driven by the conduct of a single monetary policy for the euro area. In addition, equity and bond markets are more and more dependent on common news, instead of purely local risk factors.
[4] National specificities in the firms' and banks' financial structures are documented for instance in *Chatelain & al. (2003)* or *Ehrmann & al. (2003).*
[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
[6] In other words, the bank capital channel is an additional transmission mechanism of asset prices movements, with the Tobin's Q ratio, the wealth effect and the financial accelerator à la Bernanke & al. (1999).

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[7].

This context raises the question of the appropriate macroeconomic policies in case of heterogeneous monetary union facing recurrent financial shocks. 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 desirable 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 actually concerned the lack of coordination of economic stimulus plans inside the euro area and the way the EMU-members could help the countries the most affected by the recent crisis. Discussions also existed with regards to the appropriate design of the monetary policy[8]. The aim of the present article is to determine which policy-mix arrangements are likely to mitigate the effects of financial asymmetries in a monetary union hit by financial shocks.

To this end, we proceed to some policy experiments based on a Dynamic Stochastic General Equilibrium (DSGE) model for a monetary union gathering two countries with distinct banking structures (in line with *figure 1.1* in *Appendix 1*) [9]. As for the euro area, the monetary policy is supposed to be conducted by an independent central bank that must ensure the price-stability for the Union as a whole. Budgetary policies are decentralized and remain under the responsibility of the national governments. Different strategies for monetary policy (centralized vs. based on national information) and for budgetary policies (budgetary cooperation vs. autonomous conduct of the national budgetary policy) are studied. These policies are combined in a sequential game, with the central bank choosing first its strategy, and the national governments defining afterwards their (cooperative or non-cooperative) policies. Four policy-mixes are thus obtained. Their benefits are evaluated with respect to an exogenous social welfare criteria calculated as the average of individual social loss functions within the Union.

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[7] The *figure 1.1* in the *Appendix 1* summarizes the conclusion of this exam.

[8] To this respect, the monetary policy tightening decided by ECB in summer 2008 had been widely criticized.

[9] A previous example in modeling a two-country monetary union with financial heterogeneity is provided by *Gilchrist & al. (2002)*. If their work just introduces asymmetric firms' balance sheet channels within the union and analyzes the transmission of technological shocks using a ad-hoc monetary Taylor rule to describe the monetary policy, we extend their study toward the consideration of the bank capital channel and we show how the model can be used to evaluate different policy-mix strategy in an asymmetric union.

It thus appears 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, supporting the current orientation of the European Central Bank (ECB) policy for the euro area. Besides, national budgetary policies remain the better instruments to fight the asymmetric transmission of shocks in a monetary union with financial heterogeneities. The model emphasizes the drawbacks associated to a possible cooperative budgetary regime for the union. It also proposes a simple coordination mechanism of national policies that, introduced in the non-cooperative budgetary regime, could allow reducing divergences caused by the asymmetric transmission of shocks in the union. This mechanism perfectly fulfills the conditions of the new Treaty of Lisbon entered into force on 1 December 2009. It consists in the governments' commitment to a single strategy for the budgetary policy conduct that clearly defines the stabilization objectives and their relative weights in the national loss functions.

The reminder of this paper is organized as follows. The second section introduces the baseline model. The third section verifies the dynamics of the model and discusses the role of the financial asymmetries for the transmission of shocks within the monetary union. The capacity of 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 used in this paper describes a two-country monetary union with financial heterogeneities introduced in the national banking structures, where the monetary policy decisions are delegated to a common central bank. It extends the reference financial accelerator model of *Bernanke & al. (1999)*, by introducing the bank capital channel in the analysis, in line with the instructions provided by *Sunirand (2003)* and *Levieuge (2009)*. It then proposes the transition to a two-country model, in a way similar to *Gilchrist & al. (2002)*.

2.1 An Overview

The behavior of five categories of national agents is considered for each country: entrepreneurs, households, retailers, banks and the government, to which we must add the role of the common central bank. Briefly, the financial mechanism of the model, written for a given country, relies on the following sequence: households lend money to banks, which in turn insure the financing of firms (entrepreneurs). Two types of contracts must be concluded on the imperfect credit market: a first one is between entrepreneurs and banks, necessary to the financing of firms' investment in capital; a second one is between banks and households, allowing banks to obtain funds necessary to the financing of firms.

Entrepreneurs are risk neutral. To produce wholesale final goods for the period $t+1$, the representative firm i buys, at the end of the period t, the capital K_{t+1}^{i} at a price Q_t. The entrepreneur can not entirely self-finance its project. He thus uses to this aim the firm's net wealth $\left(NF_t^{\,i}\right)$, and he borrows external funds from a representative bank j to partially finance its capital investment. Debt contracts have one period maturity, given that an idiosyncratic risk $\left(\omega_{t+1}^{i}\right)$ affects the representative firm's expected return R_{t+1}^{K}.[10] Considering a costly verification framework (*Townsend, 1979)* to introduce imperfections on the credit market, the realization of ω_{t+1}^{i} is private information. As a result, bank j has to engage verification costs to reveal this value and, as for *Williamson (1987),* the verification procedure is open only if the barrower declares bankrupt. Moreover, because this conceptual context creates a wedge between the cost of internal and external financing, it motivates the self-participation of firms to the capital investment. The loan contracted by the firm *i* from the bank j is: $B_t^{i} = Q_t K_{t+1}^{\,i} - NF_t^{\,i}$, with $NF_t^{\,i}$ the net wealth held and engaged in the capital investment by the firm, at the period t. Following *Bernanke & al. (1999),* a threshold value of ω_{t+1}^{i}, noted $\omega_{t+1}^{i,F}$, is defined such that it satisfies the relation:

$$\overline{\omega}_{t+1}^{i,F} R_{t+1}^{K} Q_t K_{t+1}^{i} = R_{i,t+1}^{B} B_t^{i} \qquad (1),$$

where $R_{i,t+1}^{B}$ represents the non-default loan rate associated to the contract signed between the firm i and the bank j, at the end of the period t. Given the predetermined threshold value $\omega_{t+1}^{i,F}$, there are two possible situations for the following period: *i)* $\omega_{t+1}^{i} \geq \overline{\omega}_{t+1}^{i,F}$, and the realized return of the firm is sufficient to repay its debt to the bank, there is no bankruptcy and the firm obtain a benefit which is: $\left(\omega_{t+1}^{i} - \overline{\omega}_{t+1}^{i,F}\right) R_{t+1}^{K} Q_t K_{t+1}^{\,i}$; or *ii)* $\omega_{t+1}^{i} < \overline{\omega}_{t+1}^{i,F}$, and the firm revenues are insufficient to fulfill the loan contract, it declares bankruptcy and is liquidated. The auditing cost the bank has to spend if the firm declares bankrupt is supposed to be proportional to the gross return to the firm's investment: $\mu^{B} \omega_{t+1} R_{t+1}^{K} Q_t K_{t+1}$, where μ^{B} is the factor of proportionality. The bank thus only receives: $\left(1-\mu^{B}\right)\omega_{t+1} R_{t+1}^{K} Q_t K_{t+1}$, after the verification procedure.

Banks operate in a perfectly competitive environment and are also risk neutral. In the reference model of *Bernanke & al. (1999),* the implicit assumption that the banks portfolios are

[10] where ω_{t+1}^{i} is a random variable that follows a log-normal distribution of mean $-\sigma^2/2$ and standard deviation σ, independent and identically distributed among firms and in time. It fulfills all general condition for the existence of the financial contract (see *Bernanke & al , 1999; Sunirand, 2003;* or *Levieuge, 2009,* for example).

infinitely large amounts to the fact that the idiosyncratic risk ω^i is completely diversified by banks. Households are thus sure to benefit from a riskless return when they lend to banks. There is no need for them to monitor banks and there is no need for banks to hold inside capital. But, if it is assumed that banks' loan portfolios are of finite size, the risk associated with firms' investment projects is partly transferred to banks' balance sheets, and finally to households. Such an approach allows avoiding the less realistic idea that banks never default and that the financial intermediation can be conducted without capital. In addition to the agency problem between entrepreneurs and banks, a new agency problem occurs in the relationship between banks and households.

Let's assume that a costly verification procedure reveals information only to the agent paying the auditing cost, and it does not become public information (see also *Krasa & Villamil, 1992*). As the return of investment of the representative firm is private information, the return on the loans portfolio of the bank financing this firm also constitutes private information. If the bank goes bankrupt, a household who borrowed funds to it has to start a costly audit procedure if he wants to observe the true value of the bank's lending return. This means that banks also face an external finance premium in obtaining funds from households, encouraging them to accumulate inside capital. The previous simple costly verification framework is transformed into a double costly verification approach and, as in *Krasa & Villamil (1992)*, households perform the role of 'monitoring the monitors'.

However, with the assumption of banks' loan portfolios of finite size, the aggregation is more difficult and it directly depends on the distribution of risky portfolio in each bank[11]. To maintain the model tractability, we follow hereafter *Sunirand (2003)* when supposing that a bank can only participate to the investment projects of one firm[12]. In such a way, the idiosyncratic risk is fully diversified at the aggregate level, but not at the bank level. This assumption also allows us to simplify hereafter the previous notations, by renouncing to indices i and j used for a given firm or bank, respectively.

Thus, at the period t, a representative bank which lends $B_t = Q_t K_{t+1} - NF_t$ to a representative firm uses for that its inside accumulated capital $\left(NB_t\right)$ and other funds raised from a representative households $\left(A_t\right)$, amounting to: $A_t = Q_t K_{t+1} - NF_t - NB_t$. The bank is part of two successive financial contracts:

On the one hand, its relationship with the entrepreneur conducts to a contract in which the bank acts as a lender. Given the previous information relative to the risk associated to the firm's project and the fact that bank should afterwards collect sufficient funds from households to

[11] See *Sunirand (2003)* for more details on this subject.
[12] See also *Chen (2001)* for an equivalent situation, when one bank can lend to several firms, but the return on firms' investment projects is perfectly correlated within a bank, but i.i.d across banks.

finance the firm, the terms of this contract come from the resolution of an optimization program which seeks to maximize the entrepreneur's expected benefice, subject to the participation condition for the bank, implicitly to that anticipated by the bank for the household. The firm demand for capital, the value of the threshold $\overline{\omega}_{t+1}^{F}$, and another threshold value $\left(\overline{\omega}_{t+1}^{B} < \overline{\omega}_{t+1}^{F}\right)$ for the idiosyncratic risk ω_{t+1}, able to produce the bank default (calculated by taking into account all information available for the bank)[13]. The non-default loan rate associated to the contract between the entrepreneur and the bank $\left(R_{t+1}^{B}\right)$ is then easily obtained from (1).

On the other hand, in a second time, the banker directly interacts with a household in order to obtain funds necessary to the financing of the firm. In this relationship, the bank acts as a borrower and the lender (household) has no information on the loan portfolio of the bank. He forms his expectations on the basis of the average return for banks in the economy. As for firms, each bank are now subject to an idiosyncratic risk, noted ε_{t+1}, supposed to follow a log-normal distribution similar to that of ω_{t+1}. The realization of ε_{t+1} represents private information, and the bank could be encouraged to not publicly announce it, in a default situation. To obtain the real value of ε_{t+1}, the household have to pay an auditing cost $\left(\mu^{A} R_{t+1}^{B} B_{t}\right)$ proportional to the gross return of the bank's loans portfolio. The intermediation activity of banks to be justified in the model, the monitoring procedure must be more costly for households than for banks (which are specialized in this kind of operations). The terms of the financial contract concluded between the bank and a household are obtained from the resolution of an optimization program that maximizes the expected bank benefit, subject to the household participation constraint. The solution of the program allows determining B_t, a threshold value $\bar{\varepsilon}_{t+1}$ under which the bank goes bankrupt, and the non-default rate $\left(R_{t+1}^{A}\right)$ on the funds raised from the household at the end of period t, by the use of the following condition:

$$\bar{\varepsilon}_{t+1} R_{t+1}^{B} B_{t} = R_{t+1}^{A} A_{t} \tag{2}$$

If $\varepsilon_{t+1} \geq \bar{\varepsilon}_{t+1}$, bank's revenues are sufficient to fulfill its commitments towards the household. Otherwise, the bank goes bankrupt and the household must support the monitoring cost in order to recuperate the maximum of his rights, amounting to: $\left(1-\mu^{A}\right) R_{t+1}^{B} B_{t}$.

Households are infinitely-lived in the model. They consume retail goods, work in wholesale enterprises and receive profits from retailers (that they are owners). Their saving

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[13] This threshold $\overline{\omega}_{t+1}^{B}$ must fulfill the condition: $\left(1-\mu^{B}\right)\overline{\omega}_{t+1}^{B} Q_{t} R_{t+1}^{K} K_{t+1} = R_{t+1}^{A_B} A_{t}$, where $R_{t+1}^{A_B}$ defined the highest return that can be demanded by the household when lending to the bank (supposing that this later is informed on the risk degree of the bank's loans portfolio).

consists in securities issued by banks (see A_t , in the previous relations, for the period t), or in other financial investments remunerated at the risk-free interest rate. Households are neutral to idiosyncratic risk hitting firms and banks, but they are averse to aggregate risk, which means that the aggregate risk inherent to the activity of firms will be borne by firms and banks. The mechanism which protects households from the aggregate risk is the following. Both the non-default lending rate $\left(R_{t+1}^{B}\right)$ and the non-default interest rate on bank securities $\left(R_{t+1}^{A}\right)$ are predetermined at the end of period t. So, if at the end of the period $t+1$, the effective return on non-idiosyncratic component of firms' investments is lower than expected, households will be compensated with the higher non-default interest rate on bank securities.

Apart from these financial relations on the credit market, the rest of the model is standard. In each country, firms use labor and capital (partially financed by debt) to produce wholesale final goods, in perfectly competitive markets. Retailers buy wholesale goods from the producers and retail them in a monopolistic competition market. They slightly differentiate the output they purchase with no costs and their presence allows introducing nominal rigidities in the model, in line with the *Calvo (1983)* pricing assumption. Households and firms (producers of wholesale final goods) purchase CES aggregates of the retail products and transform then in consumption goods or in investment goods (used as capital in the production process, after some costly internal adjustments). Because the model consists of a two-country monetary union, domestic households from a given state simultaneously consume domestic goods and goods produced in the other country of the union.

Finally, national governments are responsible for the budgetary policy, while the common central bank conducts the monetary policy for the union, by defining the level of the riskless nominal interest rate.

2.2 Partial equilibrium on the credit market

To characterize the partial equilibrium on the credit market, the mathematical approach is quite similar to that used in *Bernanke & al. (1999)* and *Sunirand (2003).* It consists in solving the two optimization program previously introduced for the two types of financial contracts on the credit market. As result, two main equations allow to describe the equilibrium on this market. It is about the determinants' description of the external finance premia associated to banks and to firms respectively. The definition of an external finance premium is standard for financial accelerator models: it is given by the gap between the non-default net return on capital required for the external financing and the risk-free interest rate (which can be seen as an opportunity cost for the internal financing).

Thus, the solution of the optimization program defining the relationship of a bank with the corresponding entrepreneur (borrower) is resumed in the following relation[14]:

$$S_t^F = \Psi_F\left[k_{t+1}^F\right], \text{ where } S_t^F = E_t\left[\frac{R_{t+1}^K}{R_{t+1}^f}\right], \frac{\partial \Psi_F(\cdot)}{\partial k_{t+1}^F} > 0 \text{ and } k_{t+1}^F = \frac{Q_t K_{t+1}}{NF_t + NB_t} \tag{3}$$

In a logarithmic form, S_t^F simply defines to the firm's external finance premium in the model, i. d. the difference between the net return on the firm's physical capital required by the bank $\left(r_{t+1}^K = R_{t+1}^K - 1\right)$ and the risk-free interest rate $\left(r_{t+1}^f = R_{t+1}^f - 1\right)$.

Unlike the reference *Bernanke & al. (1999)* model, the firm's external finance premium does not only depends on the firm's financial position $\left(\frac{Q_t K_{t+1}}{NF_t}\right)$, but also on the inside capital of its bank $\left(NB_t\right)$. All things being equal, a low level of the firm's net wealth $\left(NF_t\right)$ induces a higher cost of the external finance. Moreover, it also depends on the bank's financial situation. The lending interest rate required to the firm by a bank with low level of inside capital would be higher than that expected from another bank with better financial position (in (3), S_t^F negatively depends on NB_t). This fact clearly shows the internalization of the external financing cost for banks, by the entrepreneurs. The deterioration of the banks' balance sheets, inducing higher cost for their external finance, will also reflect a tightening of the lending conditions to firms. It is the bank capital channel manifestation, discussed in the previous paragraph.

This mechanism becomes more evident after the resolution of the second optimization program corresponding to the relationship between bank (borrower) and household (lender) on the credit market. Indeed, the relation (4) resumes the terms of this second financial contract, by defining the bank's external finance premium $\left(S_t^B\right)$.

$$S_t^B = \Psi_B\left[k_{t+1}^B\right], \text{ where } S_t^B = \frac{R_{t+1}^B}{R_{t+1}^f}, \frac{\partial \Psi_B(\cdot)}{\partial k_{t+1}^B} > 0 \text{ and } k_{t+1}^B = \frac{B_t}{NB_t} \tag{4}$$

As expected, the non-default return on the bank's loans portfolio, required by the household $\left(R_{t+1}^B\right)$, is higher than that required by the self-financing (the risk-free interest rate). The amplitude of the gap only depends in (4) on the bank's financial leverage, defined here by the inside capital on loans ratio. The financial health of the intermediary impacts on the cost of its external financing that will be finally transferred to firms.

To better understand the role of the firms' and banks' balance sheets in the dynamics of the model, accumulation processes are introduced hereafter for the firm's net wealth and for the bank's inside capital.

[14] Details on the explicit form of all optimization programs and their resolution are available on request in a separate Technical Appendix.

The firm's net wealth mainly comes from the accumulated benefits from a period to another, i.d. the value of the firm (VF_t). To keep the tractability of the model when passing to the general equilibrium, it is supposed that the entrepreneur also acts as employee on the labor market and perceives the wage (WF_t), which is added in the firm's net wealth.

$$NF_t = \gamma^F [VF_t + WF_t] \quad (5)$$

The coefficient γ^F in the equation (5) corresponds to the survival probability of the firm at the period *t*. As in all financial accelerator models, it is supposed here that a constant proportion $(1-\gamma^F)$ of firms leave the market each period. When living the market, the entire net wealth is used to consume final goods (CF_t):

$$CF_t = (1-\gamma^F)[VF_t + WF_t] = \frac{1-\gamma^F}{\gamma^F} NF_t \quad (6)$$

Besides, it can be shown that the value of the firm (VF_t) is given by the gross return on capital after the repayment of the debt and the associated interests to the lender:

$$VF_t = Q_{t-1} R_t^K K_t - \left[R_t^f + \frac{\mu^B G(\overline{\omega}_t^F) + \mu^A (1-\mu^B) G(\overline{\omega}_t^B)}{Q_{t-1} K_t - NF_{t-1}} Q_{t-1} R_t^K K_t \right] B_{t-1} \quad (7).$$

In (7), $\frac{\mu^B G(\overline{\omega}_t^F) + \mu^A (1-\mu^B) G(\overline{\omega}_t^B)}{Q_{t-1} K_t - NF_{t-1}} Q_{t-1} R_t^K K_t$ defines the external finance premium supported by the firm, and $\left[R_t^f + \frac{\mu^B G(\overline{\omega}_t^F) + \mu^A (1-\mu^B) G(\overline{\omega}_t^B)}{Q_{t-1} K_t - NF_{t-1}} Q_{t-1} R_t^K K_t \right]$ can be replaced by $S_{t-1}^F R_t^f$.

The bank inside capital comes also from the accumulated benefits of the intermediation activity, i.d. the intrinsic value of the bank (VB_t), and from small transfers (T_t^B) received from the banks that are supposed to leave the market in a proportion $(1-\gamma^B)$ each period[15]. If the bank leaves the market at the period t, a small part of its inside capital (t^B) is transferred to survival banks, the rest being used to consume final goods (CB_t). Relations (8) and (9) describe this behavior:

$$NB_t = \gamma^B VB_t + T_t^B \quad (8)$$

[15] In line with the other financial accelerator models, this assumption is also used to insure the tractability of the model, namely to give the possibility to new banks to have initial inside capital, necessary for the access to external financing.

$$CB_t = \left(1-\gamma^B\right)\left(1-t^B\right)VB_t = \frac{\left(1-\gamma^B\right)\left(1-t^B\right)}{\gamma^B\left(1-t^B\right)+t^B} NB_t \tag{9}$$

Similar to the relation (7) written for the firm, the bank's value $\left(VB_t\right)$ takes the form:

$$VB_t = R_t^K B_{t-1} - \left[R_t^f + \frac{\mu^A\left(1-\mu^B\right)G\left(\overline{\omega}_t^B\right)}{Q_{t-1}K_t - NF_{t-1} - NB_{t-1}} Q_{t-1}R_t^K K_t\right]A_{t-1} \quad (10),$$

where $\frac{\mu^A\left(1-\mu^B\right)G\left(\overline{\omega}_t^B\right)}{Q_{t-1}K_t - NF_{t-1} - NB_{t-1}} Q_{t-1}R_t^K K_t$ is an expression of the bank's external finance premium and $\left[R_t^f + \frac{\mu^A\left(1-\mu^B\right)G\left(\overline{\omega}_t^B\right)}{Q_{t-1}K_t - NF_{t-1} - NB_{t-1}} Q_{t-1}R_t^K K_t\right]$ is to be replaced by $S_{t-1}^B R_t^f$, for S_{t-1}^B given in (4).

To characterize the equilibrium on credit market, the previous individual relations must be submitted to an aggregation procedure at a national level. With a constant return to scale assumption for the Cobb-Douglas technology used by firms and with an equivalent condition defined for the banks' activity, the form of these equations remain unchanged after aggregation[16]. In the following paragraph, they will be integrated in the general equilibrium model.

2.3 General equilibrium

In this paragraph, the partial equilibrium solved on the credit market in embedded in a dynamic stochastic general equilibrium model of a two-country monetary union. Each country is inhabited by a continuum of infinitely-lived agents represented by the unit interval. They choose consumption $(C)$and leisure (L) and determine the worming period $(H = 1-L)$ remunerated at a real rate W. The one period utility function is given by:

$$U\left(C_t, H_t\right) = \frac{\sigma_c}{\sigma_c - 1} C_t^{\frac{\sigma_c - 1}{\sigma_c}} - \frac{\sigma_h}{\sigma_h + 1} H_t^{\frac{\sigma_h + 1}{\sigma_h}} \quad (11),$$

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

The consumption is a composite index which depends on the consumption of goods domestically produced or produced in the other country of the union. The provenience of goods is represented by the indexes 1 and 2, while C and C^* denote the consumption of different goods in the first and in the second country of the union, respectively. We also note by $\gamma \in [0,1]$, the relative preference for the consumption of domestic produced goods, in each country.

[16] See *Bernanke & al. (1999)* or *Sunirand (2003)* for more details on the aggregation procedure.

$$C=\frac{C_1^{\ \gamma}C_2^{\ 1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}\ ;\ C^*=\frac{(C_1^*)^{1-\gamma}(C_2^*)^{\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}} \qquad (12)$$

Price indexes for the two countries are respectively defined by: $P=P_1^{\ \gamma}P_2^{\ 1-\gamma}$ 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 and other financial investment at the risk-free interest rate, which maximizes an intertemporal utility function, based on (11), subject to the following budget constraint:

$$P_tC_t+P_tD_t+A_t\le P_tW_tH_t+A_{t-1}R_t^A+P_tD_{t-1}R_t^f-T_t+\Pi_t \qquad (13)$$

In (13), $R_t^A=1+r_t^A$ and $R_t^f=1+r_{t+1}^f$ denote respectively the gross 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, and the first order conditions associated to C_t, D_t, A_t and H_t appear in the following table:

Table 1. First order conditions for the households' optimization

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

At the optimum, there is no arbitrage for the household. Moreover, the following condition is fulfilled into the union: $(R_{t+1}^f)E_t\left[\frac{P_{t+1}}{P_t}\right]=(R_{t+1}^{f*})E_t\left[\frac{P_{t+1}^*}{P_t^*}\right]$, allowing to write:

$$C_t=C_t^*(\Theta_t)^{\sigma_c} \qquad (14),$$

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

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

$$Y_t = a_t K_t^{\alpha} L_t^{1-\alpha} \text{ and } Y_t^* = a_t^* \left(K_t^*\right)^{\alpha} \left(L_t^*\right)^{1-\alpha} \qquad (15),$$

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 imput in (15) is a composite index of households labour (H_t) and entrepreneurial labour (H_t^F): $L_t = H_t^{\Omega}\left(H_t^F\right)^{1-\Omega}$. As briefly introduced in the previous paragraph, we assume here that, in addition to operating firms, entrepreneurs supplement their income by acting as suppliers on the labour market. They are remunerated on this market at a rate W^F, and the total entrepreneurial labour is normalized to unity. This assumption allows the wholesale producers to have baseline revenue to borrow immediately; otherwise, they should face unrealistic external finance premium level.

In each country, the investment (I_t) is supposed to concern domestic produced goods[17]. The accumulation of physical capital is introduced by the standard equation:

$$K_{t+1} = (1-\delta)K_t + I_t \qquad (16),$$

where δ is the depreciation rate of the capital.

It is also assumed that there are some internal capital adjustment costs $\Phi(\cdot)$, given by:

$$\Phi(I_t, K_t) = \frac{\phi}{2}\left(\frac{I_t}{K_t} - \delta\right)^2 K_t \text{, for } \phi > 0 \qquad (17)$$

Noting $\rho_t = \frac{P_{1,t}^{\omega}}{P_{1,t}}$ the relative price of wholesale goods produced in the first country of the union, 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 maximization of the expected discounted sum of domestic firms operating income flows give the following first order conditions relative to H_t, H_t^F, I_t and K_{t+1} respectively. The first two conditions define the labour demands. The third gives the price of a unit of capital relative to the 1 price final good. The last relation in the table represents the expected gross return to holding a unity of capital from t to $t+1$. 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.

[17] Taking it as a composite index of goods produced in the two countries of the union, similar to the consumption index, would not significantly change the results of the model.

Table 2. First order conditions for firms' optimization

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

(*) 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* $(1-\gamma)$.

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

$$\hat{\pi}_{1,t}=\beta E_t\left[\hat{\pi}_{1,t+1}\right]+\kappa\hat{\rho}_t \text{ and } \hat{\pi}_{2,t}=\beta E_t\left[\hat{\pi}_{2,t+1}\right]+\kappa\hat{\rho}_t^* \qquad (18),$$

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

Financial imperfections on the credit market are then introduced in the present general equilibrium model, by considering, after aggregation, the equations (3) to (10), described in the previous paragraph of the paper. Because the firms' investment in new capital is conditional to the external financing, the demand for capital in the economy depends on the tightness of the constraints imposed on the credit market. Imperfections on this market make the cost of external financing more sensitive to the financial situation of agents, amplifying the transmission of shocks on the real economy, as we will see in the following sections of the paper.

The equilibrium relations on the national goods markets are:

$$Y_t=\Theta_t^{\frac{1-\gamma}{2\gamma-1}}C_t\left[\gamma+(1-\gamma)\Theta_t^{1-\sigma_c}\right]+I_t+G_t+CF_t+CB_t \qquad (19)$$

$$Y_t^*=(\Theta_t)^{\frac{\gamma}{1-2\gamma}+\sigma_c}C_t^*\left[(1-\gamma)+\Theta_t^{1-\sigma_c}\gamma\right]+I_t^*+G_t^*+CF_t^*+CB_t^* \qquad (19'),$$

while the national labour markets equilibrium implies:

$$\left(H_t\right)^{\frac{\sigma_h+1}{\sigma_h}} = \left(C_t\right)^{-\frac{1}{\sigma_c}} \rho_t \left(\Theta_t\right)^{1-\gamma} \Omega(1-\alpha)Y_t \quad (20)$$

$$\left(H_t^*\right)^{\frac{\sigma_h+1}{\sigma_h}} = \left(C_t^*\right)^{-\frac{1}{\sigma_c}} \rho_t^* \left(\Theta_t\right)^{\gamma-1} \Omega(1-\alpha)Y_t^* \quad (20').$$

National governments are responsible for the budgetary policy. They decide the level of government expenditures, financed by lump-sum taxes. Equations (21) and (21') define active budgetary policy conducted by governments:

$$\hat{g}_t = \rho_g \hat{g}_{t-1} + \rho_\pi \hat{\pi}_t + \rho_y \hat{y}_t + \varepsilon_g \quad (21)$$

$$\hat{g}_t^* = \rho_g^* \hat{g}_{t-1}^* + \rho_\pi^* \hat{\pi}_t^* + \rho_y^* \hat{y}_t^* + \varepsilon_g^* \quad (21'),$$

where $\rho_g, \rho_g^* < 1$, $\rho_\pi, \rho_\pi^* < 0$ represents the reaction coefficients of the budgetary policy to national inflation deviation from the steady-state, $\rho_y, \rho_y^* < 0$ are the coefficient of reaction to the output-gap deviation from the steady-state, and $\varepsilon_g, \varepsilon_g^*$ are random shocks with zero mean and unit standard deviation. If $\rho_\pi, \rho_\pi^* = 0$ and $\rho_y, \rho_y^* = 0$, there is no active policy in the economy, and government expenditures follows a standard autoregressive process.

Finally, the *common central bank* conducts a unique monetary policy for the two countries of the union. It chooses the nominal interest rate, by means of an interest rate rule oriented towards the price stability for the union as a whole:

$$\hat{r}_t^n = \beta_0 \hat{r}_{t-1}^n + (1-\beta_0)\beta_1 \hat{\pi}_t^{UM} + \varepsilon_r \quad (22),$$

where $\hat{\pi}_t^{UM} = \frac{1}{2}\left(\hat{\pi}_t + \hat{\pi}_t^*\right)$. The $\beta_1 > 0$ coefficient corresponds to the reaction of the monetary policy to the union-wide inflation deviation from the steady-state level; $\beta_0 \in (0;1)$ is the smoothing coefficient of the nominal interest rate; and ε_r is a random variable of zero average and standard deviation equal to 1, corresponding to an exogenous monetary shock (see *Clarida & al., 1998)*.

Definition of the financial shock

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, differ temporarily from its fundamental value Q_t, because of a temporary financial shocks $\left(\varepsilon_q\right)$, such that:

$$Q_t^m = Q_t + \varepsilon_q \quad (23),$$

with ε_q 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 again[18]. 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:

$$R_t^{Km} = \frac{\rho_t (\Theta_t)^{1-\gamma} \alpha \frac{Y_t}{K_t} - \frac{\phi}{2}\left(\delta^2 - \left(\frac{I_t}{K_t}\right)^2\right) + (1-\delta) Q_t^m}{Q_{t-1}} \quad (24).$$

Moreover, Q_t^m replaces Q_t in the equations (3), (4), (5) and (8), 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 rational 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). In the absence of financial shock, the *"abnormal"* return on capital coincides with the fundamental one.

Finally, the model is log-linearized around its steady state. The calibration for the parameters and the variables (or ratio) at their steady-state is made according to the references found in the literature for the euro area. Ratios such as capital/GDP, investment/GDP or total consumption expenses/GDP are all compatible with the estimations made for the euro area by *Fagan & al. (2001).* As in *Bernanke & al. (1999),* the calibration corresponding to the financial side of the model requires a reference value for the firms' financial leverage, for their probability of default and for the average external finance premium $\left(r^K - r^f\right)$. Moreover, the steady-state value for the banks' leverage (inside capital/loans ratio: $\frac{NB}{B}$) and for their default probability need to be fixed. It is realistically supposed that banks have a lower probability of default than firms and that the ratio $\frac{NB}{B}$ belongs to the interval $[0.1,0.2]$.[19] Finally, the probability for a bank to leave the credit market is lower that for firms, and the audit is more costly for households than for banks (what justifies the presence of banks in the economy).

[18] Then, the financial shock corresponds to a one-period financial bubble, whereas *Bernanke & Gertler (1999)* and *Levieuge (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.

[19] See, for example, the numerical values used by *Sunirand (2003)* or by *Levieuge (2009)* in a model with the bank capital channel, calibrated for the euro area.

The log-linearized form of the model is then used to study the impact of the financial heterogeneity in this monetary union and the potential role of macroeconomic policies to mitigate its negative effects.

3 Financial asymmetries and transmission of shocks inside the union

In order to understand the implications of the financial heterogeneity in the monetary union, we start the analysis by introducing the main transmission channels of shocks that explain asymmetries in the model dynamics. We than analyze the sensitivity of the national dynamics to the degree of the union's financial heterogeneity. We finally discuss the cost associated to the participation of a given country to such an asymmetric monetary union. Financial structural heterogeneity is reproduced by assuming that the *banks financial leverage* at their steady-state and the *sensibility coefficient of the banks' external finance premium to their financial structure* $\left(\psi_B^s\right)$ are different in the two countries.

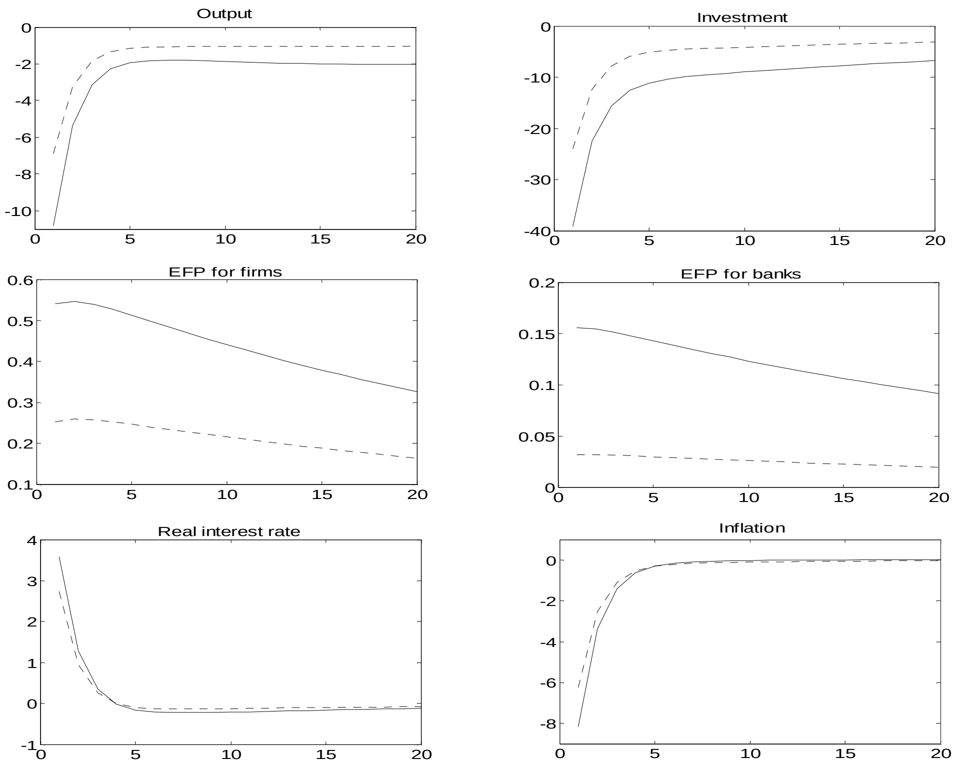
3.1 Transmission channels of shocks and dynamics of the model

We assume in this paragraph that the banking system in country 2 is better capitalized than in country 1 $\left(\frac{NB^*}{B^*}=0.2>0.15=\frac{NB}{B}\right)$. As discussed in the calibration (*Appendix 2)*, if the corresponding monitoring costs are seven times lower for banks than for households in country 2, the gap is even higher in country 1. This means that it is more advantageous for households to entrust their saving to banks and the need to keep inside capital is lower for these banks. On the other hand, the higher auditing cost for households $\left(\mu^A\right)$ could be associated to an increased aversion they have to changes in the banks' financial structures. In other words, the country 1 could be characterized by an external finance premium for banks more sensitive to changes in their leverage, compared to country 2[20]. We thus choose $\psi_B^S=0.002$ and $\psi_B^{S*}=0.001$ for the baseline calibration of the model. To well distinguish the role of the asymmetric bank capital channel in the union, we suppose that all elements of the model directly linked to the firms' balance sheet channel (the firms' leverage or the sensitivity coefficients for the firms' external finance premium) are identical in the two countries. So, besides the symmetrical financial accelerator related to the firms' financial situation, we expect to obtain an additional (asymmetrical) financial accelerator due to the banking sectors (heterogeneity).

[20] The cumulative consideration of the two sources of asymmetry represents a choice that allows observing more easily the effect of financial heterogeneity on the shocks transmission within the union. But, as we will see in the following paragraph, the two asymmetries could also be analyzed separately.

This is what is verified in the *Figure 1*, which represents the dynamics of the two member countries of the union face to a restrictive common monetary shock.[21] As expected, the increase of the nominal interest rate temporarily inhibits the real activity. Investment and consumption are both reduced in the two countries, inflation falls and the national real interest rates go up. The manifestation of the asymmetric bank capital channel is obvious.

Figure 1. Impulse response functions to a monetary shock



- - - - Country 2: Weak bank capital channel $\left(NB/B = 0.2; \psi_B^s = 0.001\right)$

—— Country 1: High bank capital channel $\left(NB/B = 0.15; \psi_B^s = 0.002\right)$

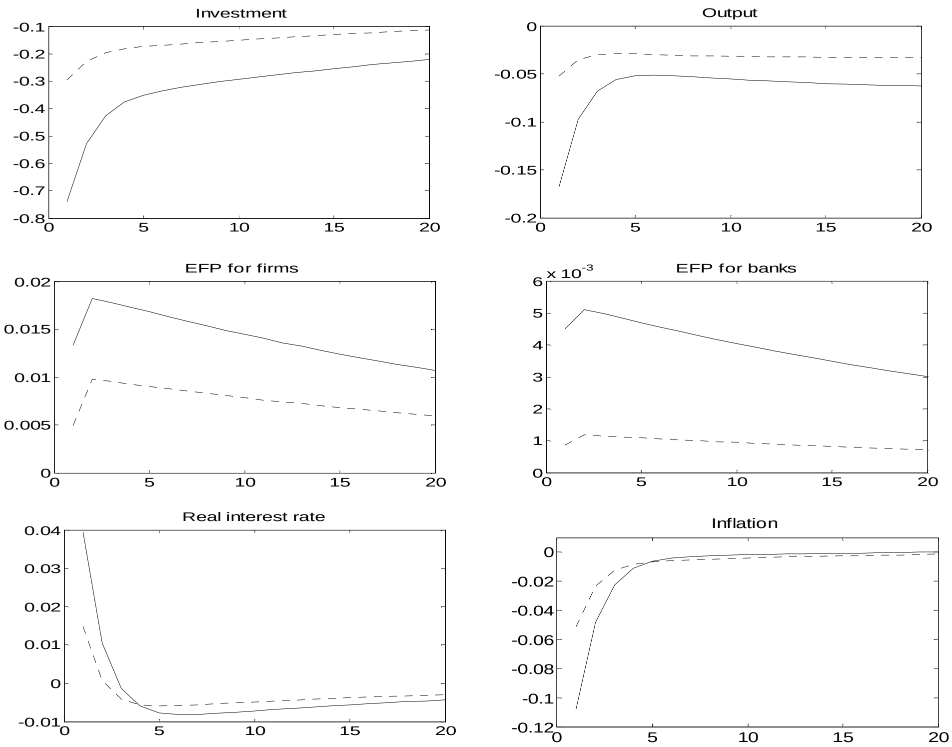
Actually, country 1 is more affected by the shock[22]: banks' external finance premiums are more reactive to the shock and their increase is passed on to the firms' premiums. This in turn tightens credit conditions for firms. Therefore, demand for capital, investment and output decline. And the drop of aggregate demand leads to a further decrease of the inflation rate in country 1, compared with country 2. Thus, the banking system plays an essential role in the model. Despite the low calibrated values for the elasticity of banks' finance premium to their

[21] Note that the *Blanchard-Kahn* conditions are satisfied; the model has a unique and stable trajectory.
[22] Remember that in country 1, the financial leverage of the banking sector is lower and the banks' external finance premium is more sensitive to variation of national banks' balance sheet structures.

respective balance sheet structures, the asymmetries in the national reaction to shock are nevertheless large. The investment and the output decreases are almost 60% more important in country 1, compared with country 2, and the inflation decrease is 30% higher.

Large asymmetries are observed whatever the shock (technological, budgetary or financial). Typically, the *figure 2* depicts the impulse response functions of the main macroeconomic aggregates in the two countries of the union, face to an unexpected fall in the market value of the physical capital (Q_m).[23]

Figure 2. Impulse response functions to a negative financial shock



---- Country 2: Weak bank capital channel $\left(NB/B = 0.2; \psi_B^s = 0.001\right)$

—— Country 1: High bank capital channel $\left(NB/B = 0.15; \psi_B^s = 0.002\right)$

This shock negatively affects the agents' net worth, their financial position and the external finance premiums they must bear. Once again country 1 is more affected than country 2. Two factors contribute to these dissimilar national adjustments. First, national banks face higher external finance premium in country 1 because of their deeper financial fragility and because of the higher sensitivity coefficient ψ_B^s to their balance sheet structure. The cost of the firms'

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[23] The results obtained for the simulation of technological or budgetary shocks are available on request.

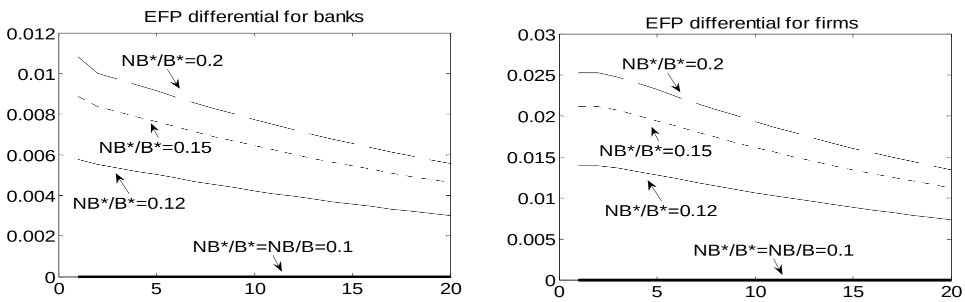
external finance is subsequently higher, reducing the incentive to invest and the aggregate demand in turn. As a result, inflation falls more in country 1.

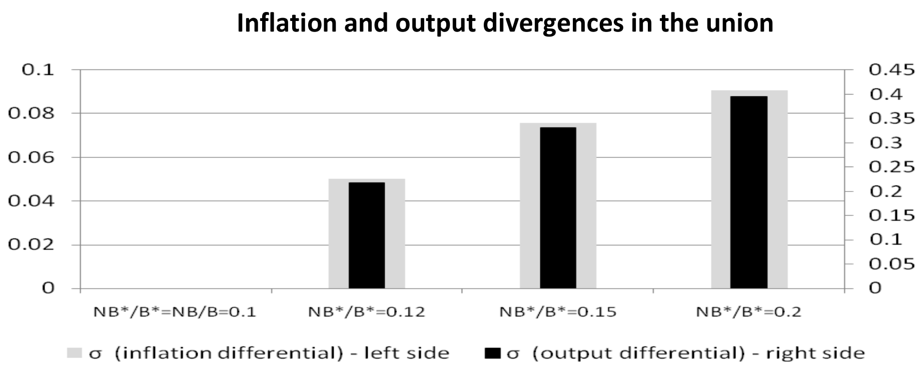
Second, as the Central Bank reduces the nominal interest rate accordingly to the average inflation rate, one can observe a higher increase of real interest rate in country 1 compared to country 2. In the absence of union, the national Central Bank of the country 1 would have cut its policy rate more than do a common Central Bank (with average objectives). This reinforces the adverse effects of the initial shock, as the higher the real interest rate, the lower the investment incentives for firms, the lower the present consumption incentives, and the lower the aggregate demand. Subsequently, the investment drop is more than 100% higher in country 1, and inflation and output divergences are important within the union.

3.2 Sensitivity of the economies to the degree of financial heterogeneity

In addition, it is not difficult to prove that the more heterogeneous the union is, the larger the effect of financial asymmetries on the transmission of shocks. *Figures 3* and *4* separately represent the impact of the two financial asymmetries discussed previously about the transmission of a symmetric (negative) financial shock. Two sources of financial asymmetries are analyzed: *asymmetric banking system leverage* and *asymmetric sensitivity coefficient of the banks' finance premium to their financial leverage*, respectively.

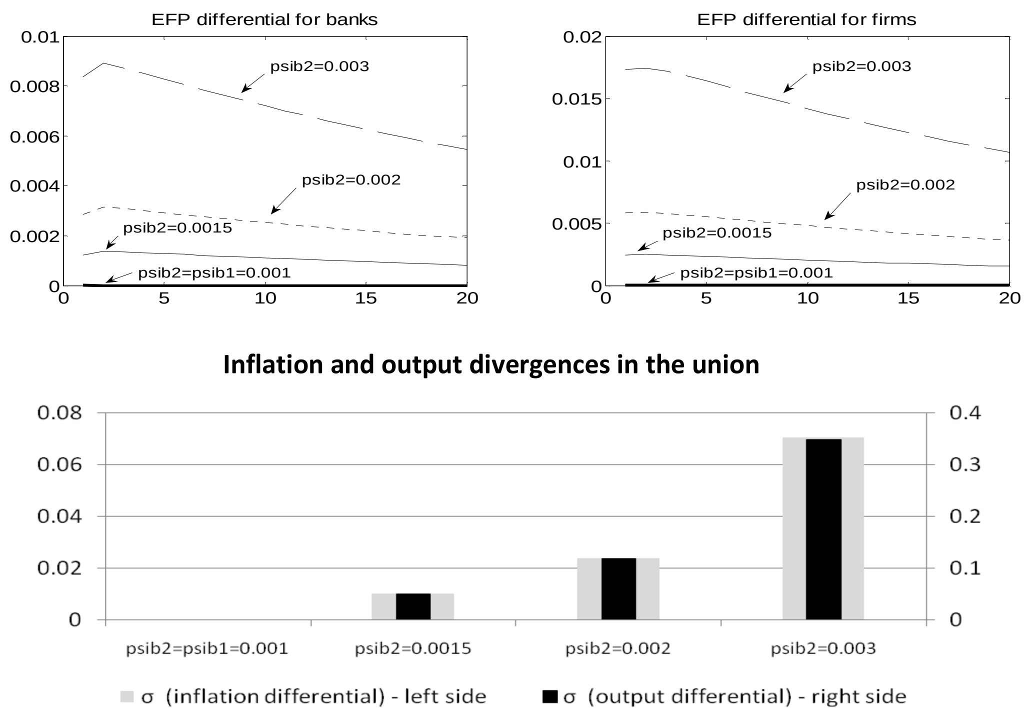
Figure 3. Impact of the banking system leverage asymmetry on the model dynamics





The *figure 3* consists in analyzing the sensitivity of the economies to the differences in terms of national banking systems leverage, which Take the value 0.1 for country 1, while it varies within the interval $[0.1,0.2]$ for country 2. In order to isolate the effect of the national banking systems leverage, the elasticity coefficient for the banks' external finance $\left(\psi_B^s\right)$ is now fixed to 0.002 for the two countries. The national differential in the banks' and firms' finance premiums (higher for country 1 than for country 2) are depicted on the first two graphs. In the first two graphs of figure 4, it clearly appears that the higher heterogeneity between national banks' financial structures, the higher external financial premiums differential (for banks and firms). Consequently, as illustrated by the last graph of the *figure 3*, which represents the variance of inflation and output differentials under the four scenarios considered, higher financial heterogeneity implies significant higher inflation and output divergences among member countries. The *figures* in *Appendix 3* echo this numerical experiment. They show that the common equity to risk-weighted assets ratio was in average weaker for U.S. banks than for European ones during the subprime mortgage crisis. As a result, U.S. banks had to bear a higher external financial premium, as indicated by the AA-rated bank bond index spreads relative to government bonds. The same empirical evidence might be noted between the EMU members.

Figure 4. Impact of the sensitivity coefficients heterogeneity on the model dynamics



Now, similar results are obtained if the financial heterogeneity is not related to the banks' financial leverage anymore, but comes from the elasticity of the finance premium for banks to their financial structure. Then, it is assumed that the $\frac{NB}{B}$ ratios are identical and equal to 0.15 in the two countries, while ψ_B^s is fixed to 0.001 for country 1, and varies within the interval $[0.001, 0.003]$ for country 2. The external finance premiums will now be higher in country 2 than in country 1. Differentials are represented in absolute value. Once again, higher heterogeneity in the sensitivity of the national banks' premiums to their balance sheet structure is associated to more asymmetric transmission of the financial shock inside the union, and to higher inflation and output divergences among member countries.

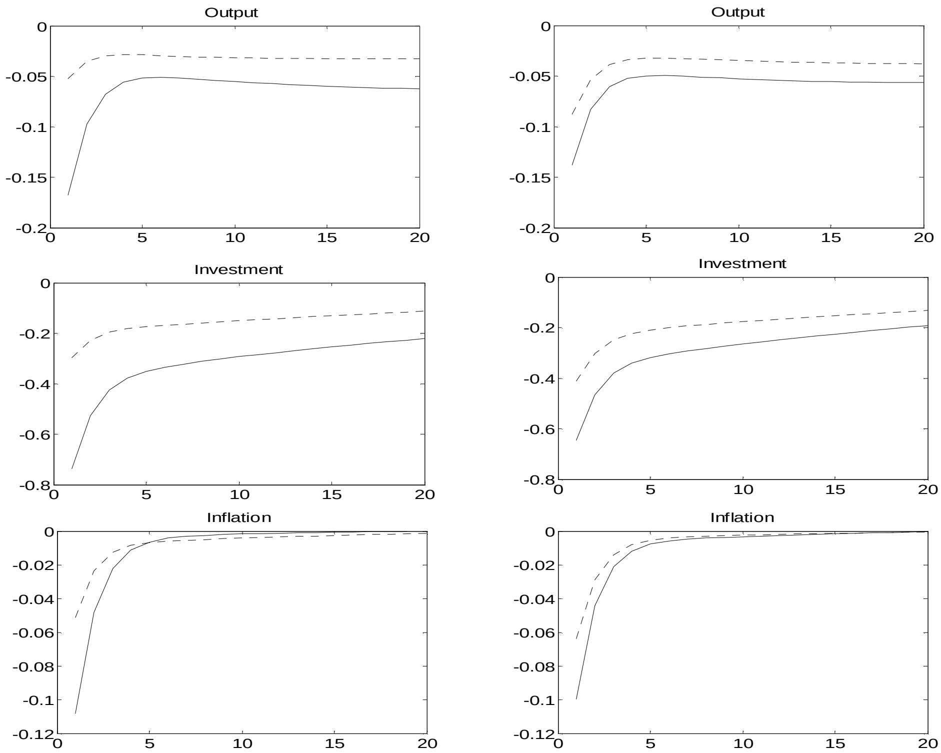
3.3 The costs of a heterogeneous monetary union

Exploring further the lessons provided by the model, it can be demonstrated that the conduct of a single monetary policy for the (financially asymmetric) union as a whole is responsible for a large part of the national divergences.

In *Sunirand (2003)* and *Levieuge (2009)*, following a monetary shock in a single economy model, the variation of output was roughly 20-25% higher when the bank capital channel was taken into account (compared with a baseline model exempt from this channel). Here, conclusions from a preliminary comparative study of the impulse response functions to a monetary shock using an asymmetric/symmetric monetary union model are the following. When considering a symmetric shock in an asymmetric union with single monetary policy, the reaction of the output of the country 1 is 60% higher than in country 2 (as depicted in *figure 1*). But, if each country conducted autonomously its monetary policy, the output response in the country 1 (stronger affected by the bank capital channel) would be only 20% higher than in country 2. This result can be easily obtained from the study of the shock dynamics in the symmetric monetary union model. The stabilization bias of the common monetary policy due to asymmetries disappears in this case, and the model provides results comparable to those obtained by *Sunirand (2003)* and *Levieuge (2009)*. Indeed, supposing that the financial features of the union replicate the credit market characteristics of the previous country 1 (country 2), its reaction to shock would also correspond to that of a country with high (weak) bank capital channel and autonomous conduct of the monetary policy.

Figure 5 illustrates similar results in a context of negative and symmetric financial shock. It appears that the country with weak bank capital channel, which is implicitly less affected by shocks under an autonomous conduct of the monetary policy, benefits from the membership to an asymmetric monetary union and becomes even less sensitive to shocks in this situation. For the country with high bank capital channel, the participation to the asymmetric monetary union comes, on the contrary, with a higher reaction to shocks compared to the national conduct of the monetary policy. A single monetary policy that only reacts to average variables of an asymmetric union thus worsens the cyclical divergences among member countries.

Figure 5. Centralized monetary policy and macroeconomic divergences



Asymmetric monetary union:
- - - - Country 2: weak bank capital channel
—— Country 1: high bank capital channel

Symmetric monetary union:
- - - - Country 2: weak bank capital channel
—— Country 1: high bank capital channel

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 to this end, how national budgetary policies have to be combined.

4 Macroeconomic policies to mitigate the effects of financial heterogeneity

Starting from the empirical evidences on the financial heterogeneity of the euro area, provided in the introduction of the study, this last section proposes an application of the previous model to study the macroeconomic policies in a monetary union driven by rules similar to that introduced by the Treaty on the European Union. We thus suppose an independent common central bank whose policy is responsible for the union-wide price stability and decentralized budgetary policies conducted by the national governments.

According to the definition given to the ECB independence in the *Article 130* of the *Treaty*, the central bank does not cooperate with the national governments and imposes its policy to all member states. We define different alternative strategies for monetary policy (centralized vs. based on national information) and for governments (budgetary cooperation vs. autonomous conduct of national budgetary policies). Then, we combine them in a sequential game, where the central bank chooses its strategy at the beginning of the game, and national governments observe the orientation of the monetary policy and define afterwards their policies. For each policy-mix analyzed, the coefficients of simple monetary and budgetary rules are optimized, and their opportunity for the union is evaluated.

In the analysis of a *monetary policy*, solely oriented towards the union-wide price stability, the common central bank is supposed to optimally choose the value for the coefficients β_0, β_1 in the previous monetary rule (22). The optimization criterion these coefficients must fulfill depends on the monetary policy strategy.

In a *centralized strategy*, the central bank stabilizes only the average inflation for the union, and is not concerned by national divergences. In order to introduce a positive coefficient β_0 in the monetary rule (in line with the empirical results for the euro area[24]), we also consider a monetary objective concerning the smoothing of the nominal interest rate. The monetary policy loss function that β_0, β_1 should minimize is:

$$L^{BC} = \mathrm{var}\left(\hat{\pi}^{UM}\right) + \lambda_r \ \mathrm{var}\left(\Delta \hat{r}^n\right) \qquad (25),$$

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

A *monetary strategy based on national information* amounts to the situation when the central bank is simultaneous concerned by the union-wide inflation stabilization and by the stabilization of the inflation differentials inside the union (*Badarau-Semenescu & al., 2009).* The loss function that β_0, β_1 should minimize becomes:

$$L^{BC} = \mathrm{var}\left(\hat{\pi}^{UM}\right) + \mathrm{var}\left(\hat{\hat{\pi}}^{UM}\right) + \lambda_r \ \mathrm{var}\left(\Delta \hat{r}^n\right), \text{ for } \hat{\hat{\pi}}_t^{UM} = \frac{\hat{\pi}_t - \hat{\pi}_t^*}{2} \qquad (26)$$

[24] See *Sauer & Sturm (2007)*, *Fourçans & Vranceanu (2007)* or *Licheron (2009)*, for example.

The *budgetary policy* is introduced in the analysis by means of active budgetary rules defined by (21) and (21'). Each national government chooses the optimal coefficients ρ_g, ρ_y and ρ_π, such as to minimize national expected loss-functions with the general form[25]:

$$L^G = \lambda_\pi^G \operatorname{var}(\hat{\pi}) + \lambda_y^G \operatorname{var}(\hat{y}) + \lambda_g^G \operatorname{var}(\hat{g}) \qquad (27),$$

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

This is the case of an *autonomous conduct of national policies* in the union. This situation characterizes a *non-cooperative budgetary policy regime*. After observing the monetary policy orientation, each national government determines the optimal value of the budgetary rule coefficients, by minimizing a national loss function (27). The public expenditures of the other country of the union are treated as exogenous in the optimization program.

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

$$L^{Coop} = \frac{1}{2}\left(L^G + L^{G*}\right) \qquad (28)$$

According to the provisions of the new Treaty of Lisbon, entered into force on 1st December 2009, national governments has the autonomy in the conduct of the budgetary policy for their own country, but they must however respect a global orientation decided at the union-wide level. Such a global orientation consists of defining the main objectives and the priorities for the budgetary policy. This corresponds, in the present model, to the fact that, in (25), λ_π^G, λ_y^G and λ_g^G are identical for all national government. It is here *an implicit coordination mechanism that affects not only the cooperative budgetary regime, but also the non-cooperative one*.

Simple optimal rules for the monetary policy

The common central bank chooses its monetary policy in priority, independently of the national governments actions. The results of the optimization procedure for the monetary rule coefficients, under the two alternative strategies defined above, are summarized in the table below:

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[25] Such form of governments' loss functions is also considered in *Villieu (2008)*. See *Van Aarle & al. (2002), Leitemo (2004)* ou *Vogel & al. (2006)* for potential reasons to the presence of a public expenditures stabilization objective in the budgetary policy loss functions.

Table 3. Optimal coefficients for the monetary policy rule

optimal β_1 with centralized strategy	**optimal β_1 with strategy based on national information**
1.45704	1.43749

We are interested here in the reaction of the monetary policy only to symmetric shocks that may hit the union (technological or financial shocks, acting as supply/demand shocks[26]). To facilitate the optimization, we fix the smoothing coefficient β_0 in the monetary rule to 0.96, value consistent with the estimations recently made for the ECB policy by *Sauer & Sturm (2007)*, *Fourçans & Vranceanu (2007)* et *Licheron (2009)*. We then search for the optimal coefficient β_1 that minimizes the monetary loss function. As expected, the centralized monetary policy appears to be more reactive to symmetric shocks than a policy that takes into account the specific situation of member countries[27].

Simple optimal rules for budgetary policies

After the central bank announces the orientation of the monetary policy (the monetary rule coefficients become public), national governments optimize their budgetary decisions. We seek to consider the reaction of the budgetary policies to symmetric (monetary, technological or financial) shocks that may hit the union. The results of the numerical optimization of the budgetary rules coefficients are summarized in *Tables 4 and 5*, under the assumption that the central bank conducts a centralized policy[28]. If the solution for the non-cooperative budgetary regime appears in *Table 4, Table 5* is dedicated to cooperative national budgetary policies.

It clearly appears from *Table 4* 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 country 1. Or, in the calibration of the model, the banking system in country 1 was assumed to be more instable, and the economy more affected by negative shocks because of the amplitude of the financial accelerator mechanisms. It thus needs more stabilization by the budgetary policy, and it is exactly what the government does by choosing higher corresponding coefficients in the budgetary rule. This means that, *with a simple non-cooperative budgetary regime, national governments could play an active role in avoiding asymmetries in the transmission of shocks due to the structural heterogeneity of the union.*

[26] Accordingly to the Treaty's provisions for the monetary policy, budgetary shocks are not included in the optimization. It is thus supposed that the central bank does not take into consideration the actions of the national governments, when deciding its policy.

[27] For asymmetric shocks, the situation reverses. They are better stabilized under a monetary policy oriented to reduce inflation divergences inside the union, than under a centralized monetary policy.

[28] Results for the announcement of an inflation divergences oriented monetary policy are quite similar and the tables of results are moved in the *Appendix 4* of the paper.

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

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

Unlike the non-cooperative regime, optimal cooperative budgetary rules are not consistent with the stabilization needs of member countries. For example, the coefficient associated to the inflation gap in the country 2 budgetary rule 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**
$\lambda_\pi^G = 1; \lambda_y^G = 1.5; \lambda_g^G = 0.5$	$\rho_g = 0.1779$ $\rho_y = -0.1901$ $\rho_\pi = -0.5985$	$\rho_g^* = 0.6051$ $\rho_y^* = -0.0632$ $\rho_\pi^* = 0.2576$
$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.5$	$\rho_g = 0.2079$ $\rho_y = -0.1237$ $\rho_\pi = -0.4442$	$\rho_g^* = 0.5625$ $\rho_y^* = -0.0459$ $\rho_\pi^* = 0.2049$
$\lambda_\pi^G = 1; \lambda_y^G = 1; \lambda_g^G = 0.1$	$\rho_g = 0.1929$ $\rho_y = -0.5955$ $\rho_\pi = -1.6366$	$\rho_g^* = 0.9225$ $\rho_y^* = -0.0445$ $\rho_\pi^* = 0.048$

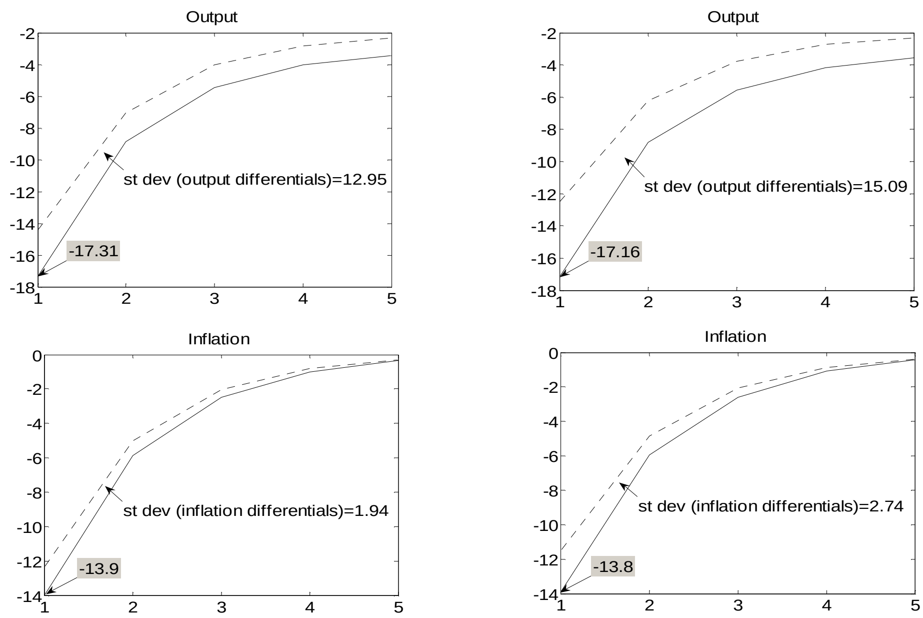
At first glance this result seems counter-intuitive, but, in fact, there's nothing surprising about it. Applying the result of *Badarau-Semenescu & al. (2009)* to a more general situation, it is not difficult to prove that the cooperative loss function L^{Coop} can be alternatively written as:

$$L^{Coop} = \lambda_\pi^G \operatorname{var}\left(\hat{\pi}^{UM}\right) + \lambda_y^G \operatorname{var}\left(\hat{y}^{UM}\right) + \lambda_g^G \operatorname{var}\left(\hat{g}^{UM}\right) + \lambda_\pi^G \operatorname{var}\left(\hat{\hat{\pi}}^{UM}\right) + \lambda_y^G \operatorname{var}\left(\hat{\hat{y}}^{UM}\right) + \lambda_g^G \operatorname{var}\left(\hat{\hat{g}}^{UM}\right) \qquad (29)$$

There are in this function implicit 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. It is the correct interpretation for the positive sign of the national inflation stabilization in the budgetary rule of country 2.

Consequently, the cooperative budgetary regime is not necessarily suitable in an asymmetric monetary union. National variables risk to be less stabilized than in a non-cooperative regime and, as shown in *figure 6*, this can be true for the two countries of the union.

Figure 6. National responses to a restrictive monetary shock[29]



Cooperative budgetary regime | Non-cooperative budgetary regime

——— *Country 1* - - - - -*Country 2*

Indeed, in country 2, the lower stabilization of the national inflation and output comes from the government reaction to inflation divergences in the union. Because national government expenditures diminish to reduce inflation divergences, the stabilizing effect of the policy on the output is also affected. In country 1, the lower stabilization of the national variables is explained by the reaction of the budgetary policy to government spending divergences in the union. This

[29] For $\lambda_\pi = 1; \lambda_y = 1.5; \lambda_g = 0.5$.

reduces the amount of the public expenditures in the cooperative regime compared to the non-cooperative one, with less stabilizing effect on the economy.

The last exercise proposed in this paper is to jointly analyze the opportunity of different monetary/budgetary policies in the union. Combining *centralized/inflation divergences oriented* monetary policies and *cooperative/non-cooperative* budgetary policies, conducts to four policy-mixes, evaluated by the expected level of the social loss function they offer to the union.

The evaluation criterion is the union-wide social loss function calculated by the average of the member countries national social loss functions:

$$EL_S = \frac{1}{2}\left[\lambda_y^S \operatorname{var}(\hat{y}) + \lambda_\pi^S \operatorname{var}(\hat{\pi}) + \lambda_g^S \operatorname{var}(\hat{g}) + \lambda_y^S \operatorname{var}(\hat{y}^*) + \lambda_\pi^S \operatorname{var}(\hat{\pi}^*) + \lambda_g^S \operatorname{var}(\hat{g}^*)\right] \quad (30),$$

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

The evaluation results of the different policy-mixes for the union are reported in *Table 6.*

Table 6. Expected social loss comparison for alternative policy-mixes

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

* $EL_S^C =$ *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 second column of the table compares the expected losses issued from alternative budgetary regimes, independently of the monetary policy announced by the central bank, in three configurations concerning the value of the social loss function's coefficients. The third column compares the expected losses issued from alternative monetary strategies for the central bank, independently of the budgetary regime in the union.

When the social preferences for stabilization are the same with the governments' preferences, the expected loss of a centralized monetary policy is systematically lower than in the alternative case where the central bank would fight inflation divergences in the union. This proves that a change in the orientation of the actual ECB policy toward the consideration of national divergences in the monetary decision is not suitable in the euro area[30].

For the best budgetary regime, numerical values obtained in *Table 6* favour the cooperative regime over the non-cooperative one, only under the assumption of identical social and governmental stabilizing preferences in the union. 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.

Indeed, the separate computation of the relative loss obtained in terms of inflation and output stabilization prove the superiority of the non-cooperative regime, as expected from *figure 7*. Considering that social preferences mostly concern inflation and output stabilization, but differ from the public spending stabilization preferences of governments, seems to us a realistic assumption. It could simply be the effect of ad-hoc budgetary constraints such as imposed by the Stability and Growth Pact in the euro area, which does not necessarily represent the social preferences in the union.

5 Conclusions

This paper proposed a study of the monetary and budgetary policy in a heterogeneous monetary union with national structural asymmetries, by using a dynamic stochastic general equilibrium model. The asymmetries are specific to the banking sector and directly influence the functioning of the credit markets. It is namely assumed that the bank capital channel acts asymmetrically inside the union and induces a heterogeneous transmission of shocks. The analysis is realized in two steps. First, based on empirical previous results concerning the financial asymmetries in the European banking systems, a *DSGE* model for a two-country monetary union with financial asymmetries is constructed. Then, it is used to compare different monetary and budgetary policies strategies for this union. It thus appears that a *centralized monetary policy dominates a strategy concerned only by inflation divergences in the Union*,

[30] 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.

whichever of the budgetary regime is chosen. This conclusion confirms previous results in the literature, according to which the aversion of the common central bank to national divergences would be beneficial only if it focuses simultaneously the inflation *and* the output divergences. The aversion to inflation differential without any interest for output differentials in the Union does not necessary correspond to an improvement on the centralized policy.

As for the national governments, they must coordinate their policies so as to take into account national specificities. A stronger reaction to shocks is necessary for countries structurally more sensitive to shocks than others. A realistic system of national budgetary rules fulfilling this condition could come from decentralized policies, if national governments respect a common strategy for the conduct of their policies. Such strategy should define common priorities for different stabilization objectives for budgetary policies, corresponding to symmetric coefficients in the national loss functions. It also appears that, unlike the non-cooperative solution, the budgetary cooperation risks to be counterproductive for all members to the union.

Thus, applied to the euro area context, the model supports the idea of a centralized monetary policy conduct (rather than an inflation-divergences oriented policy) by the European Central Bank. It also emphasizes the importance of national budgetary policies face to structural heterogeneity of the monetary Union and proposes a simple coordination mechanism for these policies, that respects the conditions of the new Treaty of Lisbon entered into force on 1 December 2009.

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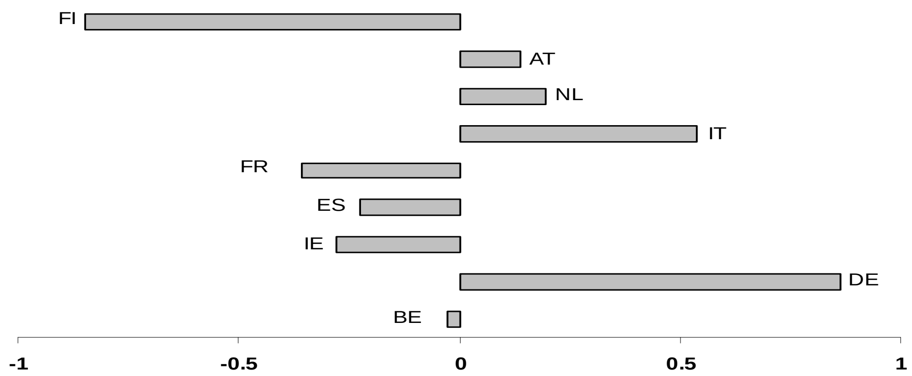
Appendix 1. *The bank capital channel heterogeneity in European countries (Badarau-Semenescu & Levieuge, 2010)*

Figure 1.1 depicts the results of a Principal Component Analysis employed to qualitatively compare the amplitude of the bank balance sheet channel in the European countries.

Figure 1.1 The extent of the bank capital channel in euro area countries

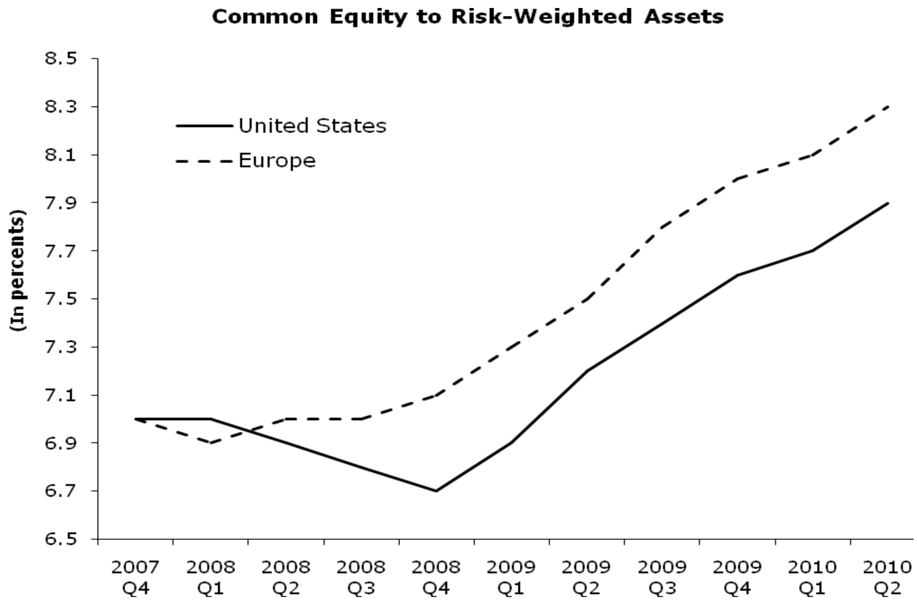


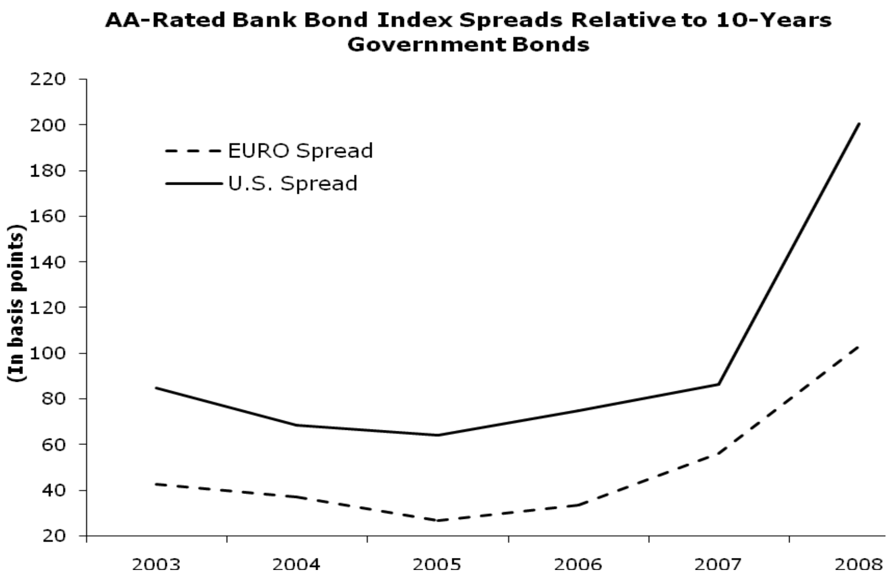
The analysis uses national data collected for nine European states, from 1999 to 2007. Indexes of concentration and competitiveness in the banking market, banks' balance sheet based structural indicators, indexes of the banking system profitability or liquidity, the importance of other financial markets (equity or corporate bonds markets) as substitute to the credit market, the existence of strong relationships among national banks, or the dependency of the domestic agents to the banking credit, are all considered in the study. After the extraction and the interpretation of the principal components, results are gathered and a cumulative score is calculated for each country. It is represented in the *figure 1.1* above. A high positive score is associated to high bank capital channel, while a negative score depicts countries with low bank capital channel compared to the union as a whole (which defines the origin 'zero' in the *figure 1*).

Appendix 2. *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 desutility	σ_h	0.32	0.32
Subjective discount factor	β	0.99	0.99
Part of retailers with unchanged prices on the period	ς	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 transferts 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
Steady State: Exogenous fixed values			
Real marginal cost	ρ	1/1.1	1/1.1
Banks nside 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	$F\left(\overline{\omega}^F\right)$	0.03	0.03
Banks probability of default	$F\left(\overline{\omega}^B\right)$	0.07	0.07
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	$\overline{\omega}^B$	0.52	0.52
ω threshold value for firms	$\overline{\omega}^F$	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 3. *The financial structure and the external finance premium for banks: A comparative analysis United-States / euro area*





Appendix 4. Budgetary policies optimization under inflation divergences-oriented monetary policy

Table 4.1 Optimal coefficients for non-cooperative budgetary policy rules

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

Table 4.2 Optimal coefficients for cooperative budgetary policy rules

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