International Journal of Economics and Financial Issues
Vol. 1, Nos. 1-2, **2020**, pp. 95-135

ARF INDIA
Academic Open Access Publishing
www.arfjournals.com

STABILIZATION OF DEMAND SHOCKS IN A MONETARY UNION: More Painful for which Heterogeneous Member Countries?

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Received: 30 January 2020 Revised: 7 February 2020 Accepted: 30 March 2020 Publication: 15 May 2020

Abstract: The current paper provides precise analytical results regarding the consequences of heterogeneities between the preferences or between the structural parameters of the member countries of a monetary union on monetary and budgetary policies, and on the stabilization of economic activity and inflation. After demand shocks, monetary or budgetary constraints reduce the potential economic stabilization, and economic activity and inflation are then higher (weaker) in a country affected by a positive (negative) demand shock. In this context, regarding the preferences of the budgetary authorities, we find that monetary unification could be more painful for a country with strong budgetary constraints, and with a high preference for stabilizing the budgetary deficit, and on the contrary with a weak preference for stabilizing economic activity and inflation. Besides, regarding structural heterogeneities, monetary unification could be more painful for a country with weak transmission mechanisms of monetary policy or with a weak budgetary multiplier. Membership in monetary union could also be more painful for the countries with the highest sensitivities of national prices to foreign prices, or with the weakest sensitivities of prices to national economic activity.

Keywords : monetary union, asymmetric demand shock, symmetric demand shock, economic stabilization

JEL classification numbers: E63, F44, F45

INTRODUCTION

In the framework of a monetary union, the common monetary policy may not be suitable to all member countries of the monetary union, and structural asymmetries may then result in asymmetric business cycles and economic conditions among the countries. Asymmetric shocks, asymmetric reactions, structural parameters and various sensitivities to symmetric shocks, to the common monetary policy, to the price competitiveness… result in a higher need of active and flexible budgetary policies, whereas in the framework of the European Monetary Union (EMU) for example, budgetary constraints have been introduced by the Stability and Growth Pact and the Fiscal Compact. Besides, currently, the EMU doesn't seem to be an 'Optimal Monetary Zone', as production factors (especially labor) are not really mobile, and as fiscal transfers by the way of the European budget remain very limited, because the political question is too sensitive. Therefore, various asymmetries between the member countries of the monetary union may result in the fact that monetary unification is not equally beneficial for all member countries, and that membership in the monetary union may be more painful for some countries with given structural characteristics.

Indeed, in a monetary union, member countries give up monetary autonomy, and the common monetary authority conducts the monetary policy which is the most suited to the average situation of the whole monetary union. Therefore, fiscal policies remain the only instrument for pursuing country-specific goals and stabilizing asymmetric shocks. Fiscal policies become more important, and they can implement strategic behaviours intended to achieve national goals. In these conditions, the timing and size of a common monetary policy could be difficult to define, if there are diverging interests of the member countries of the monetary union. Besides, if the relative burden of the stabilization is biased between the member countries, the relative advantages or drawbacks of membership in a monetary union could vary between the member countries. Sizeable distribution differences could create political tensions. In a monetary union, the single monetary policy can only address common shocks. In the absence of nominal interest and exchange rates as policy instruments, in order to adjust to asymmetric shocks, member countries have to resort to four remaining tools of economic policy. The first one is risk-sharing against country-specific shocks through fiscal transfers and financial integration. However, the EMU is not a federation but a union of politically autonomous countries, where the fiscal transfers and the European budget remain very limited. The second one is labor mobility, but the latter is also limited in Europe. So, we will mainly consider three adjustment mechanisms which are allowable in the framework of the EMU: market-driven price and output adjustment, monetary policy to stabilize common shocks, and fiscal adjustment to stabilize asymmetric shocks.

In this context, the consequences of various asymmetries are studied in the current paper. First, asymmetries may be related to the response to asymmetric shocks; so, we can analyze the implications of symmetric, but also of asymmetric demand shocks. Second, asymmetries may also be related to the asymmetric response to common shocks. This may be due to divergences between the preferences of the member countries of the monetary union, regarding the various goals of stabilizing the budgetary deficit, economic activity and inflation. But this may also be due to structural heterogeneities in the demand and supply functions of the member countries of the monetary union.

The contribution of the current paper is to provide an analytical modelling and precise analytical results regarding the consequences of heterogeneities between the preferences or between the structural parameters of the member countries of a monetary union on monetary and budgetary policies, and on the stabilization of economic activity and inflation. We find that in case of positive (negative) symmetric demand shocks, monetary and budgetary policies are both more contractionary (expansionary), and the burden of economic stabilization then mainly depends on the respective constraints of the economic authorities to modify the common interest rate or the budgetary deficits. In the same way, after an asymmetric demand shock, the biggest part of economic stabilization is realized by the budgetary authorities, and mainly by the one which is the less constrained for its budgetary policy. However, in both cases, monetary or budgetary constraints reduce the potential economic stabilization, and economic activity and inflation are then higher (weaker) in a country affected by a positive (negative) demand shock.

Our modelling can then provide important and precise analytical results. First, in case of demand shocks, regarding the preferences of the budgetary authorities, monetary unification could be more painful for a country with strong budgetary constraints, and with a high preference for stabilizing the budgetary deficit, and on the contrary with a weak preference for stabilizing economic activity and inflation. Besides, regarding structural heterogeneities, in case of symmetric as well as in case of asymmetric demand shocks, monetary unification could be more painful for a country with weak transmission mechanisms of monetary policy or with a weak budgetary multiplier. Membership in a monetary union could also be more painful for the countries with the highest sensitivities of national prices to foreign prices, or with the weakest sensitivities of prices to national economic activity.

The second section of the paper recalls the results of the economic literature regarding economic stabilization and the consequences of structural heterogeneities in a monetary union. The third section describes our analytical model. The fourth section studies symmetric demand shocks and the fifth section asymmetric demand shocks, regarding equilibrium monetary and budgetary policies, their consequences on the stabilization of economic activity and inflation. They study the implications of divergences between the preferences of the member countries of the monetary union, and between the structural characteristics of these countries, on economic stabilization, in order to derive implications for the advantages and drawbacks of monetary unification for the various member countries of the monetary union. Finally, the sixth section concludes the paper.

2. THE ECONOMIC LITERATURE

In the economic literature, country size has usually been considered as a fundamental parameter of economic adjustment to shocks. Indeed, big countries are considered to rely less on external demand, and more on internal demand. Therefore, they have a stronger effect on the monetary policy of the common central bank, and they are less sensitive to asymmetric shocks, as they influence the whole monetary union and are often at the source of symmetric shocks. On the contrary, small countries are more subject to asymmetric shocks, as the common central bank takes less care of stabilization in small countries.

However, Hoeller *et al.* (2004) show that in the framework of a monetary union, small countries are better placed to adjust swiftly to asymmetric shocks, because they are well integrated with the rest of the area and because they have a higher degree of trade-openness. Indeed, following a negative demand shock, lower inflation leads to competitiveness gains in small countries that are sufficiently strong to close the ensuing output gap already after three years. An activist fiscal policy is then not needed and also not powerful enough to smooth the cycle. On the contrary, according to the authors, large countries would be less well placed to cope with shocks and sluggish adjustment could be expected. In principle, a more activist fiscal policy could help in the large countries, but the institutional framework has so far not ensured an anti-cyclical stance over the cycle. Automatic stabilizers contribute to reducing the amplitude of the cycle to some extent and more so in big than small economies, the fiscal impact being there bigger and more persistent. In conclusion, according to Hoeller *et al.* (2004), in order to improve economic stabilization in the EMU, reforms should focus on raising trade linkages via the completion of the single market, on improving wage and price flexibility, and on making housing markets more responsive to changes in monetary policy.

Indeed, another fundamental factor of economic stabilization in a monetary union relies on the responsiveness of the output-gap to the common monetary policy.

In this context, Badarau and Levieuge (2013) underline the heterogeneity in the European financial market: the banking market is segmented, prices differentials remain high. Therefore, according to the authors, the banking channel strongly contributes to the amplification of shocks in the EMU; financial heterogeneity could accentuate the cyclical divergences in a monetary union. Besides, the authors underline that the conduct of a common monetary policy worsens national divergences in a monetary union. Decentralized budgetary policies should then be more proactive in countries which are structurally more sensitive to shocks. In the same way, Brissimis and Skotida (2008) examine the optimal design of monetary policy in the European monetary union in the presence of structural asymmetries across union member countries. They show that there are gains to be achieved by the European Central Bank (ECB) taking into account the heterogeneity of economic structures. So, they underline the importance for the ECB to take into consideration national characteristics in formulating its monetary policy, especially when these structural differences are sizeable. The authors suggest that the interest rate should be adjusted so as to stabilize more the variables of the country with the lower nominal rigidity and lower intertemporal elasticity of substitution of consumption. However, as monetary and financial integration advances, the welfare benefits of monetary policy responding to individual countries' variables may become less significant.

Furthermore, De Grauwe (2000) analyzes the optimal monetary policy in case of asymmetries of shocks and of transmission in the monetary union. He finds that as the degree of asymmetries increases, the effectiveness of stabilization of output and unemployment is reduced. As a result, when asymmetries increase, the stabilization effort of the central bank declines for given preferences about stabilization. He also finds that the central bank can improve the efficiency of its monetary policy when asymmetries in the transmission exist, by using national information in the setting of optimal policies. In the same way, Lombardo (2006) shows that the central bank of a monetary union should respond more aggressively (give a larger weight) to the inflation pressure coming from the more competitive economy, the one with more flexible prices, other things being equal. In the same way, Gros and Hefeker (2000) study the advantage, for the ECB, to take into account a weighted average of national economic variables and inflation rates, beyond only considering average variables in the monetary union. The authors show that if the ECB minimizes the (weighted) average of national welfare, it will clearly stabilize less common shocks than a central bank concerned with union wide developments would do. However, welfare would then increase, as interest rates variations detrimental and too high for some member countries would be reduced.

Besides, price flexibility and mark-up behaviour of the various member countries also affect economic stabilization in the member countries of a monetary union. Indeed, Gilchrist *et al.* (2018) show that in response to a financial shock, firms in financially weak countries (the periphery) maintain cash flows by raising markups, in order to preserve internal liquidity, while firms in financially strong countries (the core) reduce markups, undercutting their financially constrained competitors to gain market share. When the two regions are experiencing different shocks, common monetary policy then results in a substantially higher macroeconomic volatility in the periphery, compared with a flexible exchange rate regime; this translates into a welfare loss for the union as a whole, with the loss borne entirely by the periphery. The pricing behavior of firms in the core in response to an asymmetric financial shock implies a real exchange rate appreciation for the periphery, which causes an export-driven boom in the core countries and a deepening of the recession in the periphery.

Furthermore, Martin (1995) shows that a two-speed monetary unification carries a danger. Low-inflation countries in Europe have an interest in delaying entry of a high-inflation country, because it would raise the average inflation rate. However, this country might later refuse to join, when the first group finds it qualified to, and when convergence has taken place. Indeed, this high-inflation country can employ its monetary policy to stabilize against shocks, given that the member countries of the monetary union have optimally chosen a lower inflation rate. Hence, a tradeoff exists between the necessity for convergence and the free-rider problem.

Moreover, Toroj (2009) finds that in case of asymmetric demand or supply shocks, forwards looking behavior in the Phillips curve or in the demand equation reduces inflation and output fluctuations, whereas backwards looking behavior and inflation persistence (automatic wage indexation schemes) obviously increases economic cycles. Toroj (2009) also finds that a high output-gap response to the real interest rate could be stabilizing only for a big country with strongly rational expectations (strongly forward looking equations). On the contrary, a weaker output-gap response to the real interest rate could usually be stabilizing and support the adjustment process after asymmetric shocks, in case of high inflation persistence (backward looking equation) which implies pro-cyclical effects from inflation expectation growth, and particularly for the smallest countries.

In order to complement the macroeconomic and mainly econometrical results of the economic literature, the current paper provides an analytical contribution with a small macroeconomic model, regarding the consequences of structural heterogeneities between the member countries of a monetary union for the stabilization of demand shocks.

3. THE MODEL

We consider a monetary union made of two countries: (i) and (j). Therefore, this analytical modelling can capture a two-country model; but we can also consider a larger monetary union, where the country (i) faces various partner countries in a monetary union globally represented and named as 'country (j)'. We suppose that capital markets are fully integrated, capital mobility is perfect, and that there is a common nominal interest rate in the monetary union without any country risk premium. The common monetary policy and this common nominal interest rate are fixed by the common central bank of the monetary union, whereas budgetary policies are decentralized: each fiscal policy is defined by the autonomous government of each member country.

All variables are expressed in logarithms, except the interest rate which is in deviation from its long run equilibrium value, normalized to zero for simplicity. Economic variables converge towards their long run equilibrium values, where variation of output is null. We consider global macro-economic demand and supply equations, which could potentially be derived from micro-economic foundations that we will avoid to precise in the current paper. We also abstract from studying external interactions between the member countries of the monetary union and the rest of the world, and we make the hypothesis that labor is immobile between countries.

3.1. Demand equation

In the countries (i) and (j), demand equations can take the following expressions:

$$y_{i,t} = \delta_i\left(p_{j,t}^{j} - p_{i,t}^{i}\right) + \rho_i y_{j,t} + \gamma_i g_{i,t} - \sigma_i(i_t - \pi_{i,t}) + \varepsilon_{i,t}^{d} \quad (1)$$

$$y_{j,t} = -\delta_j\left(p_{j,t}^{j} - p_{i,t}^{i}\right) + \rho_j y_{i,t} + \gamma_j g_{j,t} - \sigma_j(i_t - \pi_{j,t}) + \varepsilon_{j,t}^{d} \quad (2)$$

With, in the country (i): $\left(p_{i,t}^{i}\right)$: producer prices; ($y_{i,t}$): real economic activity; ($g_{i,t}$): real budgetary deficit; ($\pi_{i,t}$): inflation rate; $\left(\varepsilon_{i,t}^{d}\right)$: demand shock which is a white noise; (i_t): common nominal interest rate in all the monetary union.

Demand increases with public expenditure, and thus with the budgetary deficit. So, (γ) is the sensitivity of economic activity to the fiscal deficit, a parameter which is high in the Keynesian literature (budgetary multiplier), but much weaker in the non-Keynesian tradition. Demand decreases with the real interest rate, favoring sparing and decreasing private consumption. So, (σ) is the sensitivity of economic activity to the real interest rate, to the common monetary policy of the central bank, an externality which is negative. Indeed, the monetary policy of the common central bank has a direct effect on output through the interest rate channel: a higher nominal interest rate increases the real interest rate in the presence of short-run rigidities in prices.

Besides, demand also increases with exports, and therefore, with the price-competitiveness of a country. So, (δ) measures the sensitivity of demand to the real exchange rate; it is a measure of the price-competitiveness channel. The real exchange rate is the difference between the home and foreign producer price level. The competitiveness channel (or real exchange rate channel) measures the fact that weaker prices increase the competitiveness of exports of the national country. Demand increases with exports, and therefore, demand also increases with imports' demand from the partner countries in the monetary union, which also affect the externalities between countries. So, (ρ) is a measure of the foreign output channel: a higher economic activity translates to other countries through higher imports, according to the degree of openness of the countries.

Regarding the partition of white noise shocks, in the rest of the paper, we will consider that the symmetric part of a shock (x), whether demand ($x = d$) or supply ($x = s$) shock, is: $\varepsilon_{i,t}^{sy,x} = \dfrac{\left(\varepsilon_{i,t}^{x} + \varepsilon_{j,t}^{x}\right)}{2}$, whereas the asymmetric part of this shock (x)

is: $\varepsilon_{i,t}^{as,x} = \frac{\left(\varepsilon_{i,t}^{x} + \varepsilon_{j,t}^{x}\right)}{2}$. Regarding demand shocks, we can suppose that common and symmetric shocks correspond, for example, to worldwide commodity shocks, or to shocks on the external exchange rate with foreign countries outside the monetary union. On the contrary, we can suppose that asymmetric demand shocks correspond to a unilateral positive (for example: the rise of Apple and the success of the iPhone had a highly significant effect on Finland because of the contribution of Nokia to the Finnish economy) or negative phenomenon (exhaustion of the demand for a product, a technology of production or an energy source) affecting the demand of a single country.

Therefore, by combining equations (1) and (2), we can obtain the following demand equations:

$$(1-\rho_i\rho_j)y_{i,t} = (\delta_i - \delta_j\rho_i)(p_{j,t}^{j} - p_{i,t}^{i}) + \gamma_i g_{i,t} + \rho_i\gamma_j g_{j,t} - (\sigma_i + \rho_i\sigma_j)i_t + \sigma_i\pi_{i,t} + \rho_i\sigma_j\pi_{j,t} + (1+\rho_i)\varepsilon_{i,t}^{sy,d} + (1-\rho_i)\varepsilon_{i,t}^{as,d} \quad (3)$$

$$(1-\rho_i\rho_j)y_{j,t} = -(\delta_j - \delta_i\rho_j)(p_{j,t}^{j} - p_{i,t}^{i}) + \rho_j\gamma_i g_{i,t} + \gamma_j g_{j,t} - (\sigma_j + \rho_j\sigma_i)i_t + \rho_j\sigma_i\pi_{i,t} + \sigma_j\pi_{j,t} + (1+\rho_j)\varepsilon_{i,t}^{sy,d} - (1-\rho_j)\varepsilon_{i,t}^{as,d} \quad (4)$$

3.2. Supply equation

We also have supply equations in the countries (i) and (j), Phillips curves relating national inflation, foreign prices and national output, which take the following expression:

$$\pi_{i,t} = p_{i,t} - p_{i,t-1} = \xi_i y_{i,t} + \zeta_i \pi_{j,t} + \varepsilon_{i,t}^{s} \quad (5)$$

With, in the country (i): $(p_{i,t})$: consumer prices; $\left(\varepsilon_{i,t}^{s}\right)$: supply shock or cost-push factor (national wage shock, etc), which is a white noise.

A positive surprise inflation increases economic activity and production (Lucas function). Or we can also consider that there is a demand-pull inflation, when output increases beyond its potential level and where there is a positive output-gap. Besides, contrary to Engwerda *et al.* (2002) for example, in our model, national prices are influenced by foreign prices, and the supply function is then more complex than a simple linear relation between inflation and economic activity. Indeed, cost-push inflation can be caused by the foreign inflation spillover. Higher foreign inflation brings about higher prices of imported goods such as raw materials (e.g. oil), intermediate and final goods used in domestic production, and it can also have an inflationary consequence on national wage negotiations.

Therefore, splitting supply shocks between a symmetric and an asymmetric part, and using equation (5), we obtain the following supply equations for the countries (*i*) and (*j*):

$$(1-\zeta_i\zeta_j)\pi_{i,t} = \xi_i y_{i,t} + \zeta_i\xi_j y_{j,t} + (1+\zeta_i)\varepsilon_{i,t}^{sy,s} + (1-\zeta_i)\varepsilon_{i,t}^{as,s} \tag{6}$$

$$(1-\zeta_i\zeta_j)\pi_{j,t} = \xi_j y_{j,t} + \zeta_j\xi_i y_{i,t} + (1+\zeta_j)\varepsilon_{i,t}^{sy,s} - (1-\zeta_j)\varepsilon_{i,t}^{as,s} \tag{7}$$

So, by combining equations (3), (4), (6) and (7), we obtain the following levels of inflation in the countries (i) and (j):

$$\begin{aligned}
&\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j - (\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j\right]\pi_{i,t} \\
&\quad = \left[\xi_i(\delta_i-\delta_j\rho_i) - \zeta_i\xi_j(\delta_j-\delta_i\rho_j) - \sigma_j\xi_i\xi_j\delta_i\right](p_{j,t}^{j} - p_{i,t}^{i}) \\
&\quad -\left[\xi_i(\sigma_i+\rho_i\sigma_j) + \zeta_i\xi_j(\sigma_j+\rho_j\sigma_i) - \sigma_i\sigma_j\xi_i\xi_j\right]i_t \\
&+\left[\xi_i(1+\rho_i) + \zeta_i\xi_j(1+\rho_j) - \sigma_j\xi_i\xi_j\right]\varepsilon_{i,t}^{sy,d} + \left[\xi_i(1-\rho_i) - \zeta_i\xi_j(1-\rho_j) - \sigma_j\xi_i\xi_j\right]\varepsilon_{i,t}^{as,d} \\
&+\left[(1-\rho_i\rho_j)(1+\zeta_i) - \sigma_j\xi_j + \sigma_j\rho_i\xi_i\right]\varepsilon_{i,t}^{sy,s} + \left[(1-\rho_i\rho_j)(1-\zeta_i) - \sigma_j\xi_j - \sigma_j\rho_i\xi_i\right]\varepsilon_{i,t}^{as,s} \\
&\qquad +\gamma_i(\xi_i + \zeta_i\xi_j\rho_j - \sigma_j\xi_i\xi_j)g_{i,t} + \gamma_j(\zeta_i\xi_j + \xi_i\rho_i)g_{j,t}
\end{aligned} \tag{8}$$

$$\begin{aligned}
&\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j - (\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j\right]\pi_{j,t} \\
&\quad = -\left[\xi_j(\delta_j-\delta_i\rho_j) - \zeta_j\xi_i(\delta_i-\delta_j\rho_i) - \sigma_i\xi_i\xi_j\delta_j\right](p_{j,t}^{j} - p_{i,t}^{i}) \\
&\quad -\left[\xi_j(\sigma_j+\rho_j\sigma_i) + \zeta_j\xi_i(\sigma_i+\rho_i\sigma_j) - \sigma_i\sigma_j\xi_i\xi_j\right]i_t \\
&+\left[\xi_j(1+\rho_j) + \zeta_j\xi_i(1+\rho_i) - \sigma_i\xi_i\xi_j\right]\varepsilon_{i,t}^{sy,d} - \left[\xi_j(1-\rho_j) - \zeta_j\xi_i(1-\rho_i) - \sigma_i\xi_i\xi_j\right]\varepsilon_{i,t}^{as,d} \\
&+\left[(1-\rho_i\rho_j)(1+\zeta_j) - \sigma_i\xi_i + \sigma_i\rho_j\xi_j\right]\varepsilon_{i,t}^{sy,s} - \left[(1-\rho_i\rho_j)(1-\zeta_j) - \sigma_i\xi_i - \sigma_i\rho_j\xi_j\right]\varepsilon_{i,t}^{as,s} \\
&\qquad +\gamma_j(\xi_j + \zeta_j\xi_i\rho_i - \sigma_i\xi_i\xi_j)g_{j,t} + \gamma_i(\zeta_j\xi_i + \xi_j\rho_j)g_{i,t}
\end{aligned} \tag{9}$$

Therefore, putting these equations (8) and (9) in equations (3) and (4), we obtain the following levels of economic activity in the countries (i) and (j):

$$\begin{aligned}
&\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j\right]y_{i,t}\\
&\quad=\left[(\delta_i-\rho_i\delta_j)(1-\zeta_i\zeta_j)-(\delta_i\sigma_j+\sigma_i\delta_j\zeta_i)\xi_j\right](p^j_{j,t}-p^i_{i,t})\\
&\quad-\left[(\sigma_i+\sigma_j\rho_i)(1-\zeta_i\zeta_j)-\sigma_i\sigma_j\xi_j(1-\zeta_i)\right]i_t\\
&\quad+\left[\sigma_i(1+\zeta_i-\sigma_j\xi_j)+\sigma_j\rho_i(1+\zeta_j)\right]\varepsilon^{sy,s}_{i,t}+\left[\sigma_i(1-\zeta_i-\sigma_j\xi_j)-\sigma_j\rho_i(1-\zeta_j)\right]\varepsilon^{as,s}_{i,t}\\
&\quad+\gamma_i(1-\zeta_i\zeta_j-\sigma_j\xi_j)g_{i,t}+\left[(1+\rho_i)(1-\zeta_i\zeta_j)-(\sigma_j-\sigma_i\zeta_i)\xi_j\right]\varepsilon^{sy,d}_{i,t}\\
&\quad+\gamma_j(\rho_i-\rho_i\zeta_i\zeta_j+\sigma_i\zeta_i\xi_j)g_{j,t}+\left[(1-\rho_i)(1-\zeta_i\zeta_j)-(\sigma_j+\sigma_i\zeta_i)\xi_j\right]\varepsilon^{as,d}_{i,t}
\end{aligned}\tag{10}$$

$$\begin{aligned}
&\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j\right]y_{j,t}\\
&\quad=-\left[(\delta_j-\rho_j\delta_i)(1-\zeta_i\zeta_j)-(\delta_j\sigma_i+\sigma_j\delta_i\zeta_j)\xi_i\right](p^j_{j,t}-p^i_{i,t})\\
&\quad-\left[(\sigma_j+\sigma_i\rho_j)(1-\zeta_i\zeta_j)-\sigma_j\sigma_i\xi_i(1-\zeta_j)\right]i_t\\
&\quad+\left[\sigma_j(1+\zeta_j-\sigma_i\xi_i)+\sigma_i\rho_j(1+\zeta_i)\right]\varepsilon^{sy,s}_{i,t}-\left[\sigma_j(1-\zeta_j-\sigma_i\xi_i)-\sigma_i\rho_j(1-\zeta_i)\right]\varepsilon^{as,s}_{i,t}\\
&\quad+\gamma_j(1-\zeta_i\zeta_j-\sigma_i\xi_i)g_{j,t}+\left[(1+\rho_j)(1-\zeta_i\zeta_j)-(\sigma_i-\sigma_j\zeta_j)\xi_i\right]\varepsilon^{sy,d}_{i,t}\\
&\quad+\gamma_i(\rho_j-\rho_j\zeta_i\zeta_j+\sigma_j\zeta_j\xi_i)g_{i,t}-\left[(1-\rho_j)(1-\zeta_i\zeta_j)-(\sigma_i+\sigma_j\zeta_j)\xi_i\right]\varepsilon^{as,d}_{i,t}
\end{aligned}\tag{11}$$

Toroj (2009) finds that the output-gap response to price competitiveness (?) is a fundamental factor for economic adjustment. Indeed, he finds that an open and highly trade-integrated economy would be more resistant to asymmetric demand shocks, and that the output-gap would then be less volatile. However, in the framework of our model, we can observe that this factor influences economic variables in case of productivity shocks on producer prices $\left(p^j_{j,t}-p^i_{i,t}\right)$, but not in case of demand or supply shocks.

3.3. Preferences of the economic authorities

Various goals of the fiscal authorities are to stabilize inflation, economic activity and budgetary deficits. Therefore, the loss function of the government in country (i) is as follows:

$$L^G_{i,t}=E_t\sum_{k=t}^{\infty}\beta^{k-t}\left\{\alpha^{Gi}_\pi\pi^2_{i,k}+\alpha^{Gi}_y y^2_{i,k}+\alpha^{Gi}_g g^2_{i,k}\right\}\tag{12}$$

With: (β): time discount factor; (α_π^G),(α_y^G) and (α_y^G): respective weights given to stabilizing inflation, economic activity and the budgetary deficit.

The parameter (α_y^G), the necessity to stabilize the fiscal instrument, the budgetary deficit, represents the fact that a high budgetary deficit increases the public debt to be serviced in the future, which is harmful as it increases taxation rates or lowers public spending. The public debt can be a factor increasing inequalities regarding inter and intra-generations income redistribution, increasing tax distortions, or implying crowding-out effects on capital accumulation and private investment. Besides, budgetary deficits and public debt levels have been constrained, in the framework of the Economic and Monetary Union (EMU), by institutional rules of fiscal discipline, and they could potentially lead to financial sanctions in the framework of the Stability and Growth Pact and of the Fiscal Compact.

We also make the hypothesis that there is no systematic incentive to deviate from the long run equilibrium values, no systematic deficit bias, so we suppose that the long term inflation, economic activity and deficit targets in terms of deviation are null. We limit ourselves to the systematic stabilization of shocks.

In Europe, the main goal of the ECB is to ensure price stability (α_π^M). However, the ECB can also try to sustain economic activity (α_y^M), in the respect of this main goal. Finally, we consider the empirical goal of interest rate smoothing (α_i^M) of any central bank. So, the loss function of the common central bank is as follows:

$$L_t^M = E_t \sum_{k=t}^{\propto} \beta^{k-t} \left\{ \alpha_\pi^M \left(\alpha_i \pi_{i,k} + \alpha_j \pi_{j,k} \right)^2 + \alpha_y^M \left(\alpha_i y_{i,k} + \alpha_j y_{j,k} \right)^2 + \alpha_i^M i_k^2 \right\} \qquad (13)$$

Where (α_i) and (α_j) are the respective weights given to countries (*i*) and (*j*) in the monetary union (economic weights, or due to a political balance of power).

3.4. Calibration of the parameters

The sensitivity of economic activity to the real interest rate has been calibrated at (σ = 0.2) in Van Aarle *et al.* (2001), at (σ = 0.4) in Engwerda *et al.* (2002), and at (σ = 0.5) in Beetsma *et al.* (2001). In this paper, we will consider (σ = 0.4) as basic calibration, but we will allow a large variation of this parameter (0 < σ < 0.8) in order to analyze the sensitivity of our results to a variation of this parameter. Regarding divergences between European countries, Brissimis and Skotida (2008) find, between 1965 and 1998, that this sensitivity would be around (σ = 0.02) in France and around (σ = 0.04) in Germany. Clausen and Hayo (2006) also find that monetary policy impulses show a relatively stronger effect on the output gap in Italy and Germany than in France in the medium run between 1980 and 1996, even if differences are too small to be able to reject the hypothesis of homogeneous monetary transmission in the EMU. Between 1979 and 1994, Aksoy *et al.* (2001) find that monetary policy has a significant effect on output in Austria, Belgium, Luxembourg and Portugal. Output also seems to respond to monetary policy changes in Finland, France, Germany, Ireland and Italy. On the contrary, they find that monetary policy would be quite ineffective for influencing output in the Netherlands or in Spain.

Many econometric studies analyze the various channels of monetary transmission in the individual European Union member countries and examine country characteristics that may explain divergences, such as the structure of the financial system (financial stability and depth, banks' concentration, availability of alternative financing, development of capital markets and non-bank financial intermediaries, lending maturities), openness, price and wage rigidity (barriers to entrepreneurship, employment protection legislation), interest rate sensitivity to demand (industrial structure) and households' and firms' portfolio composition. The main conclusion is that there is considerable dispersion across countries. However, the studies do not give clear results with respect to the ranking of countries on the basis of monetary policy effectiveness. Indeed, Mojon and Peersman (2003) assess that according to various VAR models across economic studies, differences of the effects of monetary policy on GDP are not significantly robust between European countries. Nevertheless, over the period 1980-1998, they estimate that the GDP response to monetary policy would be (σ = -0.45) in the Netherlands, (-0.44) in Finland, (-0.32) in Belgium or in Ireland, (-0.25) in Austria, (-0.20) in Germany or in France, (-0.14) in Spain, (-0.12) in Italy, (-0.08) in Portugal.

Guiso *et al.* (1999) report results of the Bank for International Settlements (BIS), for the first year of variation of the interest rate on the real GDP: (σ = -0.18) in Italy or in France, (σ = -0.15) in Germany, (σ = -0.10) in the Netherlands, (σ = -0.08) in Austria, and (σ = -0.03) in Belgium. Angeloni *et al.* (2003) report that for the period 1971-2000, after one year, the GDP response to monetary policy based on the Euro-system macro-econometric models would be on average (σ = -0.19) in the Euro Area, mainly due to the decrease in investment. It would be (-0.54) in Germany, (-0.51) in Italy or in Greece, (-0.43) in Finland, (-0.33) in Belgium, (-0.29) in Austria, (-0.28) in the Netherlands, (-0.27) in Ireland, (-0.26) in Spain, (-0.24) in France, (-0.13) in Portugal, and (-0.07) in Luxembourg.

The sensitivity of economic activity to the budgetary deficit has been calibrated at (γ = 0.5) in Beetsma *et al.* (2001), and at (γ = 1) in Van Aarle *et al.* (2001), Van Aarle *et al.* (2004), or in Engwerda *et al.* (2002). In this paper, we will consider (γ = 1) as basic calibration, but we will allow a large variation of this parameter

($0<\gamma<1.5$), in order to analyze the sensitivity of our results to variations of this parameter (see Table 1). According to the European Commission (2002, p.41), Interlink simulations give values between ($\gamma=0.6$) in France, ($\gamma=0.9$) in Italy, and ($\gamma=1$) in Germany or in the United-Kingdom. In the same way, the European Commission (2012, p.139) tries to estimate fiscal multipliers (γ), the impact of budgetary changes in revenues and expenditures on real GDP, with a VAR analysis, for the period 1985-2010. It finds that it would only be around ($\gamma=0.3$) for Italy after one year, but around ($\gamma=1.2$) for Germany and Spain, while the average value would be around ($\gamma=1.4$) for the whole Euro Area.

The sensitivity of national economic activity to the foreign economic activity has been calibrated at ($\rho=0.4$) in Engwerda *et al.* (2002) or in Van Aarle *et al.* (2001), and at ($\rho=0.5$) in Beetsma *et al.* (2001) or in Van Aarle *et al.* (2004). In this paper, we will consider ($\rho=0.4$) as basic calibration, but we will allow a large variation of this parameter ($0<\rho<0.8$) in order to analyze the sensitivity of our results to a variation of this parameter (see Table 1).

The sensitivity of the demand to the real exchange rate has been calibrated at ($\delta=0.2$) in Engwerda *et al.* (2002), ($\delta=0.25$) in Van Aarle *et al.* (2004), ($\delta=0.3$) in Van Aarle *et al.* (2001), and at ($\delta=0.5$) in Beetsma *et al.* (2001). In this paper, we will consider ($\delta=0.3$) as basic calibration, but we will allow a large variation of this parameter ($0<\delta<0.6$) in order to analyze the sensitivity of our results to a variation of this parameter (see Table 1). Regarding divergences between European countries, according to Buissière *et al.* (2016, p.38) for example, the estimates of the effect of a 1% depreciation of the exchange rate on net exports over GDP (δ) are ranged between: only 0.03 in the United-Kingdom, 0.06 in Greece, 0.07 in Italy, 0.08 in France, 0.11 in Germany, in Finland or in Portugal, 0.12 in Spain, 0.14 in Austria, 0.22 in Denmark, 0.24 in Poland, 0.30 in the Czech Republic, 0.32 in Belgium, 0.42 in the Netherlands or in Hungary, and until 0.68 in Ireland where openness to trade is very high. For the period between 1998 and 2008, Toroj (2009) finds that the influence of price-competitiveness on the output-gap would be quite insignificant in Italy, in Portugal, in Spain, in France or in Finland. It would be 0.03 in Austria or in the Netherlands, 0.04 in Greece, 0.11 in Luxembourg, 0.12 in Germany, 0.19 in Belgium, but it would reach 0.58 in Ireland.

The parameter (ξ) measures the slope of the Phillips curve, and reflects the rigidities in the prices adjustment dynamics. The sensitivity of prices to the national economic activity has been calibrated at ($\xi=0.2$) in Van Aarle *et al.* (2004), and at ($\xi=0.25$) in Engwerda *et al.* (2002) or in Van Aarle *et al.* (2001). In this paper, we will consider ($\xi=0.25$) as basic calibration, but we will allow a large variation of this parameter ($0< \xi <0.5$) in order to analyze the sensitivity of our results to a variation of this parameter (see Table 1). Regarding divergences between European countries, Brissimis and Skotida (2008) find, between 1965 and 1998, that this sensitivity would be much higher in France (around ξ=0.25) than in Germany (around ξ=0.04), where the degree of price stickiness is higher. Dyne *et al.* (2009, p. 36) also observe that, for a period between 1996 and 2003 for most countries, the monthly frequency of prices changes are much higher for energy prices (oil products) than for services. Besides, they find that monthly prices changes would be more frequent in Luxembourg (23%), in Portugal (21.1%), in France (20.9%), in Finland (20.3%), in Belgium (17.6%), in the Netherlands (16.2%), in Austria (15.4%) and less frequent in Germany (13.5%), in Spain (13.3%) or in Italy (10%).

The sensitivity of national prices to foreign prices has been calibrated at (ζ=0.1) in Van Aarle *et al.* (2004) and at (ζ=0.8) in Van Aarle *et al.* (2001). In this paper, we will consider (ζ=0.5) as basic calibration, but we will allow a large variation of this parameter (0< ζ <1) in order to analyze the sensitivity of our results to a variation of this parameter. Regarding divergences between European countries, according to Buissière *et al.* (2016, p.32) for example, the average elasticity of import prices with respect to the exchange rate would be (ζ=0.48). It ranges between incomplete pricing to market strategy and 0.28 in Belgium, 0.35 in Spain, 0.37 in Denmark, 0.38 in Germany, 0.41 in Austria or in Italy, 0.44 in France or in Poland, 0.46 in the Czech Republic, 0.47 in Ireland, 0.48 in Finland, in Netherlands or in the United-Kingdom, 0.49 in Portugal, 0.62 in Greece, and until 0.71 and incomplete pass- through in Hungary.

Table 1
Calibration of the parameters of our model

	Basic calibration	*Potential variation*
Sensitivity of demand to the real interest rate	$\sigma = 0.4$	$0 < \sigma < 0.8$
Sensitivity of demand to the fiscal deficit	$\gamma = 1$	$0 < \gamma < 1.5$
Sensitivity of demand to the foreign activity	$\rho = 0.4$	$0 < \rho < 0.8$
Sensitivity of demand to the real exchange rate	$\delta = 0.3$	$0 < \delta < 0.6$
Sensitivity of national prices to national activity	$\xi = 0.25$	$0 < \xi < 0.5$
Sensitivity of national to foreign prices	$\zeta = 0.5$	$0 < \zeta < 1$
Budgetary preference for stabilizing inflation	$\alpha_\pi^G = 2$	$0 < \alpha_\pi^G < \infty$
Budgetary preference for stabilizing activity	$\alpha_y^G = 5$	$0 < \alpha_y^G < \infty$
Budgetary preference for stabilizing public finances	$\alpha_g^G = 2.5$	$0 < \alpha_g^G < \infty$
Monetary preference for stabilizing inflation	$\alpha_\pi^M = 2.5$	$0 < \alpha_\pi^M < \infty$
Monetary preference for stabilizing activity	$\alpha_y^M = 1$	$0 < \alpha_y^M < \infty$
Monetary preference for stabilizing the interest rate	$\alpha_i^M = 2.5$	$0 < \alpha_i^M < \infty$

Regarding the preferences of the European Central Bank (ECB), the main goal mentioned in its statutes is to stabilize inflation, whereas empirical studies show that interest rate smoothing would be quite significant. So, in Engwerda *et al.* (2002), the common central bank cares more about inflation than about output stabilization $\left(\alpha_\pi^M = 2.5 > \alpha_y^M = 1\right)$, and it has also an interest rate smoothing objective $\left(\alpha_i^M = 2.5\right)$. Beetsma *et al.* (2001) also consider: $\left(\alpha_i^M = \alpha_\pi^M\right)$. We will retain these values in our own basic calibration (see Table 1). In Van Aarle *et al.* (2001), the relative shares of the former objectives are: $\left(\frac{\alpha_y^M}{\alpha_\pi^M} = 0.6\right)$, whereas in Van Aarle *et al.* (2004), they are: $\left(\frac{\alpha_y^M}{\alpha_\pi^M} = \frac{1}{3} = 0.33\right)$. Besides, in our basic calibration, we will consider that each country is equally weighted by the common central bank: ($\alpha_i = \alpha_j = 0.5$).

Regarding the preferences of the governments, Engwerda *et al.* (2002) use the following parameters: $\left(\alpha_\pi^{Gi} = 2\right), \left(\alpha_y^{Gi} = 5\right)$ and $\left(\alpha_y^{Gi} = 2.5\right)$. We will retain these values in our own basic calibration (see Table 1), but we will allow a very large variation of these values in order to analyze the sensitivity of our results to these governmental preferences. In Van Aarle *et al.* (2001), the relative shares of the former objectives are: $\left(\frac{\alpha_y^{Gi}}{\alpha_\pi^{Gi}} = 1.5 \textit{ and } \frac{\alpha_g^{Gi}}{\alpha_\pi^{Gi}} = 0.8\right)$, whereas in Beetsma *et al.* (2001), they are: $\left(\frac{\alpha_y^{Gi}}{\alpha_\pi^{Gi}} = 2\right)$.

Furthermore, what are the potential heterogeneities between the European countries, regarding these preferences of the governments? With an econometrical study for the period 1979-1998, Ballabriga and Martinez-Mongay (2002) find values for the fiscal smoothing parameter between: insignificant (France, the Netherlands, Austria, Portugal), 0.47 (Belgium, Finland), 0.49 (Denmark), 0.50 (Spain), 0.54 (Germany), 0.58 (Italy), 0.62 (Sweden), 0.84 (United Kingdom) and 0.87 (Ireland). In parallel, they find values for the fiscal response to the output-gap between: insignificant (Germany, Ireland, Italy), 0.05 (Portugal), 0.24 (the Netherlands, Austria), 0.26 (France), 0.33 (Spain), 0.34 (Belgium), 0.92 (Finland) 1.05 (United Kingdom), 1.14 (Denmark), 1.46 (Sweden). So, according to the results of these authors, there would mainly be a large fiscal policy inertia associated with a weak weight given to economic activity stabilization in Ireland, in Italy or in Germany, while on the contrary, in France, in the Netherlands, in Austria or in Portugal, there would be much more fiscal policy fluctuations associated with a higher weight given to the output-gap stabilization. Besides, responses to output-gap fluctuations would also be much more important in the Nordic Countries.

In a more recent paper, Mohl *et al.* (2019) study the two parts of automatic stabilizers in the European countries: cyclical revenues (such as income and indirect taxes) and rather acyclical expenditure (such as unemployment benefits). They mention that in 2018, the fiscal semi-elasticity, which measures by how many percentage points the budget surplus increases following a 1% increase in GDP, would be: 0.3% in Bulgaria, 0.32% in Romania, 0.38% in Latvia or Slovakia, 0.40% in the Czech Republic or in Lithuania, 0.44% in Croatia, 0.45% in Hungary, 0.46% in Luxembourg, 0.47% in Slovenia, 0.48% in Malta, O.49% in Estonia, 0.5% in Poland, Cyprus or Germany, 0.52% in Ireland or Greece, 0.54% in Portugal or Italy, 0.55% (the EU28 average) in the United-Kingdom or in Sweden, 0.57% in Austria, 0.58% in Finland, 0.59% in Denmark, 0.6% in Spain, 0.61% in the Netherlands, 0.62% in Belgium and until 0.63% in France. So, it appears that the semi-elasticities of both expenditure and budget balance would be smaller in central and eastern European countries, since those member States have on average lower expenditure to-GDP ratios. However, these automatic stabilizers can be challenged by discretionary active fiscal policies. More particularly, in case of economic growth, sufficient reserves are not made to face potential future more difficult economic conditions, and a budgetary surplus is hardy attained, especially for political reasons. On the contrary, in case of a downturn, if the public debt level is high, the pro-cyclicality of fiscal policies is usually amplified by the constraint of public debt solvability and by European institutional rules (Stability and Growth Pact and Fiscal Compact), which prevent the use of sufficiently contra-cyclical and expansionary budgetary policies.

4. SYMMETRIC DEMAND SHOCKS

The main contribution of the current paper is to provide a very precise analytical study of the consequences of demand shocks in a monetary union, in which preferences of the governments and structural parameters can differ between member countries. Indeed, appendixes A and B derive analytically respectively the monetary and budgetary reaction functions and the consequences on economic activity and inflation in case of demand shocks.

Even if the monetary authority is constrained by interest rate smoothing for its monetary policy $\left(\alpha_i^M > 0\right)$, the central bank reacts to demand shocks and to the fiscal policies. In the same way, even if the governments are constrained for their budgetary policies $\left(\alpha_g^{Gi} > 0 \text{ and } \alpha_g^{Gj} > 0\right)$, for example because of institutional budgetary constraints (Fiscal Compact) and because of their public debt levels, the governments react to demand shocks and to the common monetary policy. In this context, is economic stabilization more difficult in some member countries of the monetary union with distinct structural characteristics or preferences, and for which structurally heterogeneous countries could monetary unification be more detrimental?

4.1. Heterogeneity in preferences between the governments

After a positive symmetric demand shock, which implies a rise in economic activity and in prices in all the monetary union, the common nominal interest rate increases and budgetary policies are also more contractionary, in order to alleviate the excessive economic outburst. As in Beetsma *et al.* (2001), the conflict between economic authorities is then only on the sharing of the 'burden' of the economic stabilization with a more contractionary policy, which depends on the cost of using its stabilization instrument by each authority. Indeed, according to equations (A5) and (A6) in Appendix A, we obtain:

$$\frac{\partial i_t}{\partial \varepsilon_{i,t}^{sy,d}} = \frac{2}{(\sigma_i + \sigma_j)} - \frac{2\alpha_i^M \Delta_2}{(\sigma_i + \sigma_j)\Delta_1} + \frac{(\sigma_i - \sigma_j)\Delta_{4,i}}{(\sigma_i + \sigma_j)\Delta_1} \tag{14}$$

$$\frac{\partial g_{i,t}}{\partial \varepsilon_{i,t}^{sy,d}} = -\gamma_i \left[\alpha_i^M \frac{\Delta_{6,i}}{\Delta_1} - (\sigma_i - \sigma_j)\alpha_g^{Gj} \frac{\Delta_{5,i}}{\Delta_1}\right] \tag{15}$$

$\Delta_1 = \Delta_3 + \alpha_i^M \Delta_2 > 0$; $\Delta_2 > 0$; $\Delta_3 > 0$; $\Delta_{4,i}$; $\Delta_{5,i} > 0$; $\Delta_{6,i} > 0$ are defined in Appendix A.

Without structural heterogeneity in the transmission mechanisms of the common monetary policy between the member countries of the monetary union, and if there were no cost of a variation of the interest rate, the latter would strongly vary in order to allow the common monetary policy to fully stabilize symmetric demand shocks $\lim_{\substack{\alpha_i^M \to 0 \\ \sigma_i \to \sigma_j}} i_t = \frac{2}{(\sigma_i + \sigma_j)} = 2.5$ with our basic calibration]. However, the medium term in equation (14) shows that interest rate smoothing reduces this variation of the common interest rate [$\lim_{\alpha_i^M \to \infty} i_t = 0$]. Besides, even in case of fully symmetric demand shocks, a part of the common nominal interest rate should react to the structural heterogeneity between the member countries of the monetary union. Indeed, the last part in equation (14) shows that monetary policy should be slightly more contractionary if the country (i) with the most efficient transmission mechanisms of monetary policy ($\sigma_i > \sigma_j$) is also the one with the highest weight given to stabilizing economic variables and the weakest weight given to stabilizing the budgetary deficit [Indeed, $(\Delta_{4,i} > 0)$ if $\left(\alpha_\pi^{Gi} > \sigma_\pi^{Gj}\right)$ and $\left(\alpha_y^{Gi} > \sigma_y^{Gj}\right)$, but if $\left(\alpha_g^{Gi} > \alpha_g^{Gj}\right)$.

Our simulations show that: $\left(\frac{\partial i_t}{\partial \varepsilon_{i,t}^{sy,d}}\right) = 0.16$ and $\left(\frac{\partial g_{i,t}}{\partial \varepsilon_{i,t}^{sy,d}} = \frac{\partial g_{j,t}}{\partial \varepsilon_{i,t}^{sy,d}}\right) = -0.84$ with our basic calibration. However, if the variations of budgetary deficits are strongly constrained, monetary policy is much more contractionary $\left(\frac{\partial i_t}{\partial \varepsilon_{i,t}^{sy,d}} \xrightarrow[\alpha_g^{Gi} = \alpha_g^{Gj} \to \infty]{} 0.98\right)$, whereas if interest rate smoothing increases, budgetary policies are slightly more contractionary and the budgetary surpluses increase [$\left(\frac{\partial g_{i,t}}{\partial \varepsilon_{i,t}^{sy,d}} = \frac{\partial g_{j,t}}{\partial \varepsilon_{i,t}^{sy,d}}\right) \xrightarrow[\alpha_i^M \to \infty]{} -0.90$]. Besides, as it appears in Figure 1, budgetary policy is obviously less contractionary in the country (*j*) where the cost of the variation of the budgetary deficit is the highest $\left(\alpha_g^{Gj} > \alpha_g^{Gi}\right)$, but where the cost of economic fluctuations is the weakest $\left(\alpha_\pi^{Gj} < \alpha_\pi^{Gi} \ and \ \alpha_y^{Gj} < \alpha_y^{Gi}\right)$.

The budgetary deficit would be null if monetary policy could fully stabilize symmetric demand shocks and if there were no structural heterogeneity [$\lim_{\substack{\alpha_i^M \to 0 \\ \sigma_i \to \sigma_j \ if \ \alpha_g^{Gi} > 0}} g_{i,t} = 0$], or in case of structural heterogeneity in the transmission mechanisms of monetary policy between the member countries of the monetary union ($\sigma_i \neq \sigma_j$) if one foreign country (j) had no budgetary constraint and could fully stabilize the structural part of symmetric demand shocks $\left(\alpha_g^{Gj} = 0\right)$. Otherwise, after a symmetric positive demand shock, budgetary policy should be contractionary and the budgetary surplus should increase as soon as interest rate smoothing and the costs of variations of the interest rate $\left(\alpha_i^M > 0\right)$ reduce monetary stabilization. In this context, obviously, the budgetary surplus should be higher in the country (i) with the highest preference for inflation or output stabilization, but the weakest preference for stabilizing the budgetary deficit [($\Delta_{6,i}$) increases if $\left(\alpha_\pi^{Gi} > \alpha_\pi^{Gj}\right)$ and $\left(\alpha_y^{Gi} > \alpha_y^{Gj}\right)$, but if $\left(\alpha_g^{Gi} < \alpha_g^{Gj}\right)$].

Regarding the stabilization of economic activity and inflation, according to equations (B1) and (B2) in Appendix B, we obtain:

$$\frac{\partial y_{i,t}}{\partial \varepsilon_{i,t}^{sy,d}} = \alpha_i^M \frac{\Delta_{8,i}}{\Delta_1} - \alpha_g^{Gi} \alpha_g^{Gj} (\sigma_i - \sigma_j) \frac{\Delta_{9,i}}{\Delta_1} \tag{16}$$

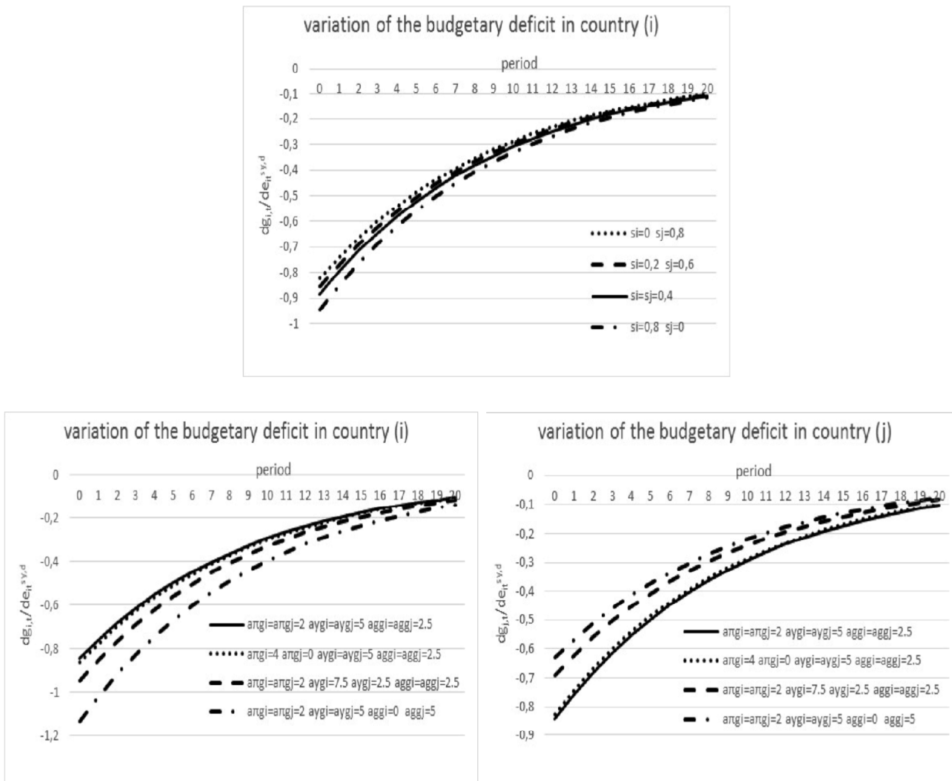

Figure 1: Variation of economic instruments according to the preferences of the governments in case of symmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 2.5\right)$

Persistence of symmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\ \varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where (ε_t) is a white noise.

$$\frac{\partial \pi_{i,t}}{\partial \varepsilon_{i,t}^{sy,d}} = \alpha_i^M \frac{\Delta_{12,i}}{\Delta_1} - \alpha_g^{Gi} \alpha_g^{Gj} (\sigma_i - \sigma_j) \frac{\Delta_{11,i}}{\Delta_1} \tag{17}$$

$\Delta_{8,i}$; $\Delta_{9,i} > 0$; $\Delta_{11,i} > 0$; $\Delta_{12,i} >$ are defined in Appendix B.

In case of symmetric demand shocks, economic activity and inflation could perfectly be stabilized if the budgetary deficits were without cost in both countries [$\Delta_{8,i}$ =0 and $\Delta_{12,i}$ = 0 if $\alpha_g^{Gi} = 0$ and $\alpha_g^{Gj} = 0$]; or if monetary policy could perfectly stabilize the symmetrical part of the shock $\left(\alpha_i^M = 0\right)$ and if at least one government could stabilize the structural asymmetrical part of the shock $\left(\alpha_g^{Gi} = 0 \text{ } or \text{ } \alpha_g^{Gj} = 0\right)$.

Otherwise, economic activity and inflation increase if the monetary authority is constrained in the stabilization of positive symmetric demand shocks $\left(\alpha_i^M > 0\right)$. However, economic activity and inflation are then better stabilized, obviously, in the country (i) with a higher preference for economic stabilization but a weaker preference for stabilizing budgetary deficits [$\Delta_{8,i}$) and ($\Delta_{12,i}$) decrease if $\left(\alpha_\pi^{Gi} > \alpha_\pi^{Gj}\right)$ and $\left(\alpha_y^{Gi} > \alpha_y^{Gj}\right)$, whereas $\left(\alpha_g^{Gi} > \alpha_g^{Gj}\right)$], whereas economic variables are then less stabilized in the country (*j*).

Therefore, our analytical modelling could contribute to sustain the following conclusion. Monetary unification could be detrimental for a country with strong budgetary constraints, and with a high preference for the stabilization of budgetary deficits; for example, for a very indebted country with a weak budgetary flexibility.

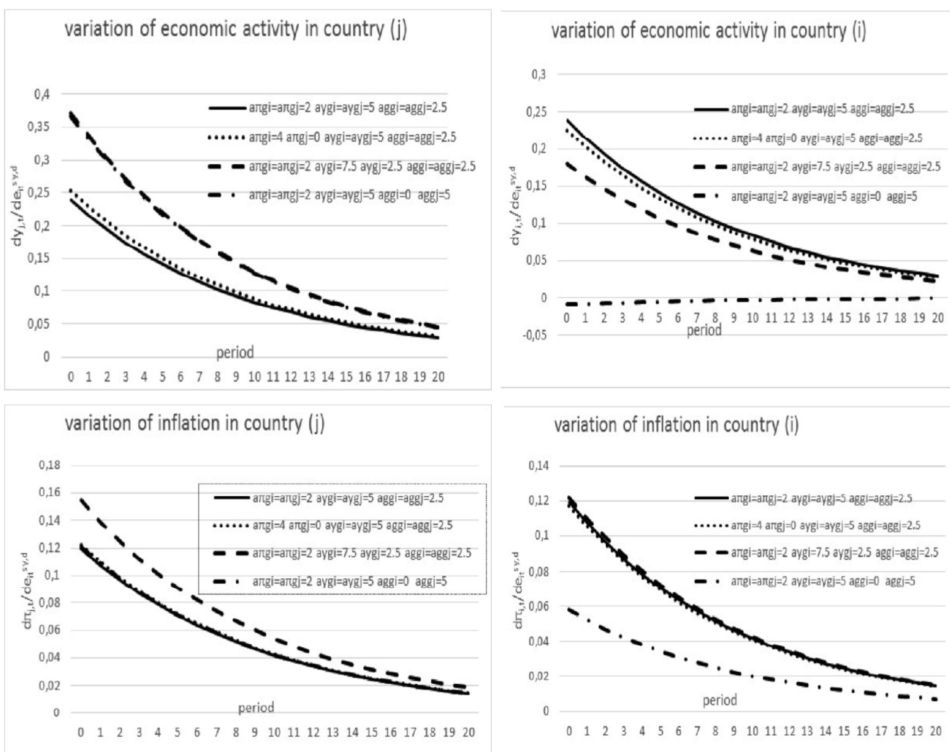

Figure 2: Variation of economic activity and inflation according to the preferences of the governments in case of symmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 2.5\right)$

Persistence of symmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\,\varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where ($\varepsilon_t$) is a white noise.

In the same way, monetary unification could be detrimental for a country with a weak preference for stabilizing economic activity and inflation.

4.2. Structural heterogeneity between the member countries

According to equation (14), the factor of variation of the common nominal interest rate due to the structural heterogeneity between the member countries is related to the last part of this equation, to the value of $[(\sigma_i - \sigma_j)\,\Delta_{4,i}]$. However, our basic calibration shows that in this last part of equation (14), the empirical reaction of the common nominal interest to the structural heterogeneity between the member countries of the monetary union is very limited. Indeed, the interest rate mostly depends on the average transmission mechanisms of monetary policy (σ) and on interest rate smoothing $\left(\alpha_i^M\right)$ in the first part of equation (14).

Regarding fiscal policies, according to equation (15), the budgetary activism increases with the efficiency of the budgetary policy in the national country, with the budgetary multiplier, with the sensitivity of demand to the fiscal deficit (γ_i). Nevertheless, equation (15) also shows that after a symmetric positive demand shock, the budgetary surplus increases (or the budgetary deficit is more reduced) if this sensitivity is weaker in the national country (i) than in the rest of the monetary union ($\gamma_i < \gamma_j$) [(Δ_1) then decreases whereas ($\Delta_{6,i}$) increases]. So, economic stabilization of the asymmetric and structural part of these shocks is mainly realized by the country (i) with the weakest budgetary multiplier [see Figure 3]. Indeed, this country (*i*) must then compensate for its weakest budgetary multiplier by a higher budgetary surplus.

The budgetary policy is also more active [the budgetary surplus is higher and ($g_{i,t}$) is more negative in case of positive demand shocks] in the country (i) where the transmission mechanisms of monetary policy, the sensitivity of demand to the real interest rate, is higher ($\sigma_i > \sigma_j$) [(Δ_1) then decreases whereas $\Delta_{6,i}$) increases]. Besides, budgetary policy is then all the more active as monetary policy is constrained (α_i^M is high). However, the stabilization realized by the foreign country in the limits of its budgetary constraints $\left(\alpha_g^{Gi} > 0\right)$ can reduce the national budgetary activism [($\Delta_{5,i}$)) increases]. Therefore, the effect on the budgetary surplus of the heterogeneity in the transmission mechanisms of monetary policy between the member countries of the monetary union can empirically be reduced and quite limited.

After a symmetric positive demand shock, the budgetary surplus can also increase in a given country (i) if the sensitivity of its demand to the foreign activity is higher than in the rest of the monetary union ($\rho_i > \rho_j$). However, our calibration shows that this effect is quite limited and even ambiguous [Indeed, ($\Delta_{5,i}$) then

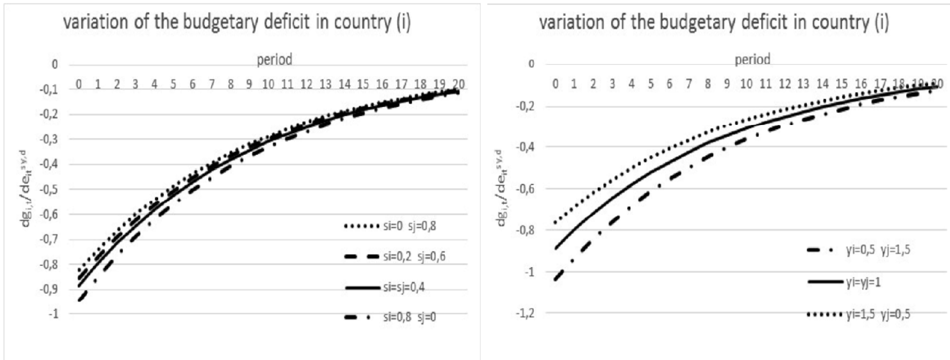

Figure 3: Variation of the budgetary deficit according to the monetary and budgetary transmission mechanisms in case of symmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 2.5\right)$

Persistence of symmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\ \varepsilon_{i,t}^{sy,d} + \varepsilon_t$ where (ε_t) is a white noise.

decreases whereas (Δ_1) and ($\Delta_{6,i}$) increase]. The budgetary surplus can also increase if the sensitivity of national prices to national activity is higher than in the rest of the monetary union ($\xi_i > \xi_j$). However, our calibration shows that this effect is quite limited and even ambiguous [Indeed, ($\Delta_{5,i}$) then decreases whereas (Δ_1) and ($\Delta_{6,i}$) increase]. Finally, the budgetary surplus can also increase if the sensitivity of national prices to foreign prices is higher than in the rest of the monetary union ($\zeta_i > \zeta_j$). However, our calibration shows that this effect is quite limited and even ambiguous [($\Delta_{5,i}$), ($\Delta_{6,i}$)) and (Δ_1) then all increase].

What are then the consequences of these equilibrium monetary and budgetary policies on economic stabilization, for economic activity and inflation? Equations (16) and (17) show that after symmetric demand shocks, economic stabilization remains un-perfect as soon as there are budgetary constraints [($\Delta_{8,i}$) and ($\Delta_{12,i}$) are null if $\left(\alpha_g^{Gi} = 0\right)$ and $\left(\alpha_g^{Gj} = 0\right)$].

Besides, economic activity and inflation are less stabilized in the country (i) where the transmission mechanisms of monetary policy are less efficient ($\sigma_i < \sigma_j$) [Then: (Δ_1) decreases, whereas ($\Delta_{8,i}$), ($\Delta_{9,i}$), ($\Delta_{11,i}$) and ($\Delta_{12,i}$) increase]. The effect is then obvious, as equations (16) and (17) show that economic activity and inflation tend to increase both because of interest rate smoothing by the monetary authority $\left(\alpha_i^M\right)$ limiting the monetary stabilization, and because of the budgetary constraints ($\alpha_g^{Gi} > 0$ and $\alpha_g^{Gj} > 0$) reducing the budgetary stabilization.

Our analytical model also shows that economic activity and inflation are both less stabilized in the country (i) where the budgetary multiplier is the weakest ($\gamma_i < \gamma_j$), despite the higher budgetary surplus in this country (i) [Then: (Δ_1) decreases, whereas ($\Delta_{8,i}$) and ($\Delta_{12,i}$) increase]. Indeed, the variation of the budgetary surplus has then a limited impact on economic activity. On the contrary, Figure 4 shows that if the budgetary multiplier is higher in the country (i) ($\gamma_i > \gamma_j$), economic activity is then better stabilized by the budgetary activism in this country (i), whereas inflation is then less stabilized [Then: (Δ_1), ($\Delta_{8,i}$) and ($\Delta_{12,i}$) all decrease].

Furthermore, economic activity and inflation are less stabilized if the sensitivity of national demand to foreign economic activity differs between both countries ($\rho_i \neq \rho_j$) [Then: (Δ_1), ($\Delta_{8,i}$), ($\Delta_{9,i}$), ($\Delta_{11,i}$) and ($\Delta_{12,i}$) all increase]. In the same way, if the sensitivity of national prices to foreign prices is higher in the country (i) ($\zeta_i > \zeta_j$), inflation and economic activity are both less stabilized in the country (i) [Then:

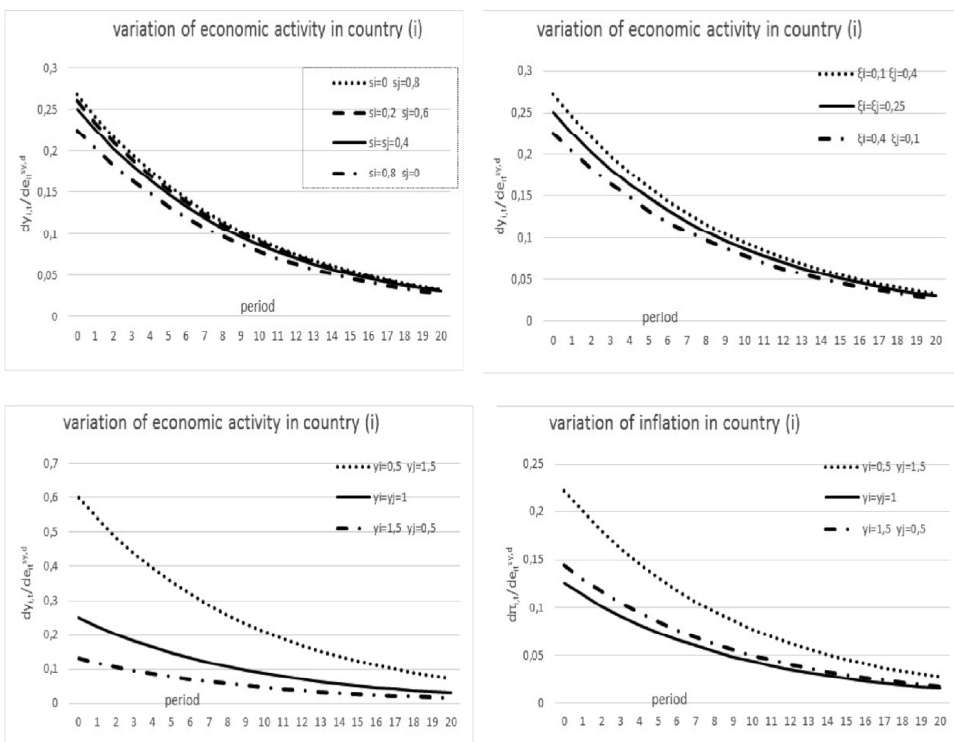

Figure 4: Variation of economic variables according to various structural parameters in case of symmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 2.5\right)$

Persistence of symmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\ \varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where ($\varepsilon_t$) is a white noise.

(Δ_1), ($\Delta_{8,i}$), ($\Delta_{9,i}$) and ($\Delta_{12,i}$) all increase whereas ($\Delta_{11,i}$) decreases]. On the contrary, if the sensitivity of national prices to foreign prices is weaker in the country (i) ($\zeta_i < \zeta_j$), inflation is better stabilized whereas economic activity is less stabilized in this country (i) [Then: (Δ_1), ($\Delta_{8,i}$), ($\Delta_{9,i}$), ($\Delta_{11,i}$) and ($\Delta_{12,i}$) all increase]. However, in case of such structural heterogeneities, the empirical effect would remain quite limited according to our calibration.

Finally, the sensitivity of national prices to national economic activity implies a trade-off between stabilizing economic activity and inflation. Indeed, if this sensitivity is weaker in the country (i) than in the rest of the monetary union ($\xi_i < \xi_j$), inflation is better stabilized whereas economic activity is less stabilized in this country (i) [Then: (Δ_1), ($\Delta_{8,i}$) and ($\Delta_{9,i}$) increase whereas ($\Delta_{11,i}$) and ($\Delta_{12,i}$) decrease]. On the contrary, inflation is less stabilized whereas economic activity is better stabilized in the country (j) where the sensitivity of national prices to national economic activity is the highest ($\xi_j > \xi_i$) [Then: (Δ_1), ($\Delta_{11,j}$) and ($\Delta_{12,j}$) increase whereas ($\Delta_{8,j}$) and ($\Delta_{9,j}$) decrease]. However, here also, the empirical effect would remain quite limited according to our calibration.

Therefore, our analytical modelling could contribute to sustain the following conclusions. In case of symmetric demand shocks, monetary unification could be detrimental for a country with weak transmission mechanisms of monetary policy (σ) or with weak budgetary multipliers (γ). Indeed, a country where transmission mechanisms of monetary policy are weak conducts also a less active budgetary policy, and economic variables are then less stabilized. On the contrary, a country where the budgetary multiplier is weak must have a higher budgetary activism in order to stabilize symmetric demand shocks; however, this fiscal policy has then a weak efficiency, and economic activity and inflation are less stabilized. To become member of a monetary union could also be more detrimental for the country with the highest sensitivity of national prices to foreign prices (ζ), as economic variables are then less stabilized despite the stronger budgetary activism. It could also be detrimental for the country with the weakest sensitivity of prices to national economic activity (ξ), provided stabilizing economic activity is a more important goal for the governments than stabilizing inflation. However, our calibration shows that the consequences would remain quite moderate in the two latter cases.

5. ASYMMETRIC DEMAND SHOCKS

5.1. Heterogeneity in preferences between the governments

We are now going to analyze the consequences of asymmetric demand shocks. Regarding economic policies, according to equations (A5) and (A6) in Appendix A, we obtain:

$$\frac{\partial i_t}{\partial \varepsilon_{i,t}^{as,d}} = -\frac{\Delta_{4,i}}{\Delta_1} \tag{18}$$

$$\frac{\partial g_{i,t}}{\partial \varepsilon_{i,t}^{as,d}} = -\gamma_i \left\{ (\sigma_i + \sigma_j)\alpha_g^{Gj} \frac{\Delta_{5,i}}{\Delta_1} + \alpha_i^M \frac{\Delta_{6,i}}{\Delta_1} - 2\alpha_i^M \alpha_g^{Gj} \frac{\Delta_{7,i}}{\Delta_1} \right\} \tag{19}$$

$\Delta_1 > 0$; $\Delta_{4,i}$; $\Delta_{5,i} > 0$; $\Delta_{6,i} > 0$; $\Delta_{7,i} > 0$ are defined in Appendix A.

So, even if an asymmetric demand shock doesn't affect average inflation, the monetary policy isn't passive in case of heterogeneity between the member countries of the monetary union (when $\Delta_{4,i} \neq 0$), except if $\left(\alpha_i^M \to \infty\right)$ and in case of extreme interest rate smoothing. The monetary authority should react to asymmetric demand

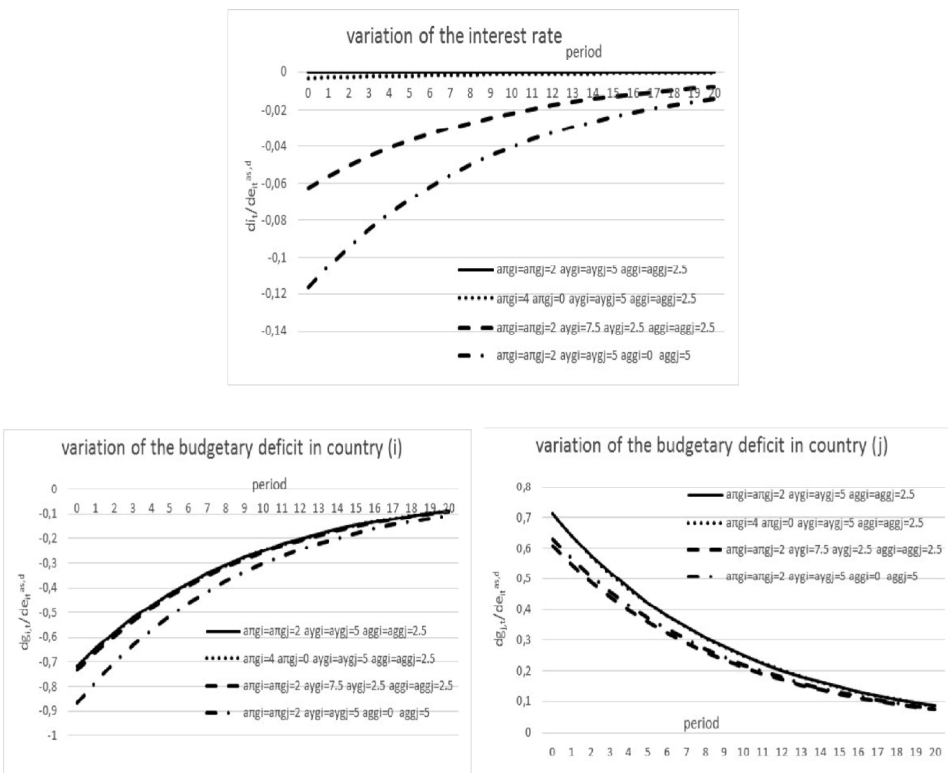

Figure 5: Variation of economic instruments according to the preferences of the governments in case of asymmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 2.5\right)$

Persistence of asymmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\, \varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where (ε_t) is a white noise.

shocks. Indeed, equation (18) shows that monetary policy is more contractionary and the nominal interest rate increases if the country (i) affected by an asymmetric positive demand shock is the one with the weakest preference for prices and output stabilization, but with the highest preference for stabilizing the budgetary deficit [$\Delta_{4,i} < 0 \ if \ \left(\alpha_\pi^{Gi} < \alpha_\pi^{Gj}\right), \left(\alpha_y^{Gi} < \alpha_y^{Gj}\right) \ or \ \left(\alpha_g^{Gi} > \alpha_g^{Gj}\right)$]. Indeed, the country (i) which is affected by a positive asymmetric demand shock then realizes a smallest part of the economic stabilization.

In case of an asymmetric positive demand shock in a given country (i), budgetary policy is contractionary in this country (i) whereas it is expansionary in the foreign country (j): indeed, $\left(\frac{\partial g_{i,t}}{\partial \varepsilon_{i,t}^{as,d}} \to -0.71 \ and \ \frac{\partial g_{j,t}}{\partial \varepsilon_{i,t}^{as,d}} \to 0.71\right)$ with our basic calibration. In case of homogeneity in preferences and in structural parameters between the member countries of the monetary union, if the monetary authority equally weights each country and if it is not constrained, these budgetary policies would be independent from the monetary preferences for inflation and output stabilization. Indeed, equation (19) implies:

$$\frac{\partial g_{i,t}}{\partial \varepsilon_{i,t}^{as,d}} \xrightarrow[\alpha_i^M \to 0]{} -\gamma_i(\sigma_i + \sigma_j)\alpha_g^{Gj}\frac{\Delta_{5,i}}{\Delta_3} \xrightarrow[\alpha_i = \alpha_j]{}$$

$$-\frac{\gamma_i}{\left\{\alpha_g^{Gi}\frac{[(1+\zeta_i)(1+\rho_i)-\sigma_i\xi_i]\left[(1-\zeta_i^2)(1-\rho_i^2)-\sigma_i\xi_i(2-\sigma_i\xi_i+2\rho_i\zeta_i)\right]}{\left[\alpha_y^{Gi}(1+\zeta_i)(1-\zeta_i^2-\sigma_i\xi_i)+\alpha_\pi^{Gj}\xi_i^2(1-\sigma_i\xi_i+\zeta_i\rho_i)\right]} + \gamma_i^2\right\}} \quad (20)$$

Besides, after an asymmetric positive demand shock, according to equation (19), the budgetary surplus should still increase in the positively affected country (i), whereas the budgetary deficit should still increase in the rest of the monetary union, if this country (i) gives a higher weight to inflation and output stabilization, and a weaker weight than its partners to stabilizing the budgetary deficit [($\Delta_{5,i}$), ($\Delta_{6,i}$) and ($\Delta_{7,i}$) increase if $\left(\alpha_\pi^{Gi} > \alpha_\pi^{Gj}\right)$ and $\left(\alpha_y^{Gi} > \alpha_y^{Gj}\right)$, but ($\Delta_{6,i}$) also increases if $\left(\alpha_g^{Gi} > \alpha_g^{Gj}\right)$]. Indeed, the country (i) then favors economic stabilization more than the other member countries of the monetary union, its budgetary policy is less constrained, and the burden of the economic stabilization therefore relies mainly on its budgetary policy, whereas monetary policy is less active.

What are then the consequences of these economic policies on fluctuations of economic activity and inflation? According to equations (B1) and (B2) in Appendix B, we obtain:

$$\frac{\partial y_{i,t}}{\partial \varepsilon_{i,t}^{as,d}} = \alpha_g^{Gi} \alpha_g^{Gj} \left(\sigma_i + \sigma_j\right) \frac{\Delta_{9,i}}{\Delta_1} + \alpha_i^M \frac{\Delta_{10,i}}{\Delta_1} \tag{21}$$

$$\frac{\partial \pi_{i,t}}{\partial \varepsilon_{i,t}^{as,d}} = \alpha_g^{Gi} \alpha_g^{Gj} \left(\sigma_i + \sigma_j\right) \frac{\Delta_{11,i}}{\Delta_1} - \alpha_i^M \frac{\Delta_{13,i}}{\Delta_1} \tag{22}$$

$\Delta_{9,i} > 0$; $\Delta_{10,i} > 0$; $\Delta_{11,i} > 0$; $\Delta_{13,i}$ are defined in Appendix B.

So, obviously, equations (21) and (22) show that after a positive asymmetric demand shock in a given country (i), economic activity and inflation are higher in this country (i) if the budgetary ($\alpha_g^{Gi} > 0$ and $\alpha_g^{Gj} > 0$) or monetary ($\alpha_i^M > 0$) authorities are constrained in their economic policies. Besides, economic activity and inflation are still higher in the country (i) affected by an asymmetric positive

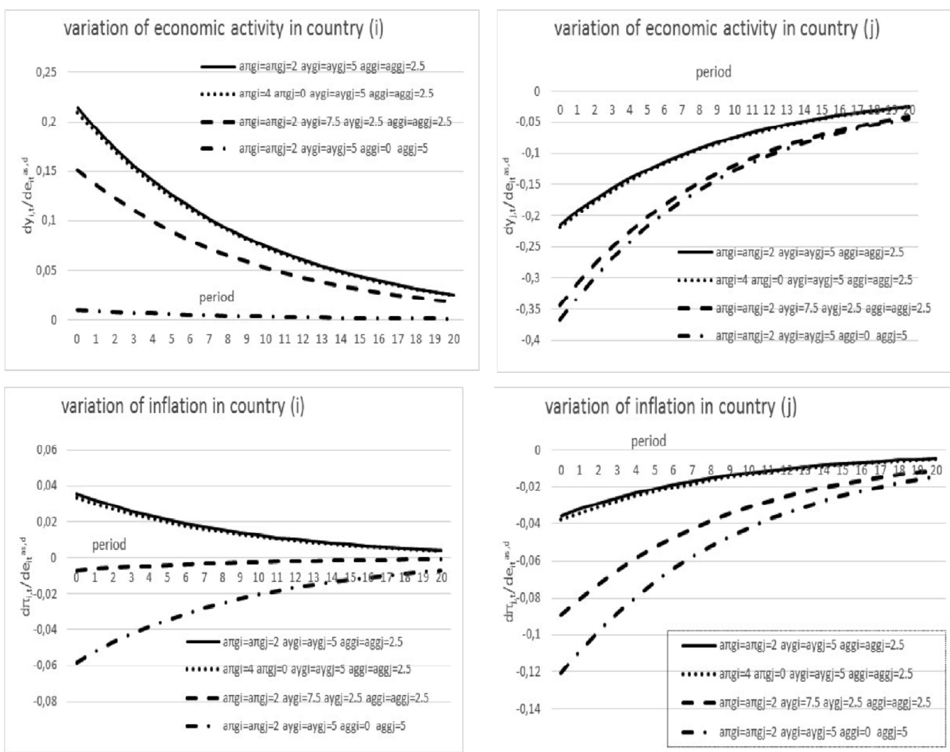

Figure 6: Variation of economic activity and inflation according to the preferences of the governments in case of asymmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 2.5\right)$

Persistence of asymmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\ \varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where (ε_t) is a white noise.

demand shock, if this country gives a weaker weight to stabilizing economic variables and a higher weight to stabilizing the budgetary deficit [($\Delta_{10,i}$) increases and ($\Delta_{13,i}$) decreases if $\left(\alpha_{\pi}^{Gi} < \alpha_{\pi}^{Gj}\right)$ and $\left(\alpha_{y}^{Gi} < \alpha_{y}^{Gj}\right)$, but if $\left(\alpha_{g}^{Gi} < \alpha_{g}^{Gj}\right)$].

Therefore, conclusions are the same for asymmetric as for symmetric demand shocks. Monetary unification could be detrimental for a country with strong budgetary constraints, and with a high preference for the stabilization of budgetary deficits. In the same way, monetary unification could be detrimental for a country with a weak preference for stabilizing economic activity and inflation.

5.2. Structural heterogeneity between the member countries

In case of asymmetric demand shocks, we are now going to analyze the consequences of structural heterogeneities between the member countries of a monetary union. In case of a positive demand shock in a given country (i), according to equation (18), monetary policy is more contractionary and the interest rate very slightly increases if this country (i) has the weakest transmission mechanisms of monetary policy ($\sigma_i < \sigma_j$) [Indeed, then: ($\Delta_{4,i}$) < 0]. According to equation (19), budgetary policy can then be slightly less contractionary in the country (i). However, this effect would remain quite limited [Indeed, ($\Delta_{5,i}$) and ($\Delta_{6,i}$) then decrease, while (Δ_1) and ($\Delta_{7,i}$) also decrease].

The interest rate also slightly increases if the country (i) affected by a positive demand shock has the weakest budgetary multiplier ($\gamma_i < \gamma_j$), in order to compensate for the less efficiency of budgetary policy [Indeed, then: ($\Delta_{4,i}$) < 0]. Besides, the weakness of the budgetary multiplier compel the budgetary surplus to increase further in the country (i), and all the more as monetary policy is hardly constrained $\left(\alpha_{i}^{M} > 0\right)$ [Indeed, then (Δ_1) decreases while ($\Delta_{6,i}$) increases]. Indeed, if the budgetary multiplier is weak, budgetary policy is less efficient to affect economic activity, and it must then be more active in the country (i).

The common nominal interest rate also slightly increases if the monetary authority gives a higher weight to the country (i) which is affected by a positive demand shock ($\alpha_i > \alpha_j$), while the budgetary policy can be on the contrary slightly less contractionary in this country (i) [Indeed, then: ($\Delta_{4,i}$) < 0, while ($\Delta_{5,i}$) decreases]. According to equation (18), the common interest rate also very slightly increases if the sensitivity of prices to national economic activity is higher in the country (i) affected by a positive demand shock ($\xi_i > \xi_j$) than in the foreign country (j) [Indeed: ($\Delta_{4,i}$) < 0]. In these conditions, according to equation (19), the budgetary policy is then also more contractionary in the country (i) [Indeed, then ($\Delta_{6,i}$) increases, even if (Δ_1) and ($\Delta_{7,i}$) also increase, and if ($\Delta_{5,i}$) decreases]. However, if the budgetary policy of the foreign country (j) is hardly constrained $\left(\alpha_{g}^{Gj} > 0\right)$, the budgetary activism of the country (i) is simultaneously reduced, and the effect on the national budgetary policy is then quite limited.

The interest rate also very slightly increases if the sensitivity of national to foreign prices is weaker in the country (i) affected by an asymmetric positive demand shock than in the rest of the monetary union ($\zeta_i < \zeta_j$) [Indeed, then: ($\Delta_{4,i}$) < 0]. In these conditions, the budgetary policy can then be on the contrary less contractionary in the country (i) affected by a positive demand shock [Indeed, (Δ_1) and ($\Delta_{7,i}$) increase, whereas ($\Delta_{5,i}$) and ($\Delta_{6,i}$) decrease]. However, according to our calibration, this effect would remain quite limited. Furthermore, the interest rate also very slightly increases if the sensitivity of national demand to the foreign activity is weaker in the country (i) affected by an asymmetric positive demand shock than in the rest of the monetary union ($\rho_i < \rho_j$) [Indeed, then ($\Delta_{4,i}$) < 0]. In these conditions, the budgetary policy is also more contractionary in this country (i), even if our calibration shows that the effect would remain quite limited [Indeed, then: ($\Delta_{5,i}$) increases and ($\Delta_{7,i}$) decreases, even if ($\Delta_{6,i}$) decreases and if (Δ_1) increases].

After asymmetric demand shocks, what are then the consequences of these economic policies on the stabilization of economic variables? Equations (21) and (22) show that economic activity and inflation are less stabilized in the country (i) where the transmission mechanisms of monetary policy are less efficient ($\sigma_i < \sigma_j$) [Then: (Δ_1) and ($\Delta_{13,i}$) decrease, whereas: ($\Delta_{9,i}$), ($\Delta_{10,i}$) and ($\Delta_{11,i}$) increase]. The effect is then obvious, as equations (21) and (22) show that economic activity and inflation tend to increase both because of interest rate smoothing for the monetary

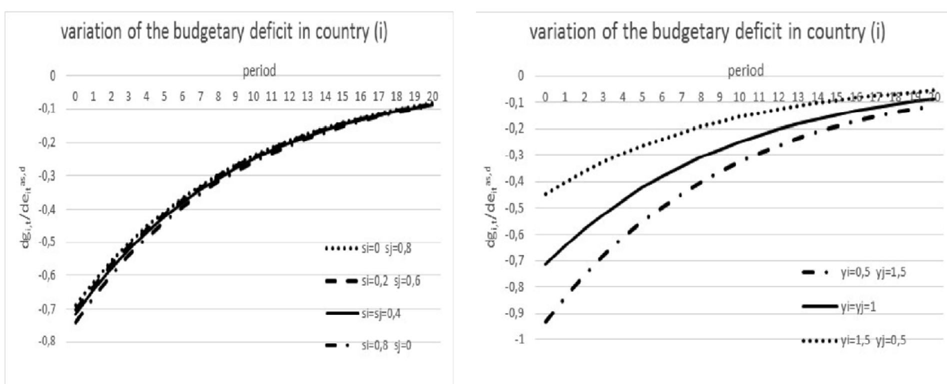

Figure 7: Variation of the budgetary deficit according to the monetary and budgetary transmission mechanisms in case of asymmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 10\right)$

Persistence of asymmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\,\varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where ($\varepsilon_t$) is a white noise.

authority $\left(\alpha_i^M > 0\right)$ limiting the monetary stabilization, and because of the budgetary constraints (α_g^{Gi} and $\alpha_g^{Gj} > 0$) limiting the budgetary stabilization.

Our analytical model also shows that after an asymmetric positive demand shock in a given country (i), economic activity and inflation are both less stabilized if this country has a weaker budgetary multiplier than its partners in the monetary union ($\gamma_i < \gamma_j$), despite the stronger budgetary surplus in this country (i) [Then: (Δ_1) and ($\Delta_{13,i}$) decrease, whereas ($\Delta_{10,i}$) increases]. This destabilizing effect depends and increases with the monetary constraint $\left(\alpha_i^M > 0\right)$. Indeed, the variation of the budgetary surplus has then a limited impact on economic activity in the country (i). Figure 8 also shows that on the contrary, if the budgetary multiplier is higher in

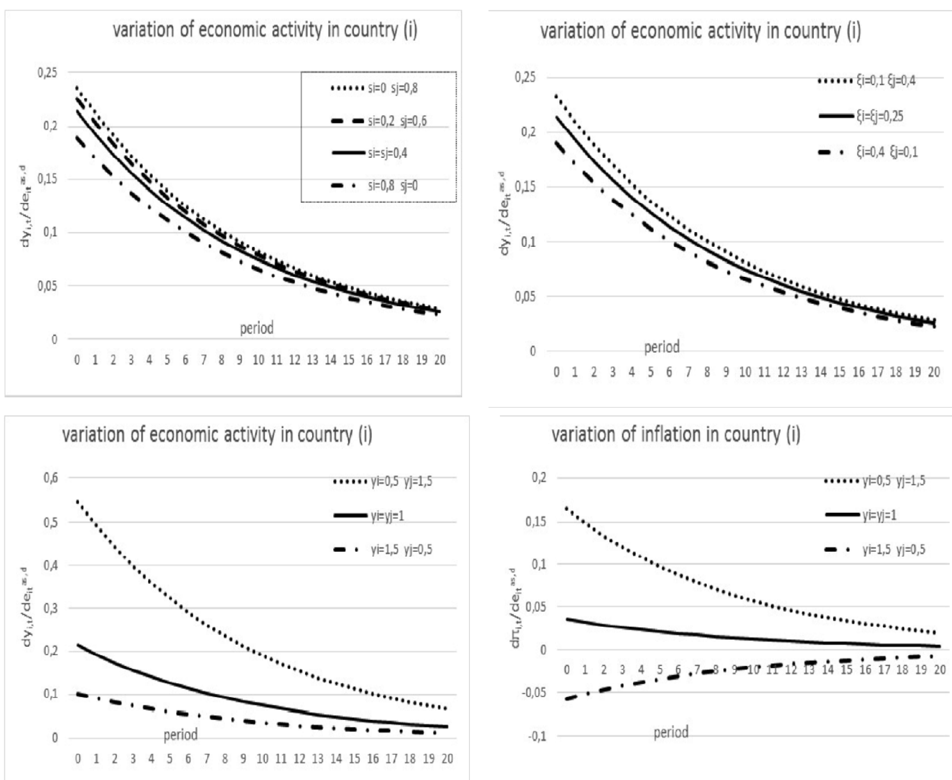

Figure 8: Variation of economic variables according to various structural parameters in case of asymmetric demand shocks

Calibration: basic calibration of structural parameters, $\left(\alpha_i^M > 10\right)$

Persistence of asymmetric demand shocks: $\varepsilon_{i,t+1}^{sy,d} = 0.9\ \varepsilon_{i,t}^{sy,d} + \varepsilon_t$, where (ε_t) is a white noise.

the country (i) than in the rest of the monetary union ($\gamma_i > \gamma_j$), economic activity is then better stabilized by the budgetary activism in this country (i), whereas inflation is then less stabilized [Then: (Δ_1) and ($\Delta_{10,i}$) decrease while ($\Delta_{13,i}$) increases].

In our model, according to equations (B1) and (B2) in Appendix B, the relative size and weight given to each member country of the monetary union by the common central bank (?) only impacts economic variables if monetary transmission mechanisms (?) differ between countries. In the economic literature, for a big country (with a higher weight in the loss function of the central bank), an asymmetric demand shock should imply a stronger reaction of the monetary authority, and therefore a more limited variation of the output-gap. However, Toroj (2009) considers that this incidence of the size of the country could be quite limited.

Furthermore, after an asymmetric positive demand shock in a given country (i), economic activity and inflation are also less stabilized if the sensitivity of demand to foreign activity differs between both countries ($\rho_i \neq \rho_j$). [Then: (Δ_1), ($\Delta_{9,i}$), ($\Delta_{10,i}$), ($\Delta_{11,i}$) and ($\Delta_{13,i}$) all increase]. Toroj (2009) also mentions that the influence of foreign demand on economic activity is ambiguous, and therefore limited. Indeed, if this parameter (ρ) is high, an asymmetric shock translates into more perturbations in the national economy, whereas a more active monetary policy then helps to smooth the consequences of the shock.

Besides, if the sensitivity of national to foreign prices is higher in the country (i) ($\zeta_i > \zeta_j$), inflation and economic activity are both less stabilized in the country (i) [Then: (Δ_1), ($\Delta_{9,i}$), ($\Delta_{10,i}$) and ($\Delta_{13,i}$) all increase whereas ($\Delta_{11,i}$) decreases], despite its higher budgetary activism. On the contrary, if the sensitivity of national to foreign prices is weaker in the country (i) ($\zeta_i < \zeta_j$), inflation is better stabilized whereas economic activity is less stabilized in the country (i) [Then: (Δ_1), ($\Delta_{9,i}$), ($\Delta_{10,i}$) and ($\Delta_{11,i}$) increase while ($\Delta_{13,i}$) decreases]. However, in all these cases, our calibration shows that the effect would remain quite limited.

Finally, the sensitivity of national prices to national economic activity implies a trade-off between stabilizing economic activity and inflation. Indeed, if this sensitivity is weaker in the country (i) affected by an asymmetric demand shock than in the rest of the monetary union ($\xi_i < \xi_j$), inflation is better stabilized but economic activity is less stabilized in this country (i) [Then: (Δ_1), ($\Delta_{9,i}$), ($\Delta_{10,i}$) and ($\Delta_{13,i}$) increase whereas ($\Delta_{11,i}$) decrease]. On the contrary, if this sensitivity is higher in the country (i) ($\xi_i > \xi_j$), inflation is less stabilized whereas economic activity is better stabilized in this country (i) [Then: (Δ_1) and ($\Delta_{11,i}$) increase whereas ($\Delta_{9,i}$), ($\Delta_{10,i}$) and ($\Delta_{13,i}$) decrease]. However, here also, our calibration shows that the effect would remain limited. Toroj (2009) also finds that the inflation responsiveness to the output gap (ξ), market flexibility, price flexibility on the product and labor markets, is a factor which helps to mitigate real economic fluctuations, whereas rigidities prevent prices from quick adjustment to excess demand, in case of asymmetric demand shocks.

Therefore, in case of asymmetric demand shocks, the implications of structural heterogeneities between the member countries of the monetary union on the stabilization of economic activity and inflation would be exactly the same as after symmetric demand shocks.

6. CONCLUSION

The contribution of the current paper is to provide an analytical modelling and precise analytical results regarding the consequences of heterogeneities between the preferences or between the structural parameters of the member countries of a monetary union on monetary and budgetary policies, and on the stabilization of economic activity and inflation. We find that in case of positive (negative) symmetric demand shocks, monetary and budgetary policies are both more contractionary (expansionary), and the burden of economic stabilization then mainly depends on the respective constraints of the economic authorities to modify the common interest rate or the budgetary deficits. In the same way, after an asymmetric demand shock, the biggest part of economic stabilization is realized by the budgetary authorities, and mainly by the one which is the less constrained for its budgetary policy. However, in both cases, monetary or budgetary constraints reduce the potential economic stabilization, and economic activity and inflation are then higher (weaker) in a country affected by a positive (negative) demand shock.

In this context, our modelling can provide important and precise analytical results. First, in case of demand shocks, regarding the preferences of the budgetary authorities, monetary unification could be detrimental for a country with strong budgetary constraints, and with a high preference for stabilizing the budgetary deficit; for example, for a very indebted country with a weak budgetary flexibility. In the same way, monetary unification could be detrimental for a country with a weak preference for stabilizing economic activity and inflation, or with weak automatic stabilizers. In particular, becoming members of the EMU was a challenge and could be more difficult for Central and Eastern European countries, since those Member States have on average lower expenditure to-GDP ratios. On the contrary, larger automatic stabilizers could have facilitated participation to the EMU for France, the Netherlands, Belgium, Austria or Finland.

Besides, regarding structural heterogeneities, in case of symmetric as well as in case of asymmetric demand shocks, monetary unification could be more difficult for a country with weak transmission mechanisms of monetary policy or with a weak budgetary multiplier. Indeed, a country where transmission mechanisms of monetary policy are weak conducts also a less active budgetary policy, and economic variables are then less well stabilized. In this framework, transmissions mechanisms would be mainly weaker in Southern European countries like Spain or Portugal. On the contrary, a country where the budgetary multiplier is weak must have a higher budgetary activism in order to stabilize demand shocks; however, this fiscal policy has then a weak efficiency, and economic activity and inflation are also less well stabilized. In this context, budgetary multiplier seem to be weak in Italy, whereas it is higher in Germany.

To become member of a monetary union could also be more difficult for the countries with the highest sensitivities of national prices to foreign prices (for example: Greece), as economic variables are then less well stabilized despite the stronger budgetary activism. It could also be difficult for the countries with the weakest sensitivities of prices to national economic activity (Italy or Spain), with the strongest rigidities on the labor or product markets, provided stabilizing economic activity is a more important goal for the governments than stabilizing inflation.

This paper analyzes in a precise analytical framework the stabilization of symmetric and asymmetric demand shocks. So, we let the analytical study of the consequences of supply or productivity shocks for monetary and budgetary policies and for the stabilization of economic activity and inflation, in a framework where there are differences in the preferences or structural heterogeneities between the member countries of a monetary union, for another paper.

APPENDIX A: NASH EQUILIBRIUM OF THE MODEL

According to equation (12), with ($\frac{\partial g_{i,k}}{\partial g_{i,t}} = 0$ for k>t), the budgetary deficit chosen in the country (i) verifies:

$$\frac{\partial L_{i,t}^{G}}{\partial g_{i,t}} = 2\alpha_{\pi}^{Gi}\pi_{i,t}\frac{\partial \pi_{i,t}}{\partial g_{i,t}} + 2\alpha_{y}^{Gi}y_{i,t}\frac{\partial y_{i,t}}{\partial g_{i,t}} + 2\alpha_{g}^{Gi}g_{i,t} = 0 \qquad \text{(A1)}$$

Indeed, we only consider the current period, as all periods are ex ante identical. Then, using equations (8), (9), (10) and (11), we obtain a relation between budgetary deficits in both countries, and afterwards, we have:

$$g_{i,t} = f\left[i_t, \left(p_{j,t}^{j} - p_{i,t}^{i}\right), \varepsilon_{i,t}^{sy,d}, \varepsilon_{i,t}^{as,d}, \varepsilon_{i,t}^{sy,s}, \varepsilon_{i,t}^{as,s}\right] \qquad \text{(A2)}$$

Besides, according to equation (13), the nominal interest rate chosen by the monetary authority verifies:

$$\frac{\partial L_{t}^{M}}{\partial i_t} = 2\alpha_{\pi}^{M}\left(\alpha_i\pi_{i,t} + \alpha_j\pi_{j,t}\right)\left(\alpha_i\frac{\partial \pi_{i,t}}{\partial i_t} + \alpha_j\frac{\partial \pi_{j,t}}{\partial i_t}\right)$$
$$+2\alpha_{y}^{M}\left(\alpha_i y_{i,t} + \alpha_j y_{j,t}\right)\left(\alpha_i\frac{\partial y_{i,t}}{\partial i_t} + \alpha_j\frac{\partial y_{j,t}}{\partial i_t}\right) + 2\alpha_{i}^{M}i_t = 0 \qquad \text{(A3)}$$

Therefore, using equations (8), (9), (10) and (11), we obtain the equilibrium common nominal interest rate:

$$i_t = f\left[g_{i,t}, g_{j,t}, \left(p_{j,t}^{j} - p_{i,t}^{i}\right), \varepsilon_{i,t}^{sy,d}, \varepsilon_{i,t}^{as,d}, \varepsilon_{i,t}^{sy,s}, \varepsilon_{i,t}^{as,s}\right] \qquad \text{(A4)}$$

Finally, by combining this equation (A4) with the budgetary deficits ($g_{i,t}$) and ($g_{j,t}$) in equation (A2), we obtain the following equilibrium nominal interest rate:

$$i_t = \left\{\frac{2}{(\sigma_i + \sigma_j)} - \frac{2\alpha_i^M\Delta_2}{(\sigma_i + \sigma_j)\Delta_1} + \frac{(\sigma_i - \sigma_j)\Delta_{4,i}}{(\sigma_i + \sigma_j)\Delta_1}\right\}\varepsilon_{i,t}^{sy,d} - \frac{\Delta_{4,i}}{\Delta_1}\varepsilon_{i,t}^{as,d}$$
$$+f\left[\left(p_{j,t}^{j} - p_{i,t}^{i}\right), \varepsilon_{i,t}^{sy,s}, \varepsilon_{i,t}^{as,s}\right] \qquad \text{(A5)}$$

$\Delta_1 = \Delta_3 + \alpha_i^M\Delta_2 > 0$

(Δ_1) decreases if ($\alpha_{\pi}^{Gi} \neq \alpha_{\pi}^{Gj}$), ($\alpha_{y}^{Gi} \neq \alpha_{y}^{Gj}$) and ($\alpha_{g}^{Gi} \neq \alpha_{g}^{Gj}$).

(Δ_1) decreases if ($\sigma_i \neq \sigma_j$) and ($\gamma_i \neq \gamma_j$), but it increases if ($\xi_i \neq \xi_j$), ($\rho_i \neq \rho_j$) and ($\zeta_i \neq \zeta_j$).

$$\Delta_2 = \alpha_g^{Gi}\alpha_g^{Gj}\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j - (\sigma_i + \sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j + \sigma_i\rho_j\zeta_i)\xi_j\right]^3$$
$$+\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j - (\sigma_i + \sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j + \sigma_i\rho_j\zeta_i)\xi_j\right]$$

$$[\alpha_y^{Gi}\alpha_g^{Gj}\gamma_i^2\left(1-\zeta_i\zeta_j-\sigma_j\xi_j\right)^2+\alpha_g^{Gi}\alpha_y^{Gj}\gamma_j^2\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)^2$$

$$+\alpha_g^{Gi}\alpha_\pi^{Gj}\gamma_j^2\left(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i\right)^2+\alpha_\pi^{Gi}\alpha_g^{Gj}\gamma_i^2\left(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j\right)^2]$$

$$+\alpha_y^{Gi}\alpha_\pi^{Gj}\gamma_i^2\gamma_j^2\xi_j\left(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i\right)\left(1-\zeta_i\zeta_j-\sigma_j\xi_j\right)$$

$$+\alpha_y^{Gj}\alpha_\pi^{Gi}\gamma_i^2\gamma_j^2\xi_i\left(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j\right)\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)$$

$$+\alpha_y^{Gi}\alpha_y^{Gj}\gamma_i^2\gamma_j^2\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)\left(1-\zeta_i\zeta_j-\sigma_j\xi_j\right)\left(1-\zeta_i\zeta_j\right)$$

$$+\alpha_\pi^{Gi}\alpha_\pi^{Gj}\gamma_i^2\gamma_j^2\xi_i\xi_j\left(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j\right)\left(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i\right)>0$$

$$\Delta_3=\alpha_\pi^M\alpha_g^{Gi}\alpha_g^{Gj}\left[\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)\left(\sigma_i+\sigma_j\rho_i\right)-\xi_i\sigma_i\sigma_j\xi_j+\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left(\sigma_j+\sigma_i\rho_j\right)\right]^2$$

$$\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$

$$+\alpha_\pi^M\left[\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)\left(\sigma_i+\sigma_j\rho_i\right)-\sigma_i\sigma_j\xi_j\xi_i+\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left(\sigma_j+\sigma_i\rho_j\right)\right]$$

$$[\alpha_y^{Gi}\alpha_g^{Gj}\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\gamma_i^2\left(1-\zeta_i\zeta_j-\sigma_j\xi_j\right)\sigma_j+\alpha_g^{Gi}\alpha_y^{Gj}\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)\gamma_j^2\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)\sigma_i$$

$$+\alpha_g^{Gi}\alpha_\pi^{Gj}\alpha_i\xi_i\xi_j\gamma_j^2\left(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i\right)\sigma_i$$

$$+\alpha_\pi^{Gi}\alpha_g^{Gj}\alpha_j\xi_i\xi_j\gamma_i^2\left(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j\right)\sigma_j]$$

$$+\alpha_y^M\alpha_g^{Gi}\alpha_g^{Gj}\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$

$$[(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j)\left(1-\zeta_i\zeta_j\right)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)-\alpha_j\sigma_j\sigma_i\xi_i\left(1-\zeta_j\right)]^2$$

$$+\alpha_y^M\left[\left(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j\right)\left(1-\zeta_i\zeta_j\right)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)-\alpha_j\sigma_j\sigma_i\xi_i\left(1-\zeta_j\right)\right]$$

$$[\alpha_y^{Gi}\alpha_g^{Gj}\left(1-\zeta_i\zeta_j-\sigma_j\xi_j\right)\alpha_j\gamma_i^2\sigma_j\left(1-\zeta_i\zeta_j\right)+\alpha_g^{Gi}\alpha_y^{Gj}\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)\alpha_i\gamma_j^2\sigma_i\left(1-\zeta_i\zeta_j\right)$$

$$+\alpha_g^{Gi}\alpha_\pi^{Gj}\gamma_j^2\left(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i\right)\sigma_i\left(\alpha_i\xi_j-\alpha_j\zeta_j\xi_i\right)$$

$$+\alpha_\pi^{Gi}\alpha_g^{Gj}\gamma_i^2(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)\sigma_j\left(\alpha_j\xi_i-\alpha_i\xi_j\zeta_i\right)]>0$$

$$\Delta_{4,i}=\alpha_\pi^M\alpha_g^{Gi}\alpha_g^{Gj}\left[\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)\left(\sigma_i+\sigma_j\rho_i\right)-\sigma_i\sigma_j\xi_j\xi_i+\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left(\sigma_j+\sigma_i\rho_j\right)\right]$$

$$\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$

$$\left[-\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)(1-\rho_i)-\xi_i\xi_j(\alpha_j\sigma_i-\alpha_i\sigma_j)+\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left(1-\rho_j\right)\right]$$

$$+\alpha_{\pi}^{M}\left[\xi_i(\alpha_i+\alpha_j\zeta_j)(\sigma_i+\sigma_j\rho_i)-\sigma_i\sigma_j\xi_j\xi_i+\xi_j(\alpha_j+\alpha_i\zeta_i)(\sigma_j+\sigma_i\rho_j)\right]$$

$$[\alpha_g^{Gj}\alpha_y^{Gi}\gamma_i^2\xi_j(1-\zeta_i\zeta_j-\sigma_j\xi_j)(\alpha_j+\alpha_i\zeta_i)-\alpha_g^{Gi}\alpha_y^{Gj}\gamma_j^2\xi_i(\alpha_i+\alpha_j\zeta_j)(1-\zeta_i\zeta_j-\sigma_i\xi_i)$$

$$-\alpha_{\pi}^{Gj}\alpha_g^{Gi}\alpha_i\xi_i\xi_j\gamma_j^2(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i)+\alpha_{\pi}^{Gi}\alpha_g^{Gj}\alpha_j\xi_i\xi_j\gamma_i^2(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)]$$

$$+\alpha_y^{M}\alpha_g^{Gi}\alpha_g^{Gj}\left[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j\right]$$

$$\left[(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j)(1-\zeta_i\zeta_j)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)-\alpha_j\sigma_j\sigma_i\xi_i(1-\zeta_j)\right]$$

$$\left[(\alpha_i\rho_i-\alpha_i+\alpha_j-\alpha_j\rho_j)(1-\zeta_i\zeta_j)+(\alpha_i\xi_j\sigma_j-\alpha_j\xi_i\sigma_i-\alpha_j\xi_i\sigma_j\zeta_j+\alpha_i\xi_j\sigma_i\zeta_i)\right]$$

$$+\alpha_y^{M}\left[(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j)(1-\zeta_i\zeta_j)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)-\alpha_j\sigma_j\sigma_i\xi_i(1-\zeta_j)\right]$$

$$\begin{aligned}&[\alpha_g^{Gj}\alpha_y^{Gi}\gamma_i^2\alpha_j(1-\zeta_i\zeta_j)(1-\zeta_i\zeta_j-\sigma_j\xi_j)\\&\quad-\alpha_g^{Gi}\alpha_y^{Gj}\gamma_j^2\alpha_i(1-\zeta_i\zeta_j-\sigma_i\xi_i)(1-\zeta_i\zeta_j)\\&\quad-\alpha_{\pi}^{Gj}\alpha_g^{Gi}\gamma_j^2(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i)(\alpha_i\xi_j-\alpha_j\zeta_j\xi_i)\\&\qquad+\alpha_{\pi}^{Gi}\alpha_g^{Gj}\gamma_i^2(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)(\alpha_j\xi_i-\alpha_i\zeta_i\xi_j)]\end{aligned}$$

($\Delta_{4,i}>0$) if ($\alpha_{\pi}^{Gi}>\alpha_{\pi}^{Gj}$) and ($\alpha_y^{Gi}>\alpha_y^{Gj}$), but if ($\alpha_g^{Gi}<\alpha_g^{Gj}$).

($\Delta_{4,i}>0$) if ($\sigma_i>\sigma_j$), ($\zeta_i>\zeta_j$), ($\rho_i<\rho_j$)and ($\gamma_i>\gamma_j$), but if ($\xi_i<\xi_j$),and ($\alpha_i<\alpha_j$).

So, replacing this equation (A5) in equation (A2), we obtain the following budgetary expenditure in the country (i):

$$\begin{aligned}g_{i,t}=\gamma_i\left\{(\sigma_i-\sigma_j)\alpha_g^{Gj}\frac{\Delta_{5,i}}{\Delta_1}-\alpha_i^{M}\frac{\Delta_{6,i}}{\Delta_1}\right\}\varepsilon_{i,t}^{sy,d}+f\left[(p_{j,t}^{j}-p_{i,t}^{i}),\varepsilon_{i,t}^{sy,s},\varepsilon_{i,t}^{as,s}\right]\\-\gamma_i\left\{(\sigma_i+\sigma_j)\alpha_g^{Gj}\frac{\Delta_{5,i}}{\Delta_1}+\alpha_i^{M}\frac{\Delta_{6,i}}{\Delta_1}-2\alpha_i^{M}\alpha_g^{Gj}\frac{\Delta_{7,i}}{\Delta_1}\right\}\varepsilon_{i,t}^{as,d}\end{aligned}\tag{A6}$$

$$\begin{aligned}\Delta_{5,i}=\alpha_{\pi}^{M}\xi_j&\left[\xi_i(\alpha_i+\alpha_j\zeta_j)(\sigma_i+\sigma_j\rho_i)-\sigma_i\sigma_j\xi_j\xi_i+\xi_j(\alpha_j+\alpha_i\zeta_i)(\sigma_j+\sigma_i\rho_j)\right]\\&\left[\alpha_y^{Gi}(\alpha_j+\alpha_i\zeta_i)(1-\zeta_i\zeta_j-\sigma_j\xi_j)+\alpha_{\pi}^{Gi}\alpha_j\xi_i(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)\right]\\+\alpha_y^{M}&\left[(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j)(1-\zeta_i\zeta_j)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)-\alpha_j\sigma_j\sigma_i\xi_i(1-\zeta_j)\right]\\&\left[\alpha_y^{Gi}(1-\zeta_i\zeta_j)\alpha_j(1-\zeta_i\zeta_j-\sigma_j\xi_j)+\alpha_{\pi}^{Gi}(\alpha_j\xi_i-\alpha_i\xi_j\zeta_i)(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)\right]>0\end{aligned}$$

$$\Delta_{6,i}=\alpha_y^{Gi}\alpha_y^{Gj}\gamma_j^2(1-\zeta_i\zeta_j-\sigma_j\xi_j)(1-\zeta_i\zeta_j-\sigma_i\xi_i)(1-\zeta_i\zeta_j)$$

$$+\alpha_g^{Gj}\alpha_y^{Gi}(1-\zeta_i\zeta_j-\sigma_j\xi_j)[(1+\rho_i)(1-\zeta_i\zeta_j)-(\sigma_j-\sigma_i\zeta_i)\xi_j]$$
$$[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j]$$
$$+\alpha_\pi^{Gi}\alpha_g^{Gj}(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)[\xi_i(1+\rho_i)-\sigma_j\xi_i\xi_j+\zeta_i\xi_j(1+\rho_j)]$$
$$[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j]$$
$$+\alpha_\pi^{Gi}\alpha_y^{Gj}\xi_i\gamma_j^2(1-\zeta_i\zeta_j-\sigma_i\xi_i)(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)$$
$$+\alpha_\pi^{Gj}\alpha_y^{Gi}\xi_j\gamma_j^2(1-\zeta_i\zeta_j-\sigma_j\xi_j)(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i)$$
$$+\alpha_\pi^{Gj}\alpha_\pi^{Gi}\xi_i\xi_j\gamma_j^2(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i)>0$$

$$\Delta_{7,i}=[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j]$$
$$\{\alpha_y^{Gi}(1-\zeta_i\zeta_j-\sigma_j\xi_j)[\rho_i(1-\zeta_i\zeta_j)+\sigma_i\zeta_i\xi_j]+\alpha_\pi^{Gi}(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)(\xi_i\rho_i+\zeta_i\xi_j)\}>0$$

($\Delta_{5,i}$) increases if ($\alpha_\pi^{Gi}>\alpha_\pi^{Gj}$) and ($\alpha_y^{Gi}>\alpha_y^{Gj}$)

($\Delta_{5,i}$) increases if ($\sigma_i>\sigma_j$) and ($\zeta_i>\zeta_j$), but if ($\xi_i<\xi_j$), ($\rho_i<\rho_j$), and ($\alpha_i<\alpha_j$)

($\Delta_{6,i}$) increases if ($\alpha_\pi^{Gi}>\alpha_\pi^{Gj}$) and ($\alpha_y^{Gi}>\alpha_y^{Gj}$), but if ($\alpha_g^{Gi}<\alpha_g^{Gj}$)

($\Delta_{6,i}$) increases if ($\sigma_i>\sigma_j$), ($\xi_i>\xi_j$), ($\zeta_i>\zeta_j$) and ($\rho_i>\rho_j$), but if ($\gamma_i<\gamma_j$)

($\Delta_{7,i}$) increases if ($\alpha_\pi^{Gi}>\alpha_\pi^{Gj}$) and ($\alpha_y^{Gi}>\alpha_y^{Gj}$).

($\Delta_{7,i}$) increases if ($\zeta_i\neq\zeta_j$), and if ($\sigma_i>\sigma_j$), ($\xi_i>\xi_j$) and ($\rho_i>\rho_j$)

APPENDIX B: ECONOMIC ACTIVITY AND INFLATION

Replacing equation (A5) for (i_t) and equation (A6) for ($g_{i,t}$)) and ($g_{j,t}$)) in equation (10), we obtain the following economic activity in the country (i):

$$y_{i,t}=\left\{\alpha_i^M\frac{\Delta_{8,i}}{\Delta_1}-\alpha_g^{Gi}\alpha_g^{Gj}(\sigma_i-\sigma_j)\frac{\Delta_{9,i}}{\Delta_1}\right\}\varepsilon_{i,t}^{sy,d}+f[(p_{j,t}^j-p_{i,t}^i),\varepsilon_{i,t}^{sy,s},\varepsilon_{i,t}^{as,s}]$$
$$+\left\{\alpha_i^M\frac{\Delta_{10,i}}{\Delta_1}+\alpha_g^{Gi}\alpha_g^{Gj}(\sigma_i+\sigma_j)\frac{\Delta_{9,i}}{\Delta_1}\right\}\varepsilon_{i,t}^{as,d}\quad\text{(B1)}$$

$$\Delta_{8,i}=[(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j]$$
$$\{\alpha_g^{Gi}\alpha_g^{Gj}[(1+\rho_i)(1-\zeta_i\zeta_j)-(\sigma_j-\sigma_i\zeta_i)\xi_j][(1-\zeta_i\zeta_j)(1-\rho_i\rho_j)+\sigma_i\sigma_j\xi_i\xi_j$$
$$-(\sigma_i+\sigma_j\rho_i\zeta_j)\xi_i-(\sigma_j+\sigma_i\rho_j\zeta_i)\xi_j]$$

$$+\alpha_g^{Gi}\alpha_y^{Gj}\gamma_j^2\left(1-\zeta_i\zeta_j\right)\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)+\alpha_g^{Gi}\alpha_\pi^{Gj}\gamma_j^2\xi_j(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i)$$
$$-\alpha_\pi^{Gi}\alpha_g^{Gj}\xi_j\zeta_i\gamma_i^2\left(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j\right)\}$$

$$\Delta_{9,i}=\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$
$$\{\alpha_\pi^M\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left[\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)\left(\sigma_i+\sigma_j\rho_i\right)-\xi_i\sigma_i\sigma_j\xi_j+\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left(\sigma_j+\sigma_i\rho_j\right)\right]$$
$$+\alpha_y^M\left(1-\zeta_i\zeta_j\right)\alpha_j\left[\left(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j\right)\left(1-\zeta_i\zeta_j\right)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)\right.$$
$$\left.-\alpha_j\sigma_j\sigma_i\xi_i\left(1-\zeta_j\right)\right]>0$$

$$\Delta_{10,i}=\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$
$$\{\alpha_g^{Gi}\alpha_g^{Gj}\left[(1-\rho_i)\left(1-\zeta_i\zeta_j\right)-\left(\sigma_j+\sigma_i\zeta_i\right)\xi_j\right]\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j\right.$$
$$\left.-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$
$$+\alpha_g^{Gi}\gamma_j^2\left[\alpha_y^{Gj}\left(1-\zeta_i\zeta_j\right)\left(1-\zeta_i\zeta_j-\sigma_i\xi_i\right)+\alpha_\pi^{Gj}\xi_j(\xi_j-\xi_i\sigma_i\xi_j+\xi_i\zeta_j\rho_i)\right]$$
$$+\alpha_\pi^{Gi}\alpha_g^{Gj}\xi_j\zeta_i\gamma_i^2(\xi_i-\xi_i\sigma_j\xi_j+\xi_j\zeta_i\rho_j)\}>0$$

($\Delta_{8,i}$) increases if ($\alpha_\pi^{Gi}<\alpha_\pi^{Gj}$) and ($\alpha_y^{Gi}<\alpha_y^{Gj}$), but if ($\alpha_g^{Gi}>\alpha_g^{Gj}$)

($\Delta_{8,i}$) increases if ($\zeta_i \neq \zeta_j$), ($\rho_i \neq \rho_j$), and if ($\sigma_i < \sigma_j$), ($\xi_i < \xi_j$) and ($\gamma_i < \gamma_j$)

($\Delta_{9,i}$) increases if ($\sigma_i \neq \sigma_j$), ($\rho_i \neq \rho_j$), ($\zeta_i \neq \zeta_j$), and if ($\xi_i < \xi_j$) and ($\alpha_i < \alpha_j$)

($\Delta_{10,i}$) increases if ($\alpha_\pi^{Gi}<\alpha_\pi^{Gj}$) and ($\alpha_y^{Gi}<\alpha_y^{Gj}$), but if ($\alpha_g^{Gi}>\alpha_g^{Gj}$)

($\Delta_{10,i}$) increases if ($\rho_i \neq \rho_j$), ($\zeta_i \neq \zeta_j$), and if ($\sigma_i < \sigma_j$), ($\xi_i < \xi_j$) and ($\gamma_i < \gamma_j$)

Replacing equation (A5) for (i_t) and equation (A6) for ($g_{i,t}$) and ($g_{j,t}$) in equation (8), we obtain the following inflation rate in the country (i):

$$\pi_{i,t}=\left\{\alpha_i^M\frac{\Delta_{12,i}}{\Delta_1}-\alpha_g^{Gi}\alpha_g^{Gj}\left(\sigma_i-\sigma_j\right)\frac{\Delta_{11,i}}{\Delta_1}\right\}\varepsilon_{i,t}^{sy,d}+f\left[\left(p_{j,t}^j-p_{i,t}^i\right),\varepsilon_{i,t}^{sy,s},\varepsilon_{i,t}^{as,s}\right]$$
$$-\left\{\alpha_i^M\frac{\Delta_{13,i}}{\Delta_1}-\alpha_g^{Gi}\alpha_g^{Gj}\left(\sigma_i+\sigma_j\right)\frac{\Delta_{11,i}}{\Delta_1}\right\}\varepsilon_{i,t}^{as,d} \quad \text{(B2)}$$

$$\Delta_{11,i}=\left[\left(1-\zeta_i\zeta_j\right)\left(1-\rho_i\rho_j\right)+\sigma_i\sigma_j\xi_i\xi_j-\left(\sigma_i+\sigma_j\rho_i\zeta_j\right)\xi_i-\left(\sigma_j+\sigma_i\rho_j\zeta_i\right)\xi_j\right]$$
$$\{\alpha_\pi^M\xi_i\xi_j\alpha_j\left[\xi_i\left(\alpha_i+\alpha_j\zeta_j\right)\left(\sigma_i+\sigma_j\rho_i\right)-\xi_i\sigma_i\sigma_j\xi_j+\xi_j\left(\alpha_j+\alpha_i\zeta_i\right)\left(\sigma_j+\sigma_i\rho_j\right)\right]$$
$$+\alpha_y^M(\alpha_j\xi_i-\alpha_i\zeta_i\xi_j)[\left(\alpha_i\sigma_i+\alpha_i\sigma_j\rho_i+\alpha_j\sigma_j+\alpha_j\sigma_i\rho_j\right)\left(1-\zeta_i\zeta_j\right)-\alpha_i\sigma_i\sigma_j\xi_j(1-\zeta_i)$$
$$-\alpha_j\sigma_j\sigma_i\xi_i\left(1-\zeta_j\right)]]\}\quad>0$$

$$\Delta_{12,i} = [(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j - (\sigma_i + \sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j + \sigma_i\rho_j\zeta_i)\xi_j]$$
$$\{\alpha_g^{Gi}\alpha_g^{Gj}[\zeta_i\xi_j(1+\rho_j) - \sigma_j\xi_j\xi_i + \xi_i(1+\rho_i)][(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j$$
$$- (\sigma_i + \sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j + \sigma_i\rho_j\zeta_i)\xi_j]$$
$$+\alpha_g^{Gj}\alpha_y^{Gi}\gamma_i^2\zeta_i\xi_j(1-\zeta_i\zeta_j - \sigma_j\xi_j)$$
$$+\alpha_g^{Gi}\gamma_j^2\xi_i[\alpha_y^{Gj}(1-\zeta_i\zeta_j - \sigma_i\xi_i) + \alpha_\pi^{Gj}\xi_j(\xi_j - \xi_i\sigma_i\xi_j + \xi_i\zeta_j\rho_i)]\} > 0$$

$$\Delta_{13,i} = [(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j - (\sigma_i + \sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j + \sigma_i\rho_j\zeta_i)\xi_j]$$
$$\{\alpha_g^{Gi}\alpha_g^{Gj}[\zeta_i\xi_j(1-\rho_j) - \xi_i(1-\rho_i) + \sigma_j\xi_i\xi_j][(1-\zeta_i\zeta_j)(1-\rho_i\rho_j) + \sigma_i\sigma_j\xi_i\xi_j$$
$$- (\sigma_i + \sigma_j\rho_i\zeta_j)\xi_i - (\sigma_j + \sigma_i\rho_j\zeta_i)\xi_j]$$
$$+\alpha_g^{Gj}\alpha_y^{Gi}\gamma_i^2\zeta_i\xi_j(1-\zeta_i\zeta_j - \sigma_j\xi_j)$$
$$-\alpha_g^{Gi}\gamma_j^2\xi_i[\alpha_y^{Gj}(1-\zeta_i\zeta_j - \sigma_i\xi_i) + \alpha_\pi^{Gj}\xi_j(\xi_j - \xi_i\sigma_i\xi_j + \xi_i\zeta_j\rho_i)]\}$$

($\Delta_{11,i}$) increases if ($\sigma_i \neq \sigma_j$), ($\rho_i \neq \rho_j$), and if ($\zeta_i < \zeta_j$), ($\xi_i > \xi_j$), and ($\alpha_i < \alpha_j$)

($\Delta_{12,i}$) increases if ($\alpha_\pi^{Gi} < \alpha_\pi^{Gj}$) and ($\alpha_y^{Gi} < \alpha_y^{Gj}$), but if ($\alpha_g^{Gi} > \alpha_g^{Gj}$)

($\Delta_{12,i}$) increases if ($\zeta_i \neq \zeta_j$), ($\rho_i \neq \rho_j$), and if ($\sigma_i < \sigma_j$), ($\xi_i > \xi_j$) and ($\gamma_i < \gamma_j$)

($\Delta_{13,i}$) increases if ($\alpha_\pi^{Gi} > \alpha_\pi^{Gj}$) and ($\alpha_y^{Gi} > \alpha_y^{Gj}$), but if ($\alpha_g^{Gi} < \alpha_g^{Gj}$)

($\Delta_{13,i}$) increases if ($\zeta_i > \zeta_j$), ($\rho_i > \rho_j$), ($\sigma_i > \sigma_j$) and ($\gamma_i > \gamma_j$) but if ($\xi_i < \xi_j$)

NOTE

1. Van Aarle *et al.* (2001) use a very similar model, but they also introduce the nominal wage as exogenous variable of the model, and a goal of stabilizing the unemployment rate in the loss function of the economic authorities, in order to study the importance of the adjustment on the labor market.

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