Structural heterogeneity and partial budgetary cooperation in a monetary union

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Abstract

The paper analyzes the usefulness of the budgetary cooperation in a monetary union, even if it is limited to a subgroup of countries with close structural characteristics. We find that its advantages depend on the nature of the shocks and on the width of the heterogeneities within the monetary union. The budgetary cooperation, between countries where the sensibilities of the economic activity to the public expenditures and to the foreign economic activity are sufficiently high, is beneficial to stabilize symmetrical demand shocks. It is beneficial to stabilize symmetrical supply shocks if it concerns a sufficiently large number of countries. On the contrary, the budgetary cooperation is generally detrimental to stabilize asymmetrical demand or supply shocks.

keywords: economic stabilization, monetary union, budgetary cooperation, demand shocks, supply shocks, structural heterogeneity.

JEL classification numbers: E61, E63, F41, F42

1 Introduction

Monetary unification and the creation of the Economic and Monetary Union (EMU) suppressed two stabilization mechanisms for the member countries of the monetary union: the autonomous variation in the exchange rates and in the interest rates. According to the Optimal Currency Area theory, the stabilization can then first be provided by the mobility of the production factors (labor, capital). Nevertheless, as this mobility seems quite low today in Europe, fiscal transfers or a kind of budgetary cooperation can also be useful. Indeed, the cooperation between the budgetary authorities is often argued to be necessary in the framework of a monetary unification, in order to prevent the excessive and conflicting

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use of the budgetary instrument in the various member countries, and in order to obtain global and more efficient effects when large positive externalities exist. It is also often considered as a fundamental condition in order to maintain price stability in the monetary union. Therefore, in the context of the EMU, fiscal decisions have been restricted in the framework of the Stability and Growth Pact and of the Excessive Deficit Procedure (article 104 of the Maastricht Treaty), in the direction of a long run budgetary sustainability. This institutional framework aims at insuring the fiscal discipline in the EMU, and therefore, at preventing lax fiscal policies which could endanger the price stability aim of the European Central Bank (ECB). However, in the framework of the ECOFIN Council, or in the more informal context of the Euro-group, the European governments could perhaps have interest in coordinating more strictly their budgetary policies in the short term. Indeed, currently, the effective coordination of the budgetary decisions is very weak and quite minimal in Europe.

More precisely, in Europe, there is now a single monetary policy decided by the independent ECB, but many national and decentralized budgetary policies. The conduct of monetary policy is then made difficult because of the asymmetries in the conjuncture conditions and in the shocks hitting the member countries. Indeed, a common monetary policy can then no longer respond to asymmetrical shocks: it can only stabilize average variables. In this framework, the sharing of responsibilities between the economic authorities, the ECB mainly stabilizing the common and symmetrical shocks whereas the governments stabilize the asymmetrical shocks, is generally obtained in the framework of a structurally homogeneous monetary union. But the conduct of monetary policy is also made difficult because of the asymmetries in the transmission mechanisms of these shocks and of the economic policies. For example, in Europe, the European countries are very heterogeneous regarding their opening rates and regarding the sensibility of their exports to price competitiveness or economic activity differentials. But whereas the first concern, the asymmetry in the shocks, has been widely studied in the literature, the second point of interest, the structural heterogeneity between the member countries of a monetary union, has perhaps been less often analyzed. However, the structural heterogeneities are still very important in Europe, regarding the financial structure (degrees of financial intermediation and capital markets), as well as regarding the labor markets (centralization of negotiations, wage flexibility), as shown for example by Penot *et al.* (2000). Furthermore, with the gradual enlargement of the Eurozone, these heterogeneities will become even more significant and will therefore influence the mechanisms of macroeconomic stabilization.

The idea of a 'reinforced cooperation' between a group of European countries has then been advanced. In this context, the cooperation would be limited to a group of countries which have close structural characteristics. So, the aim of the current paper is to analyze whether such a limited cooperation could not be more

beneficial than an absence of any budgetary cooperation between all European countries for the stabilization of demand or supply shocks. Indeed, we consider that the structural heterogeneity of the monetary union affects the relative benefit of the budgetary cooperation, and we study the efficiency of this cooperation in terms of macroeconomic stabilization. More precisely, we will make a distinction between the shocks according to their type and origin and we will analyze whether the fiscal cooperation can improve the global national welfare in the monetary union.

To study this question, the second section gives a review of literature. The third section describes the model, whereas the fourth section defines the various economic activity levels, according to the degree of cooperation between the budgetary authorities. The fifth section analyzes the stabilization of symmetrical and asymmetrical demand shocks, and the sixth section the stabilization of supply shocks. The seventh section concludes.

2 The economic literature

The economic literature about the consequences of monetary unification on the optimal policy-mix and on the stabilization of various shocks is very large. More specifically, many papers study the implications of a common currency for the necessity also to coordinate the budgetary policies of the members of a monetary union. E.g. Beetsma *et al.* (2001) consider that monetary unification boosts welfare by increasing the strategic position of the central bank, and by limiting the 'spending distortion' that encourages the governments to increase their public expenditures. Nevertheless, an eventual fiscal coordination would strengthen the strategic position of the governments, and would reduce this disciplining effect of monetary unification: it could then be counterproductive. On the contrary, Levine and Pearlman (2001) find that there are significant incentives for countries to free-ride from the benefits that staying out the monetary union provides. Joining a monetary union could therefore only be convenient if the 'ins' coordinate their fiscal policies, which is a necessary condition for a large monetary union to become feasible. In the same way, Catenaro and Tirelli (2000) assume that if the fiscal authorities have an incentive to increase their public expenditures to boost welfare, the fiscal coordination might be beneficial to reduce this spending distortion, and all the more as the central bank is conservative, and as monetary policy will anyway vanish any budgetary tentative to boost output by excessive expenditures. Furthermore, Villieu (2000) shows that after a monetary unification, the higher budgetary decentralization increases the optimal average inflation and implies an inefficient budgetary reaction to symmetrical supply shocks. As enlargement exacerbates these two problems, it increases fiscal coordination benefits. However, it decreases the countries' temptation to resort to insufficiently active budgetary policies to stabilize their own asymmetrical demand shocks, and

may then constitute a good substitute for fiscal coordination.

Therefore, fiscal policy coordination can have different effects according to the type of shocks affecting the economy. For example, Uhlig (2002) assumes that the specialization between the economic authorities is beneficial. The monetary authority should stabilize symmetrical shocks, and the budgetary authorities asymmetrical shocks. Furthermore, the Stability and Growth Pact is beneficial as implicit coordination mechanism between the budgetary authorities, in order to improve the macroeconomic stabilization. Indeed, it prevents the budgetary authorities from an excessive use of their fiscal expenditures, which could only result in a higher level of interest rates. Nevertheless, Villieu (2000) states that with the enlargement of the monetary Union, the fiscal coordination becomes less efficient if the degree of shock asymmetry grows. In the same way, Andersen (2002) finds that the costs of non-cooperative fiscal policies tend to be large in case of aggregate (symmetrical) shocks, and increase with the number of policy actors; on the contrary, these costs are small in the case of idiosyncratic shocks, and decreasing in the number of actors. On the opposite, Beetsma *et al.* (2001) show that paradoxically, fiscal policy coordination has positive effects on the stabilization of asymmetrical shocks, but that it can be useless and even detrimental in order to stabilize symmetrical shocks. The conclusions of the existing studies regarding the usefulness of the fiscal coordination remain, therefore, very mixed.

Ad regards the nature of this budgetary coordination, Mundschenk and Von Hagen (2003) claim that the fiscal policies are inefficient being limited exclusively to the use of automatic stabilizers, and that the Stability Pact cannot guarantee an efficient macroeconomic stabilization. They support the idea of an active coordination of the fiscal policies that could improve the efficiency of the macroeconomic stabilization compared to a non cooperative equilibrium. Indeed, in the short run, the authors underline the potential conflicts of goals between the budgetary authorities and between them and the central bank, which are not currently efficiently taken into account by the European institutional framework. Lambertini and Rovelli (2003) also defend the same idea, and they show that the informational power plays an essential part in the mechanisms of shock stabilization. Thus, the governments leadership improves the efficiency of macroeconomic stabilization, and the budgetary policies should efficiently be coordinated, in particular along the Broad Economic Policy Guidelines, in order to take properly into account the broad interests of all the monetary union.

Nevertheless, all these studies, like most of the literature on the subject, have a major drawback: they are based on the hypothesis of a perfect structural homogeneity within the monetary Union. They consider countries which are fully identical, whereas it is also necessary to integrate the potential structural heterogeneities between the members of a monetary union; but the studies which integrate the implications of such heterogeneities on the stabilization of various shocks are much less numerous. E.g., Coricelli *et al.* (2001) find that the higher

the product market competitiveness (low product differentiation) and the higher the centralization of wage bargaining (small number of unions), the lower are the expected values of the union-wide inflation and unemployment rates in a country of a monetary union. Furthermore, Brigden and Nolan (1999) find that only when all members of the monetary union have the same structural parameters of their supply functions and the same preferences and if the supply shocks are perfectly correlated, will it be optimal for a new member to have these same parameters values. Otherwise, if the new member differs in one of these characteristics, it will also have interest in having different values for the other structural parameters (second-best).

Finally, there are only few papers analyzing the implications of various structural heterogeneities on the usefulness of the budgetary coordination to improve the macroeconomic stabilization of various shocks. Van Aarle *et al.* (2002) study, in a dynamic game model, the cooperation between the monetary and fiscal authorities in a monetary union, the partial cooperation between the two budgetary authorities or between one country and the central bank, and the non cooperative equilibrium. They also study the effects of an heterogeneity in the structural parameters or in the preferences of the economic authorities. Then, the authors find that there are large gains to be obtained from a fiscal cooperation for the budgetary authorities, since a common stance against the ECB produces a Pareto improvement for them. However, the stronger the asymmetry of the bargaining powers, the less likely a coalition among players becomes. Léonard and Oros (2007) also find, in a static framework, that the budgetary cooperation between a sub-group of countries is generally beneficial in a monetary union, if the budgetary externalities are sufficiently negative between the various regional subgroups. However, the structural heterogeneity implies that a partial budgetary cooperation can more easily be decided at the level of a sub-group of homogeneous countries than at the global level of all the monetary union. Our paper is thus in the tradition of these former studies. It aims at analyzing the respective advantages of a partial or global budgetary cooperation between the member countries of a monetary union, in order to stabilize various shocks, according to the nature of the potential structural heterogeneity between these countries.

3 The Model

The main limit associated with most former studies on the stabilization of shocks in a monetary union is that they often suppose that the member countries are completely identical. On the contrary, our paper aims at introducing structural heterogeneities between the countries, in a dynamic framework. Each economy produces a single perfectly substitutable good; monetary policy is defined by the common central bank, whereas fiscal policies are set by the decentralized governments at the national level. In a short term perspective, we neglect here

the problems related to the increase in the deficit and in the public debt implied by the budgetary policy. We also neglect the problems due to the possible inflationary monetary financing of the public debt, empirically slight in Europe today and institutionally forbidden by the Maastricht Treaty.

We use a dynamic New Keynesian model of a closed monetary union made of n countries, which face symmetrical or asymmetrical demand or supply shocks. There are two groups of countries. In the group (p), (n_p) homogeneous countries are open to put in place a 'reinforced cooperation' between their budgetary policies, while in the group (k), (n_k=n-n_p) countries would rather keep their full budgetary autonomy in the monetary union. Both groups are supposed to be heterogeneous regarding their structural characteristics as well as regarding the conjunctural shocks affecting them. The production is determined by the demand, but the prices are flexible. We also make the hypothesis that in a monetary union, the interest rates are the same in all member countries, without any particular risk premium associated with their budgetary situation (particularly in terms of public debt).

3.1 The demand and supply functions

In this model, all the variables (except the interest rates) are expressed in logarithms and as deviations from their long run equilibrium values. The demand in the country (h) of the group (p) in period (t) is as follows:

$$y_{h,t(p)} = \lambda_{(p)} y_{h,t\text{-}1(p)} + \eta_{(p)} g_{h,t(p)} - \sigma_{(p)} (i_{t\text{-}1} - \pi_{h,t\text{-}1(p)}) + \beta_{(p)} \Sigma_{\substack{f \epsilon p \\ f \neq h}} \frac{(\pi_{f,t(p)} - \pi_{h,t(p)})}{(n_p - 1)}$$
$$+ \beta_{(p)} \Sigma_{\substack{f \epsilon k \\ k \neq p}} \frac{(\pi_{f,t(k)} - \pi_{h,t(p)})}{n_k} + \tau_{(p)} \Sigma_{\substack{f \epsilon p \\ f \neq h}} \frac{y_{f,t(p)}}{(n_p - 1)} + \tau_{(p)} \Sigma_{\substack{f \epsilon k \\ k \neq p}} \frac{y_{f,t(k)}}{n_k} + d_{h,t(p)} \quad (1)$$

With, for the country (h) in the group (p) in period (t): ($y_{h,t(p)}$): income; ($g_{h,t(p)}$): net public expenditures; ($\pi_{h,t(p)}$): prices; ($d_{h,t(p)}$): positive demand shock. (i_t): nominal short run interest rate in period (t) in all monetary union.

$0<\lambda_{(p)}<1$; $0<\eta_{(p)}<1$ (eviction effects); $0<\sigma_{(p)}<1$; $0<\beta_{(p)}<1$; $0<\tau_{(p)}<0.5$.

So, change in demand is firstly a function of the lagged variation in economic activity. Then, it is an increasing function of the change in net public expenditures in the country, but a decreasing function of the lagged interest rate[1]. The net public expenditures are supposed to be the budgetary instrument in the hands of the national governments, whereas the nominal interest rate is the monetary instrument of the central bank. The demand is also an increasing function of the net exports of the country: the sensibility to the price competitiveness is then (β), whereas the sensibility to the change in foreign economic activity is (τ). Finally, the demand is also an increasing function of positive demand shocks.

[1] Svensson (2000) and Ball (1998) also mention that monetary policy influences the activity by the aggregated demand channel, but with a lag of one period.

The supply in the country (h) of the group (p) in period (t) is as follows:

$$\pi_{h,t(p)} = \pi_{h,t-1(p)} + \nu_{(p)} y_{h,t-1(p)} + \phi_{(p)} \Sigma_{\substack{f \epsilon p \\ f \neq h}} \frac{\pi_{f,t-1(p)}}{(n_p - 1)} + \phi_{(p)} \Sigma_{\substack{f \epsilon k \\ k \neq p}} \frac{\pi_{f,t-1(k)}}{n_k} + s_{h,t(p)} \quad (2)$$

with $(s_{h,t(p)})$: inflationary supply shock in the country (h) of the group (p) in period (t). $0<\nu_{(p)}<1$; $0<\phi_{(p)}<1$.

Inflation is therefore a function of the lagged inflation and of the lag of output. In our model, monetary policy needs then two periods to influence the inflation by the way of the aggregated demand channel, as in Ball (1998) or Svensson (2000). Moreover, inflation is an increasing function of the lagged inflation in the foreign countries (ϕ), by the mean of the prices of the imported intermediate goods. Finally, inflation is also an increasing function of inflationary supply shocks.

In the rest of the paper, we will note: $x_t = \frac{(n_p x_{t(p)} + n_k x_{t(k)})}{n}$ the symmetrical component of a variable or of a shock within all the monetary union, and: $\overline{x_t} = \frac{(n_p x_{t(p)} - n_k x_{t(k)})}{n}$ the asymmetrical component of a variable or of a shock between the groups of countries (p) and (k). Combining the former demand and supply functions, we can obtain the economic activity functions mentioned in Appendix A[2].

3.2 The objective functions

The economic authorities have quadratic loss functions penalizing the weighted sum of the squared deviations of each objective from its equilibrium value. The main objective of the common central bank is to maintain the price stability (α^M is high). But it can also be interested in a long run growth objective in the monetary zone (weight: γ^M) and in limiting the variations in interest rates (weight: ξ^M), which introduce some harmful uncertainty for the private agents. Furthermore, we suppose that the government of each country (h) has mostly an immediate horizon, and tries to limit the current fluctuations in the economic variables. The governments are mainly looking to ameliorate the immediate living conditions of the economic agents, and to sustain the present level of economic activity (γ^G is high). However, they also try to limit the variations in prices (weight: α^G), and to reduce the variations in their public expenditures (weight: ξ^G), as their budgetary policies can be constrained like in Europe by the Stability and Growth Pact for example. The reference value for the inflation rate is supposed to be zero, whereas it is (y^*) for the economic activity, which corresponds

[2]The derivation of the activity and price equations, and mainly the complete derivation of the optimal economic activity levels according to the three degrees of fiscal cooperation, as well as the details of the comparison between these equilibria, are available upon request from the author.

to a kind of natural employment rate, and (g*) for the public expenditures[3]. Thus, if (δ) is the discount rate, we have the following loss functions, respectively for the central bank and the government (h) in period (t):

$$L^M = \Sigma_{s=t}^{\infty} \delta^{s-t} [\alpha^M \pi_s^2 + \gamma^M (y_s - y^*)^2 + \xi^M (i_s - i_{s-1})^2] \qquad \alpha^M > 0,\ \gamma^M > 0,\ \xi^M > 0 \quad (3)$$

$$L^G_{h(p)} = [\alpha^G \pi^2_{h,t(p)} + \gamma^G (y_{h,t(p)} - y^*)^2 + \xi^G (g_{h,t(p)} - g^*)^2] \qquad \alpha^G > 0,\ \gamma^G > 0,\ \xi^G > 0 \quad (4)$$

with: (α): weight given to the objective of price stability; (γ): to the one of sustaining the economic activity; (ξ): to the one of limiting the variations in the instrument.

So, to simplify, we have supposed here that the preferences of the governments are the same. Moreover, the conflict of goals which can appear between the governments and the central bank is only due to the heterogeneity between their preferences, as their long run targets of activity and inflation are the same. Furthermore, we are necessarily in the framework of a Stackelberg equilibrium in our dynamic model, as monetary policy always takes more time to influence the economic activity and then the inflation than the budgetary policies. More precisely, $\mathrm{dL}^M/\mathrm{di}_t = 0$ implies the optimal monetary policy:

$$i_t = f(g_t, \overline{g_t}, d_t, \overline{d_t}, s_t, \overline{s_t}, y_{t-1}, \overline{y_{t-1}}, \pi_{t-1}, \overline{\pi_{t-1}}, i_{t-1}, y^*) \quad (5)$$

The budgetary authorities are therefore 'Stackelberg leaders' in this dynamic model. Indeed, as the interest rate can only affect the future economic variables, the budgetary authorities take into account the preceding monetary reaction function to define their optimal budgetary expenditures. The monetary authority then has to adapt to the existing budgetary policies. Thus, the increase in interest rates is the higher and the monetary policy is all the more contractionary as the budgetary policies are expansionary ($\mathrm{di}_t/dg_t > 0$). Furthermore, this situation seems to fit well the existing European institutional arrangement, where fiscal policy decisions are taken before and less frequently than monetary decisions, as mentions by Lambertini and Rovelli (2003) for example. Therefore, our dynamic model avoids the problems of conflict of goals between the monetary and budgetary authorities, and it limits the harmful consequences that the budgetary policies can have on the conduct of the monetary policy by the common central bank.

4 Three degrees of budgetary cooperation

The reference situation is the one in which all the budgetary authorities cooperate, those from the group (p) as well as those from the group (k). Indeed, in

[3]We suppose that the governments try to limit the variations in their public expenditures around a target (g*), falling because of the political necessity to maintain the supply of a certain level of public goods and services, and rising because of the necessity to avoid aggravating the public deficits.

a framework of global cooperation, the budgetary authorities minimize the common global budgetary loss function: $L^G = [\alpha^G \pi_t^2 + \gamma^G (y_t - y^*)^2 + \xi^G (g_t - g^*)^2]$. The stabilization of the average economic activity is then perfect, as: $(g_t = g^*)$ and $(y_t = y^*)$. The global cooperation is thus always more efficient than the governments' independence or than a partial cooperation limited to a group of countries, to stabilize symmetrical or asymmetrical demand or supply shocks. Nevertheless, this section aims at studying analytically the stabilization of the economic activity provided by the budgetary authorities, according to the degree of cooperation between them. Indeed, we can consider that the social loss function mainly depends on the level of economic activity, and therefore, that it is this variable which must be stabilized, from a social point of view and for the well-being of the economic agents in a monetary union.

4.1 Full independence of the budgetary authorities

If the budgetary authorities remain fully independent despite the monetary unification, $dL^G_{h(p)}/dg_{h,t(p)} = 0$ implies:

$$
\begin{aligned}
&2n_p n_k \{\xi^{G2}(n_p\text{-}1+\tau_{(p)})(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) + \xi^G \gamma^G \eta_{(k)}(n_k\text{-}1)(n_p\text{-}1+\tau_{(p)})(1\text{-}\tau_{(p)}) \\
&\quad + \xi^G \gamma^G \eta_{(p)}(n_p\text{-}1)(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)}) + \gamma^{G2}\eta_{(p)}\eta_{(k)}(n_p\text{-}1)(n_k\text{-}1)\}\ y_t(\text{indep}) \\
&= \xi^G \{\xi^G (n_p - 1 + \tau_{(p)})(n_k - 1 + \tau_{(k)})[n_p n_k (2 - \tau_{(p)} - \tau_{(k)}) + n_p^2 \tau_{(p)} + n_k^2 \tau_{(k)}] \\
&\quad + \gamma^G n_p n_k \eta_{(k)}(n_k - 1)(n_p - 1 + \tau_{(p)}) + \gamma^G n_p n_k \eta_{(p)}(n_p - 1)(n_k - 1 + \tau_{(k)})\} d_t \\
&+ \xi^G \{\xi^G (n_p - 1 + \tau_{(p)})(n_k - 1 + \tau_{(k)})(n_k - n_p)(n_p \tau_{(p)} + n_k \tau_{(k)}) \\
&\quad + \gamma^G n_p n_k \eta_{(k)}(n_k - 1)(n_p - 1 + \tau_{(p)}) - \gamma^G n_p n_k \eta_{(p)}(n_p - 1)(n_k - 1 + \tau_{(k)})\} \overline{d_t} \\
&+ \xi^G \{\xi^G (n_p\text{-}1+\tau_{(p)})(n_k\text{-}1+\tau_{(k)})[\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}+n_k\tau_{(k)})\text{-}\beta_{(k)}(n_k\text{-}n_k\tau_{(p)}+n_p\tau_{(p)})] \\
&\quad + \gamma^G n_p \eta_{(k)} \beta_{(p)}(n_k\text{-}1)(n_p\text{-}1+\tau_{(p)})\text{-}\gamma^G n_k \eta_{(p)} \beta_{(k)}(n_p\text{-}1)(n_k\text{-}1+\tau_{(k)})\}[(n_p\text{-}n_k)s_t\text{-}n\overline{s_t}] \\
&+ f(\pi_{t-1}, \overline{\pi_{t-1}}, y_{t-1}, \overline{y_{t\text{-}1}}, i_{t-1}, g^*, y^*) \qquad (6)
\end{aligned}
$$

Therefore, the global economic activity in the monetary union cannot generally fully be stabilized, as it depends on the symmetrical and asymmetrical components of demand and supply shocks. The symmetrical positive demand shocks always imply an increase in economic activity, whereas regarding the supply or asymmetrical demand shocks, everything depends on the structural heterogeneity between the member countries of the monetary union. The variation in economic activity is also a function of the past inflation rates and interest rates, of the past variations in economic activity, and of the reference values for the economic activity and for the public expenditures.

4.2 Cooperation between the countries in each group (p) and (k)

If a sub-group (p) of countries cooperates, each country minimizes the common loss function:

$$L^G_{(p)} = [\alpha^G \pi^2_{t(p)} + \gamma^G (y_{t(p)} - y^*)^2 + \xi^G (g_{t(p)} - g^*)^2] \tag{7}$$

Therefore, if the countries in the group (p) cooperate on their side, as they are structurally homogeneous and as they share the same structural parameters, whereas the countries in the group (k) also cooperate on their own side, $\mathrm{dL}^G_{(p)}/dg_{t(p)}=0$ and $\mathrm{dL}^G_{(k)}/dg_{t(k)}=0$ imply:

$$\begin{aligned}
&2n_p n_k\{\xi^{G2}(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})^3 + \xi^G\gamma^G\eta^2_{(k)}(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(1\text{-}\tau_{(p)})^2 \\
&\quad +\xi^G\gamma^G\eta^2_{(p)}(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(1\text{-}\tau_{(k)})^2 + \gamma^{G2}\eta^2_{(p)}\eta^2_{(k)}(1\text{-}\tau_{(p)})(1\text{-}\tau_{(k)})\}\ y_t(\mathrm{coop}) \\
&= \xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})[n_p n_k(2-\tau_{(p)}-\tau_{(k)}) + n_p^2\tau_{(p)} + n_k^2\tau_{(k)}] \\
&\qquad +\gamma^G n_p n_k \eta^2_{(k)}(1-\tau_{(p)}) + \gamma^G n_p n_k \eta^2_{(p)}(1-\tau_{(k)})\}d_t \\
&+\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k-n_p)(n_p\tau_{(p)} + n_k\tau_{(k)}) \\
&\qquad +\gamma^G n_p n_k \eta^2_{(k)}(1-\tau_{(p)}) - \gamma^G n_p n_k \eta^2_{(p)}(1-\tau_{(k)})\}\overline{d_t} \\
&+\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})[\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}\text{+}n_k\tau_{(k)})\text{-}\beta_{(k)}(n_k\text{-}n_k\tau_{(p)}\text{+}n_p\tau_{(p)})] \\
&\qquad +\gamma^G n_p \eta^2_{(k)}\beta_{(p)}(1\text{-}\tau_{(p)}) - \gamma^G n_k \eta^2_{(p)}\beta_{(k)}(1\text{-}\tau_{(k)})\}[(n_p\text{-}n_k)s_t - n\overline{s_t}] \\
&+f(\pi_{t-1}, \overline{\pi_{t-1}}, y_{t-1}, \overline{y_{t\text{-}1}}, i_{t-1}, g^*, y^*)
\end{aligned} \tag{8}$$

4.3 Partial cooperation limited to the group (p)

If the countries in the group (k) remain independent, whereas the budgetary authorities of the countries from the group (p) decide to cooperate, we obtain:

$$\begin{aligned}
&2n_p n_k\{\xi^{G2}(n_k\text{-}1\text{+}\tau_{(k)})(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})^2 + \xi^G\gamma^G\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(1\text{-}\tau_{(p)}) \\
&\qquad +\xi^G\gamma^G\eta^2_{(p)}(n_k\text{-}1\text{+}\tau_{(k)})(1\text{-}\tau_{(k)})^2 + \gamma^{G2}\eta^2_{(p)}\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(k)})\}\ y_t(\mathrm{partial}) \\
&= \xi^G\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1\text{+}\tau_{(k)})[n_p n_k(2-\tau_{(p)}-\tau_{(k)}) + n_p^2\tau_{(p)} + n_k^2\tau_{(k)}] \\
&\qquad +\gamma^G n_p n_k \eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) + \gamma^G n_p n_k \eta^2_{(p)}(n_k\text{-}1\text{+}\tau_{(k)})(1\text{-}\tau_{(k)})\}d_t \\
&+\xi^G\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1\text{+}\tau_{(k)})(n_k-n_p)(n_p\tau_{(p)} + n_k\tau_{(k)}) \\
&\qquad +\gamma^G n_p n_k \eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) - \gamma^G n_p n_k \eta^2_{(p)}(n_k\text{-}1\text{+}\tau_{(k)})(1\text{-}\tau_{(k)})\}\overline{d_t} \\
&+\xi^G\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1\text{+}\tau_{(k)})[\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}\text{+}n_k\tau_{(k)})\text{-}\beta_{(k)}(n_k\text{-}n_k\tau_{(p)}\text{+}n_p\tau_{(p)})] \\
&\qquad +\gamma^G n_p \eta_{(k)}\beta_{(p)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\text{-}\gamma^G n_k \eta^2_{(p)}\beta_{(k)}(1\text{-}\tau_{(k)})(n_k\text{-}1\text{+}\tau_{(k)})\}[(n_p\text{-}n_k)s_t\text{-}n\overline{s_t}] \\
&+f(\pi_{t-1}, \overline{\pi_{t-1}}, y_{t-1}, \overline{y_{t\text{-}1}}, i_{t-1}, g^*, y^*)
\end{aligned} \tag{9}$$

So, for any kind of shock, the stabilization of the economic activity tends to be perfect, whatever the degree of cooperation between the budgetary authorities, if the latter have no budgetary constraints (if $\gamma^G \rightarrow \infty$ or $\xi^G \rightarrow 0$, $y_t \rightarrow 0$). On the contrary, this stabilization is all the more limited as the authorities are hardly constrained in their budgetary expenditures; for example, if they already have a high level of indebtedness preventing them to let their automatic stabilizers fully operate. Furthermore, the differential between independent budgetary policies, a partial cooperation limited to the group (p) or a cooperation in both groups of countries diminishes with the importance given to the stabilization of the public expenditures by the budgetary authorities (ξ^G), until tending to be null for very high values of this parameter (if $\xi^G \rightarrow \infty$). Indeed, in this case, the budgetary authorities are much less efficient in stabilizing the economic activity, as they mainly seek to avoid variations in their public expenditures.

Now that we have defined the average variation in economic activity in a monetary union in the framework of various degrees of cooperation between the budgetary authorities, the following section aims at analyzing the utility or not of a cooperation limited to a sub-group of countries, according to the nature (symmetrical or asymmetrical, demand or supply) of the shocks, and according to the structural heterogeneity between the member countries of a same monetary union.

5 Stabilization of demand shocks

Demand shocks could perfectly be stabilized if the budgetary authorities were not constrained in the use of their instrument (ξ^G=0). However, the existence of constraints limiting the budgetary expenditures prevents the perfect stabilization of these shocks. Therefore, in the framework of a monetary union, is the budgetary cooperation, even between only a small number and a sub-group of countries, really beneficial for the stabilization of symmetrical or asymmetrical demand shocks?

5.1 Stabilization of symmetrical demand shocks (d_t)

In case of budgetary constraints ($\xi^G \neq 0$), the interest of a budgetary cooperation is to suppress the 'free riding' problem between the governments of a same group of countries. Indeed, independent budgetary policies have a harmful tendency to rely on the stabilization provided by the foreign countries and to reduce their own stabilization effort, the latter being costly in terms of variation in public expenditures. On the contrary, cooperative budgetary policies are much more contractionary in case of a symmetrical positive demand shock, which improves much the stabilization of the economic activity. Thus, the stabilization doesn't depend on the parameter (β), but it seems to be improved with the budgetary

cooperation, at least for sufficiently high and plausible values of our parameters [$\eta_{(p)}>B$ and $\tau_{(p)}>E$] (see Appendix B). More precisely, we have[4]:

If $\eta_{(p)}<$A: $0<y_t(\text{indep})<y_t(\text{coop})<y_t(\text{partial})$ with: $y_t(\text{indep})>y_t(\text{coop})$ if $\eta_{(p)}>$A

If A$<\eta_{(p)}<$B: $0<y_t(\text{coop})<y_t(\text{indep})<y_t(\text{partial})$ $\quad B=\dfrac{(n_p\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})}{(n_p\text{-}1+\tau_{(p)})(1\text{-}\tau_{(k)})}$

If B$<\eta_{(p)}$: $0<y_t(\text{coop})<y_t(\text{partial})<y_t(\text{indep})$.

Nevertheless, the partial cooperation limited to the countries of the group (p) is beneficial only if the sensibility of the economic activity to the public expenditures ($\eta_{(p)}$) is sufficiently high in this group (p). Otherwise, independent budgetary policies can be more appropriate to stabilize symmetrical demand shocks, as more cooperative and active budgetary policies are not really efficient anyway to avoid variations in economic activity. In the same way, the stabilization is only improved by the budgetary cooperation beyond a given value of the sensibility of the exports to the foreign economic activity ($\tau_{(p)}$), if this parameter is heterogeneous. Indeed, the exports implied by a higher level of economic activity abroad must be sufficiently sizeable, and these demand externalities must be sufficiently positive in the countries of the group (p), to make the budgetary cooperation beneficial between these countries. More precisely, we have:

If $\tau_{(p)}<$C: $0<y_t(\text{indep})<y_t(\text{partial})<y_t(\text{coop})$ $\quad C=\dfrac{[(n_k\text{-}1)(1\text{-}\tau_{(k)}\text{-}\eta_{(k)})\text{-}\eta_{(k)}\tau_{(k)}]}{[(n_k\text{-}1)(1\text{-}\eta_{(k)})\text{-}\eta_{(k)}\tau_{(k)}]}$

If C$<\tau_{(p)}<$D: $0<y_t(\text{indep})<y_t(\text{coop})<y_t(\text{partial})$ with: $y_t(\text{coop})<y_t(\text{indep})$ if $\tau_{(p)}>$D

If D $<\tau_{(p)}<$E: $0<y_t(\text{coop})<y_t(\text{indep})<y_t(\text{partial})$ $\quad E=\dfrac{(n_p\text{-}1)(1\text{-}\tau_{(k)})(1\text{-}\eta_{(p)})}{[\eta_{(p)}(1\text{-}\tau_{(k)})+n_p\text{-}1]}$

If E $<\tau_{(p)}$: $0<y_t(\text{coop})<y_t(\text{partial})<y_t(\text{indep})$.

In case of symmetrical demand shocks, the budgetary coordination can have counterproductive consequences, according to Beetsma *et al.* (2001). Indeed, it increases the budgetary activism, and therefore the share of the governments in the stabilization policy. This can be dangerous, if the variation in public expenditures in very costly, in particular in terms of public deficit and public debt, in comparison with a variation in interest rates which would be more painless. However, this counterproductive effect of the fiscal coordination is all the more limited and overcome as the governments have (like in our model) a Stackelberg leadership position, and as they can integrate the monetary reaction function to take their budgetary decisions. Therefore, our model demonstrates the same result as Catenaro and Tirelli (2000), who assume that fiscal coordination is usually beneficial, as it allows the budgetary authorities to correctly anticipate the monetary policy response to shocks. Andersen (2002) also assumes that there are

[4]The following calibration is used for all the graphs: n=20; n_p=n_k=10; $\eta_{(p)}$=$\eta_{(k)}$=0.5; $\beta_{(p)}$=$\beta_{(k)}$=0.4; $\tau_{(p)}$=$\tau_{(k)}$=0.4; γ^G=2; ξ^G=1.

With such reference values for our parameters, we have: A=0; B=0.32; C=0.16; D=0.25; E=0.29; F=0.40; G=0.28; H=7; I=0.40; J=0.28; K=0.52; L=12.

large costs of non cooperative fiscal policies for common shocks, increasing in the number of countries, as the budgetary policies are then not enough active. However, the contribution of our paper is also to underline that the sensibility of the economic activity to the public expenditures and to the foreign economic activity must be sufficiently high in a sub-group of countries members of a monetary union, if they want to take advantage of their budgetary cooperation.

5.2 Stabilization of asymmetrical demand shocks ($\overline{d_t}$)

According to Beetsma *et al.* (2001), fiscal coordination may be mostly beneficial in case of asymmetrical shocks. Indeed, the global effect on average variables in then very limited, which implies a mild monetary reaction of the common central bank, and the fiscal coordination then avoids an excessive response of the budgetary authorities to compensate for this monetary policy. The cooperation thus reduces the budgetary activism, but economic activity and inflation are kept more distant from their targets. Catenaro and Tirelli (2000) also mention that fiscal coordination is beneficial in case of asymmetrical shocks, but for opposite reasons! Indeed, they assume that without coordination, the budgetary policies are excessively cautious and not enough active, for fear that these policies imply an opposite and compensatory monetary response. Our model also supposes that a fiscal cooperation reduces the free-riding behavior on the foreign budgetary policies and increases the budgetary activism. However, it is much more ambiguous on the usefulness of the budgetary cooperation in case of asymmetrical demand shocks, if the member countries of a monetary union are heterogeneous. Indeed, our results tend to confirm Andersen (2002)'s, who finds that the costs of non cooperative fiscal policies are relatively small for idiosyncratic shocks, and decreasing in the number of countries, provided the fiscal policies can be flexibly adjusted.

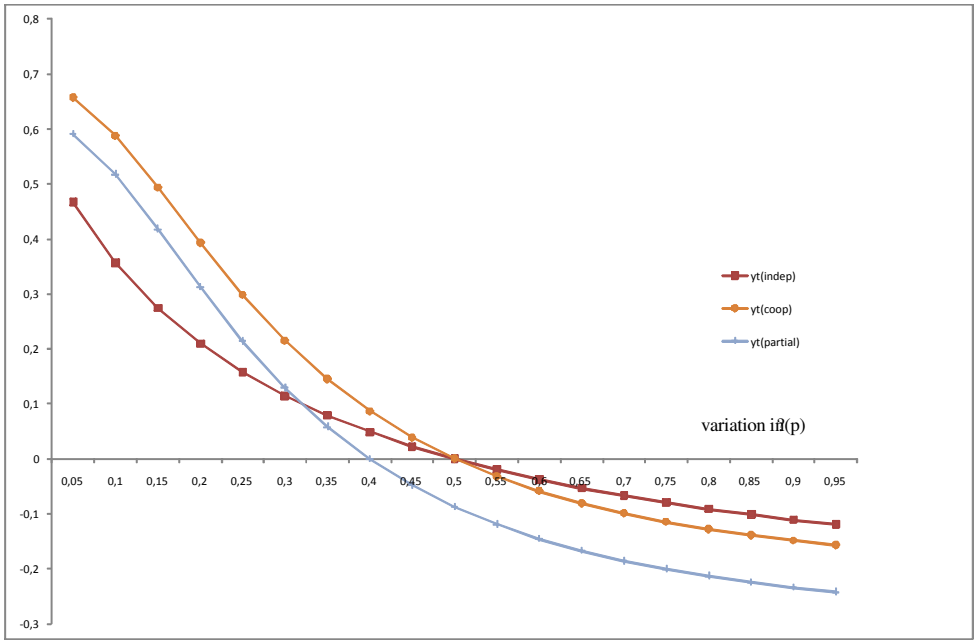
Indeed, in the framework of our model, if the countries were structurally homogeneous in all the monetary union, and if the groups (p) and (k) both represent half of the countries of the monetary union, an asymmetrical demand shock could perfectly be stabilized by the country affected by the shock (except in the case of partial cooperation, where the situation is then not fully symmetrical). Otherwise, the structural heterogeneity between the countries often makes detrimental a partial cooperation limited to a sub-group of countries. More precisely, the stabilization of demand shocks doesn't depend on the parameter (β). Nevertheless, in case of an asymmetrical positive demand shock ($\overline{d_t}>0$) affecting the countries from the group (p), the budgetary policies must be more contractionary in this group (p). Moreover, they are all the more contractionary as the budgetary authorities of the group (p) cooperate in order to stabilize the specific demand shocks. In these conditions, the budgetary cooperation can often be detrimental to the stabilization of asymmetrical demand shocks in case of an heterogeneity

in (η) or in (τ).

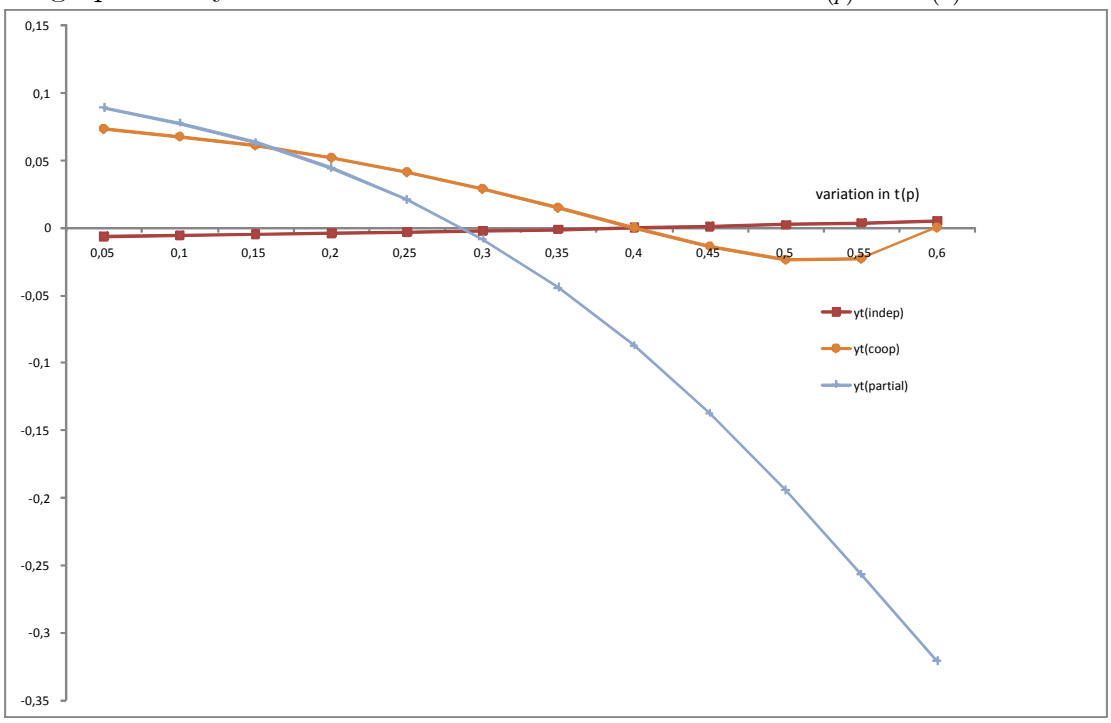
For example, after a positive demand shock affecting the countries from the group (p), if the sensibility of the economic activity to the public expenditures is smaller in this group (p) ($\eta_{(p)}<\eta_{(k)}$), the global economic activity increases in the monetary union because of the more expansionary budgetary policies in the group (k), whereas it decreases if the sensibility is higher in the group (p) ($\eta_{(p)}>\eta_{(k)}$). However, if $(\eta_{(p)})$ is quite small or on the contrary higher than $(\eta_{(k)})$, the partial budgetary cooperation limited to the group (p) appears as detrimental to stabilize asymmetrical demand shocks. Indeed, if $(\eta_{(p)})$ is too small, the very contractionary budgetary policies in the group (p) are inefficient to avoid the increase in the average economic activity in the monetary union. On the contrary, if $(\eta_{(p)})$ is too high, cooperative budgetary policies in the group (p) amplify the decrease in the average economic activity. More precisely, we have:
If $\eta_{(p)}<B$: $0<y_t(\text{indep})<y_t(\text{partial})<y_t(\text{coop})$
If $B<\eta_{(p)}<F$: $0<y_t(\text{partial})<y_t(\text{indep})<y_t(\text{coop})$ $\quad F=\sqrt{\frac{\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})}{(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})}}$
If $F<\eta_{(p)}<\eta_{(k)}$: $y_t(\text{partial})<0<y_t(\text{indep})<y_t(\text{coop})$
If $\eta_{(k)}<\eta_{(p)}$: $y_t(\text{partial})<y_t(\text{coop})<y_t(\text{indep})<0$.

In the same way, if the member countries of a monetary union haven't the same sensibility of their exports to the foreign economic activity, their budgetary policies have often interest in remaining independent. Indeed, we have:
If $\tau_{(p)}<C$, $y_t(\text{indep})<0<y_t(\text{coop})<y_t(\text{partial})$.
If $C<\tau_{(p)}<G$: $y_t(\text{indep})<0<y_t(\text{partial})<y_t(\text{coop})$ $\quad G=\frac{(1\text{-}\tau_{(k)})[\eta_{(k)}(n_k\text{-}1)\text{-}\eta^2_{(p)}(n_k\text{-}1+\tau_{(k)})]}{(n_k\text{-}1)\eta_{(k)}}$
If $G<\tau_{(p)}<E$: $y_t(\text{indep})<y_t(\text{partial})<0<y_t(\text{coop})$
If $E<\tau_{(p)}<\tau_{(k)}$: $y_t(\text{partial})<y_t(\text{indep})<0<y_t(\text{coop})$
If $\tau_{(k)}<\tau_{(p)}<0.5$: $y_t(\text{partial})<y_t(\text{coop})<0<y_t(\text{indep})$.

graph 1: Asymmetrical demand shock and variation in $\eta_{(p)}$ for $\eta_{(k)}$=0.5.



graph 2: Asymmetrical demand shock and variation in $\tau_{(p)}$ for $\tau_{(k)}$=0.4.



Moreover, a partial cooperation appears as beneficial if the number of countries which want to institute this budgetary cooperation (n_p) is relatively small. On the contrary, the cooperation between more than half of the countries of the monetary union (n_k<n_p) is detrimental to the economic stabilization, if the other member countries (k) don't also cooperate on their side. Indeed, if the countries from the group (p) affected by an asymmetrical positive demand shock cooper-

ate, their budgetary policies are more active and contractionary. Therefore, if the group (p) is very small, the average economic activity increases only moderately in the monetary union, the small size of the group (p) compensating its too aggressive budgetary policy. On the contrary, if the group (p) is very large, the decrease in the average economic activity is more accentuated in the monetary union if its members cooperate in order to conduct contractionary budgetary policies. Indeed, we have:
If n_p<H: 0 <y_t(partial) <y_t(coop) <y_t(indep) with: y_t(partial)>0 if n_p<H
If H<n_p<n_k: y_t(partial) <0 <y_t(coop) <y_t(indep)
If n_k<n_p: y_t(partial) <y_t(indep) <y_t(coop) <0.

6 Stabilization of supply shocks

Let's now study the advantages of the budgetary cooperation in order to stabilize symmetrical or asymmetrical supply shocks, in the framework of a heterogeneous monetary union.

6.1 Stabilization of symmetrical supply shocks (s_t)

The stabilization of symmetrical supply shocks is perfect whatever the heterogeneity in (η), (τ) or (β) and whatever the respective weights given to the stabilization of the public expenditures or of the economic activity, if the groups of cooperating countries have the same size (n_p=n_k). So, to stabilize symmetrical supply shocks, it is necessary to divide the monetary union in structurally homogeneous groups which have exactly the same size and which can potentially cooperate in their budgetary policies. Indeed, in this case, symmetrical supply shocks have proportional and identical consequences in all the monetary union: $\pi_{t(p)} = \pi_{t(k)} = s_t$. Therefore, the budgetary authorities should not intervene at all. Nevertheless, even if the global economic activity is perfectly stabilized, because of the absence of any price competitiveness differential, these shocks have wide inflationary consequences.

On the contrary, if the groups have not exactly the same size, if (n_p>n_k), the inflationary consequences are more limited in the biggest group of countries (p) ($\pi_{t(p)} < s_t < \pi_{t(k)}$), whose level of economic activity then increases because of the higher price competitiveness of its exports, whereas it decreases in the other group (k) of countries ($y_{t(k)} < 0 < y_{t(p)}$). Thus, the budgetary policies must be more expansionary in the group (k) and contractionary in the group (p). However, an increase in the global economic activity can't be avoided in the monetary union, as the biggest group of countries (p) is also the one in a situation of economic growth. In this framework, the budgetary cooperation appears as beneficial if all the countries are otherwise structurally homogeneous. Nevertheless, a partial budgetary cooperation is only beneficial between a group (p) of countries which are sufficiently numerous, whereas a limited cooperation between a very

small number of countries could only be detrimental. Indeed, the cooperating countries must be the most numerous and those which have contractionary budgetary policies, in order to reduce the economic growth due to symmetrical supply shocks. Effectively, we have:
If $n_p < n_k$: $0 < y_t(\text{coop}) < y_t(\text{indep}) < y_t(\text{partial})$
If $n_k < n_p$: $0 < y_t(\text{partial}) < y_t(\text{coop}) < y_t(\text{indep})$.

However, if the countries are also structurally heterogeneous, then the interest or not of any budgetary cooperation also depends on the structural heterogeneities between the countries of the monetary union...

6.2 Stabilization of asymmetrical supply shocks ($\overline{s_t}$)

If the countries were structurally homogeneous in all the monetary union, and if the groups (p) and (k) both represent half of the countries of the monetary union ($n_p=n_k$), the consequences on the economic activity of an asymmetrical supply shock could perfectly be stabilized by the independent budgetary policy of the country affected by this shock. Otherwise, the structural heterogeneity between the member countries of a same monetary union often makes detrimental a partial budgetary cooperation between some of them. More precisely, in case of an asymmetrical positive supply shock ($\overline{s_t}>0$) affecting the countries in the group (p), the inflationary consequences of the shock decrease the price competitiveness and therefore the exports and the economic activity in this group (p). On the contrary, the economic activity increases in the group (k). The budgetary policies must then be expansionary in the group (p) and contractionary in the group (k). Furthermore, in case of an heterogeneity in (τ) or in (η), the budgetary cooperation is generally detrimental for the stabilization of these asymmetrical supply shocks, as it tends to increase the intensity of the stabilization effort in the more flexible countries, and to increase the absolute value of the variation in the global economic activity.

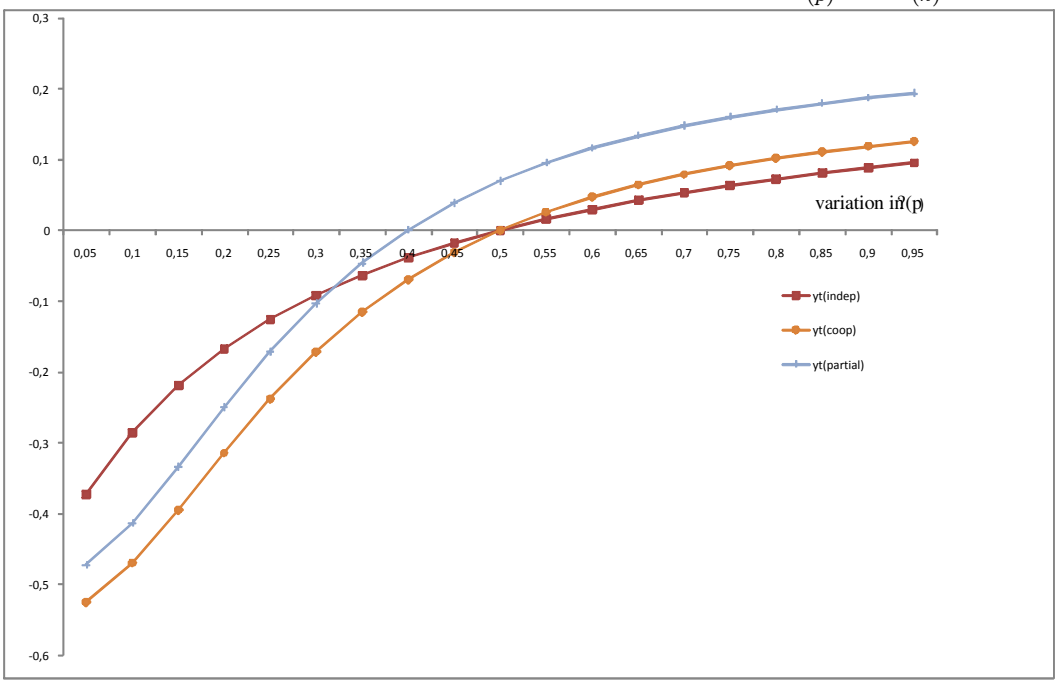
In particular, if the sensibility of the economic activity to the public expenditures is smaller in the group (p) ($\eta_{(p)}<\eta_{(k)}$) but if the groups of countries are otherwise homogeneous, the global economic activity decreases in the monetary union because of the very contractionary budgetary policies in the group (k), and all the more as the budgetary authorities in the group (k) cooperate. On the contrary, if the sensibility of the economic activity to the public expenditures is higher in the group (p) ($\eta_{(p)}>\eta_{(k)}$), the global economic activity increases because of the efficiency of the very expansionary budgetary policies in the group (p), and all the more as the authorities in this group (p) cooperate and increase their budgetary activism. Indeed, we have:
If $\eta_{(p)}<$B: $y_t(\text{coop}) < y_t(\text{partial}) < y_t(\text{indep}) < 0$

If B$<\eta_{(p)}<$I: $y_t(\text{coop}) < y_t(\text{indep}) < y_t(\text{partial}) < 0$ $\quad$ I$=\sqrt{\dfrac{\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\beta_{(p)}n_p}{(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})\beta_{(k)}n_k}}$

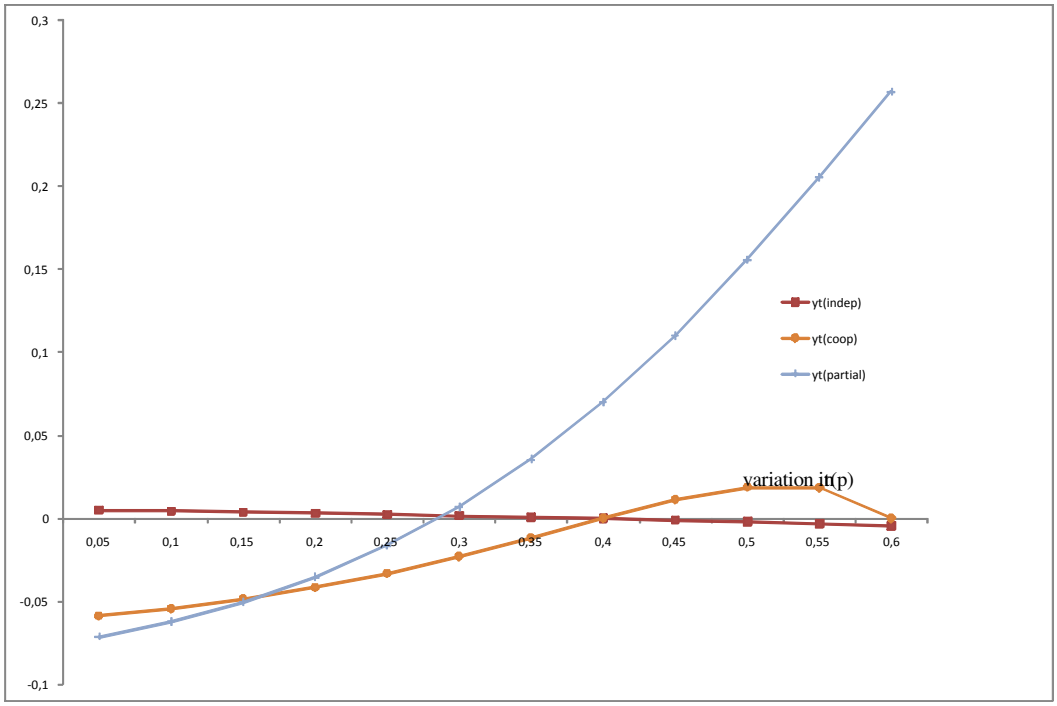
If I<$\eta_{(p)}$<$\eta_{(k)}$: y_t(coop) < y_t(indep) <0 <y_t(partial)
If $\eta_{(k)}$<$\eta_{(p)}$: 0 <y_t(indep) < y_t(coop) < y_t(partial).

In the same way, as regards the sensibility of the exports to the foreign economic activity, we have:
If $\tau_{(p)}$<C, y_t(partial) <y_t(coop) <0 <y_t(indep)
If C<$\tau_{(p)}$<J: y_t(coop)<y_t(partial)<0<y_t(indep) with: y_t(partial)>0 if $\tau_{(p)}$ >J
If J<$\tau_{(p)}$ <*E*: y_t(coop) < 0 <y_t(partial) <y_t(indep)
If E<$\tau_{(p)}$ <$\tau_{(k)}$: y_t(coop) < 0 <y_t(indep) <y_t(partial)
If $\tau_{(k)}$ <$\tau_{(p)}$ <0.5 y_t(indep) < 0 <y_t(coop) <y_t(partial).

graph 3: Asymmetrical supply shock and variation in $\eta_{(p)}$ for $\eta_{(k)}$=0.5.



graph 4 : Asymmetrical supply shock and variation in $\tau_{(p)}$ for $\tau_{(k)}$=0.4.



However, a partial budgetary cooperation can be beneficial for the stabilization of asymmetrical supply shocks if it concerns a group of countries (p) where the sensibility of the exports to the price-competitiveness ($\beta_{(p)}$) is sufficiently high. Indeed, if this parameter is smaller in the group (p) ($\beta_{(p)}<\beta_{(k)}$) affected by the shock, but if all the countries are otherwise structurally homogeneous, the global economic activity increases in the monetary union, because the exports of the group (p) are not much sensible to the decrease in their price-competitiveness. Furthermore, the economic growth is accentuated if the countries in the group (p) cooperate in order to conduct more expansionary budgetary policies, whereas it is mitigated if the authorities cooperate in the group (k) to conduct more contractionary budgetary policies. On the contrary, if the sensibility of the exports to the price competitiveness is higher in the group (p) ($\beta_{(p)}>\beta_{(k)}$) affected by the shock, the global economic activity decreases because of the large decrease in the exports of the group (p), but less if the budgetary authorities of this group cooperate. Indeed, we obtain:
If $\beta_{(p)} <\beta_{(k)}$: $0 <y_t(\text{coop}) < y_t(\text{indep}) < y_t(\text{partial})$
If $\beta_{(k)}<\beta_{(p)}<K$: $y_t(\text{indep})<y_t(\text{coop})<0<y_t(\text{partial})$ with: $y_t(\text{partial})>0$ if $\beta_{(p)}<K$
If $K <\beta_{(p)}$: $y_t(\text{indep}) < y_t(\text{coop}) < y_t(\text{partial}) <0$.

The budgetary cooperation must also concern a sufficiently large number of countries (n_p) to improve the stabilization of asymmetrical supply shocks. Indeed, the global economic activity increases in the monetary union if the group (p) affected by the inflationary and recessive supply shock is the smallest, which is accentuated if the member countries of this group cooperate. On the contrary, the global economic decreases if the group (p) affected by the shock is the largest;

however, this can be mitigated if the budgetary authorities cooperate in this group to conduct more expansionary budgetary policies. Effectively, we obtain:
If $n_p < n_k$: $0 < y_t(\text{coop}) < y_t(\text{indep}) < y_t(\text{partial})$
If $n_k < n_p < L$: $y_t(\text{indep}) < y_t(\text{coop}) < 0 < y_t(\text{partial})$ with: $y_t(\text{partial}) > 0$ if $n_p < L$
If $L < n_p$: $y_t(\text{indep}) < y_t(\text{coop}) < y_t(\text{partial}) < 0$.

7 Conclusion

The aim of this paper was to study whether the budgetary cooperation, even between only a limited number of structurally homogeneous countries members of a same monetary union, could be beneficial for the stabilization of various kinds of macroeconomic shocks. In this framework, the main contribution of our paper is to show that the structural heterogeneity between the member countries of the monetary union can affect the relative benefit of such a budgetary cooperation as regards the macroeconomic stabilization. The cooperation between the budgetary policies of some member countries of a heterogeneous monetary union could be sometimes an efficient institutional mechanism to improve the neutralization of the impact of the shocks; nevertheless, our model shows that the conditions of its efficiency are in fact quite restrictive. In summary, the fiscal cooperation could often be efficient to stabilize symmetrical shocks, whereas asymmetrical shocks would better be stabilized without any cooperation.

More precisely, in case of budgetary constraints, the budgetary cooperation is usually beneficial to stabilize symmetrical demand shocks, as it suppresses the 'free riding' problem between a group of countries, and as it implies more active budgetary policies. Nevertheless, this budgetary cooperation is only beneficial between a group of countries in which the sensibilities of the economic activity to the public expenditures and to the foreign economic activity are sufficiently high. Furthermore, the budgetary cooperation is beneficial to stabilize symmetrical supply shocks only if concerns a sufficiently large number of member countries of the monetary union. On the contrary, the budgetary cooperation is often detrimental to stabilize asymmetrical demand shocks. In particular, it is detrimental as soon as the sensibility of the economic activity to the public expenditures is very small or very high in the group of cooperating countries, and if this group is very large. Indeed, the budgetary policies of the affected countries are then too much active in a cooperative framework. The budgetary cooperation is also generally useless, and even detrimental, to stabilize asymmetrical supply shocks, if the structural heterogeneity in the monetary union concerns the sensibility of the economic activity to the budgetary expenditures or to the foreign economic activity. Nevertheless, a partial budgetary cooperation to stabilize the specific supply shocks can be beneficial between a sufficiently large group of countries where the sensibility of the exports to the price-competitiveness is high enough.

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Appendix A: Economic activity functions

Combining equations (1) and (2), we obtain:

$$\begin{aligned}
y_{h,t(p)} = {} & m_{yht(p),ght(p)}[\eta_{(p)} g_{h,t(p)} + d_{h,t(p)}] + m_{yht(p),gt}\ g_t + m_{yht(p),\overline{gt}}\ \overline{g_t} + m_{yht(p),dt}\ d_t \\
& + m_{yht(p),\overline{dt}}\ \overline{d_t} + m_{yht(p),sht(p)}\ s_{h,t(p)} + m_{yht(p),st}\ s_t + m_{yht(p),\overline{st}}\ \overline{s_t} \\
& + m_{yht(p),yht-1(p)}\ y_{h,t-1(p)} + m_{yht(p),yt-1}\ y_{t-1} + m_{yht(p),\overline{yt-1}}\ \overline{y_{t-1}} \\
& + m_{yht(p),it-1}\ i_{t\text{-}1} + m_{yht(p),\pi ht\text{-}1(p)}\ \pi_{h,t\text{-}1(p)} + m_{yht(p),\pi t\text{-}1}\ \pi_{t\text{-}1} + m_{yht(p),\overline{\pi t\text{-}1}}\ \overline{\pi_{t\text{-}1}}
\end{aligned}$$

$$\mathrm{m}_{yht(p),ght(p)} = (n_p - 1)/(n_p - 1 + \tau_{(p)})$$

$$\mathrm{m}_{yht(p),gt} = n\tau_{(p)}[n_k\eta_{(p)}(n_p\text{-}\tau_{(k)}) + n_p\eta_{(k)}(n_p\text{-}1\text{+}\tau_{(p)})]/2n_pn_k(n_p\text{-}1\text{+}\tau_{(p)})(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})$$

$$\mathrm{m}_{yht(p),\overline{gt}} = n\tau_{(p)}[n_k\eta_{(p)}(n_p\text{-}\tau_{(k)}) - n_p\eta_{(k)}(n_p\text{-}1\text{+}\tau_{(p)})]/2n_pn_k(n_p\text{-}1\text{+}\tau_{(p)})(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})$$

$$\mathrm{m}_{yht(p),dt} = n\tau_{(p)}[n_k(n_p - \tau_{(k)}) + n_p(n_p - 1 + \tau_{(p)})]/2n_pn_k(n_p - 1 + \tau_{(p)})(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yht(p),\overline{dt}} = n\tau_{(p)}[n_k(n_p - \tau_{(k)}) - n_p(n_p - 1 + \tau_{(p)})]/2n_pn_k(n_p - 1 + \tau_{(p)})(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yht(p),sht(p)} = -\beta_{(p)}(2n_p - 1)/(n_p - 1 + \tau_{(p)})$$

$$\begin{aligned}
\mathrm{m}_{yht(p),st} = {} & n[n_p\beta_{(p)}(n\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\text{-}(n_p\text{-}1\text{+}\tau_{(p)})(n_p\text{-}n_k)\beta_{(k)}\tau_{(p)}\text{+}(n_p\text{-}n_k)\beta_{(p)}(n_p\text{-}\tau_{(k)})\tau_{(p)}] \\
& /2n_pn_k(n_p - 1 + \tau_{(p)})(1 - \tau_{(p)} - \tau_{(k)})
\end{aligned}$$

$$\begin{aligned}
\mathrm{m}_{yht(p),\overline{st}} = {} & n[n_p\beta_{(p)}(1\text{+}n_k\text{-}n_p)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\text{+}n(n_p\text{-}1\text{+}\tau_{(p)})\beta_{(k)}\tau_{(p)}\text{-}n\beta_{(p)}(n_p\text{-}\tau_{(k)})\tau_{(p)}] \\
& /2n_pn_k(n_p - 1 + \tau_{(p)})(1 - \tau_{(p)} - \tau_{(k)})
\end{aligned}$$

$$\begin{aligned}
y_{t(p)} = {} & m_{yt(p),gt}\ g_t + m_{yt(p),\overline{gt}}\ \overline{g_t} + m_{yt(p),dt}\ d_t + m_{yt(p),\overline{dt}}\ \overline{d_t} \\
& + m_{yt(p),st}\ s_t + m_{yt(p),\overline{st}}\ \overline{s_t} + m_{yt(p),yt-1}\ y_{t-1} + m_{yt(p),\overline{yt-1}}\ \overline{y_{t-1}} \\
& + m_{yt(p),it-1}\ i_{t-1} + m_{yt(p),\pi t-1}\ \pi_{t-1} + m_{yt(p),\overline{\pi t-1}}\ \overline{\pi_{t-1}}
\end{aligned}$$

$$\mathrm{m}_{yt(p),gt} = n[n_k\eta_{(p)}(1 - \tau_{(k)}) + n_p\eta_{(k)}\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yt(p),\overline{gt}} = n[n_k\eta_{(p)}(1 - \tau_{(k)}) - n_p\eta_{(k)}\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yt(p),dt} = n[n_k(1 - \tau_{(k)}) + n_p\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yt(p),\overline{dt}} = n[n_k(1 - \tau_{(k)}) - n_p\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yt(p),st} = n[\beta_{(p)}(1 - \tau_{(k)}) - \beta_{(k)}\tau_{(p)}](n_p - n_k)\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})$$

$$\mathrm{m}_{yt(p),\overline{st}} = -n^2[\beta_{(p)}(1 - \tau_{(k)}) - \beta_{(k)}\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})$$

$$\begin{aligned}
y_t = {} & m_{yt,gt}\ g_t + m_{yt,\overline{gt}}\ \overline{g_t} + m_{yt,dt}\ d_t + m_{yt,\overline{dt}}\ \overline{d_t} \\
& + m_{yt,st}\ s_t + m_{yt,\overline{st}}\ \overline{s_t} + m_{yt,yt-1}\ y_{t-1} + m_{yt,\overline{yt-1}}\ \overline{y_{t-1}} + m_{yt,it-1}\ i_{t-1} \\
& + m_{yt,\pi t-1}\ \pi_{t-1} + m_{yt,\overline{\pi t-1}}\ \overline{\pi_{t-1}}
\end{aligned}$$

$m_{yt(p),gt} = [n_k\eta_{(p)}(n_p\text{-}n_p\tau_{(k)}+n_k\tau_{(k)})+n_p\eta_{(k)}(n_k\text{-}n_k\tau_{(p)}+n_p\tau_{(p)})]$ / $2n_pn_k(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})$

$m_{yt(p),\overline{gt}} = [n_k\eta_{(p)}(n_p\text{-}n_p\tau_{(k)}+n_k\tau_{(k)})\text{-}n_p\eta_{(k)}(n_k\text{-}n_k\tau_{(p)}+n_p\tau_{(p)})]$ / $2n_pn_k(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})$

$m_{yt(p),dt} = [n_pn_k(2-\tau_{(p)}-\tau_{(k)}) + n_p^2\tau_{(p)} + n_k^2\tau_{(k)}]$ / $2n_pn_k(1-\tau_{(p)}-\tau_{(k)})$

$m_{yt(p),\overline{dt}} = [n_pn_k(\tau_{(p)}-\tau_{(k)}) - n_p^2\tau_{(p)} + n_k^2\tau_{(k)}]$ / $2n_pn_k(1-\tau_{(p)}-\tau_{(k)})$

$m_{yt(p),st} = [\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}+n_k\tau_{(k)}) - \beta_{(k)}(n_k\text{-}n_k\tau_{(p)}+n_p\tau_{(p)})](n_p\text{-}n_k)$ / $2n_pn_k(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})$

$m_{yt(p),\overline{st}} = -n[\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}+n_k\tau_{(k)}) - \beta_{(k)}(n_k\text{-}n_k\tau_{(p)}+n_p\tau_{(p)})]$ / $2n_pn_k(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})$

Appendix B: Comparison between the various equilibria

In case of a positive symmetrical demand shock (d_t):

y_t(indep) >0; y_t(coop) >0; y_t(partial) >0.

y_t(indep) > y_t(coop) if: $\eta_{(p)}(1\text{-}\tau_{(k)})(n_p\text{-}1+\tau_{(p)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_p\text{-}1)$
and/or $\eta_{(k)}(1\text{-}\tau_{(p)})(n_k\text{-}1+\tau_{(k)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1)$.

y_t(indep) > y_t(partial) if and only if: $\eta_{(p)}(1\text{-}\tau_{(k)})(n_p\text{-}1+\tau_{(p)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_p\text{-}1)$.

y_t(partial) > y_t(coop) if and only if: $\eta_{(k)}(1\text{-}\tau_{(p)})(n_k\text{-}1+\tau_{(k)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1)$.

In case of a positive asymmetrical demand shock ($\overline{d_t}$):

y_t(indep) >0 if: $\eta_{(k)}>\eta_{(p)}$, $n_k>n_p$ or $\tau_{(p)}>\tau_{(k)}$.

y_t(coop) >0 if: $\eta_{(k)}>\eta_{(p)}$, $n_k>n_p$ or $\tau_{(k)}>\tau_{(p)}$.

y_t(partial) > 0 if: $\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})>\eta_{(p)}^2(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})$ and/or $n_k>n_p$.

y_t(indep) > y_t(coop) if: $\eta_{(p)}>\eta_{(k)}$, $n_k>n_p$ or $\tau_{(p)}>\tau_{(k)}$.

y_t(indep) > y_t(partial) if and only if: $\eta_{(p)}(1\text{-}\tau_{(k)})(n_p\text{-}1+\tau_{(p)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_p\text{-}1)$.

y_t(partial) > y_t(coop) if and only if: $(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1) > \eta_{(k)}(1\text{-}\tau_{(p)})(n_k\text{-}1+\tau_{(k)})$.

In case of a positive symmetrical supply shock (s_t):

y_t(indep) >0; y_t(coop) >0; y_t(partial) > 0.

y_t(indep) > y_t(coop).

y_t(indep) > y_t(partial) if and only if: $n_p>n_k$.

y_t(partial) > y_t(coop) if and only if: $n_p<n_k$.

In case of a positive asymmetrical supply shock ($\overline{s_t}$):

y_t(indep) >0 if: $\eta_{(p)}>\eta_{(k)}$, $\beta_{(k)}>\beta_{(p)}$,$n_k>n_p$ or $\tau_{(k)}>\tau_{(p)}$.

y_t(coop) >0 if: $\eta_{(p)}>\eta_{(k)}$, $\beta_{(k)}>\beta_{(p)}$,$n_k>n_p$ or $\tau_{(p)}>\tau_{(k)}$.

y_t(partial) > 0 if: $\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}+n_k\tau_{(k)})<\beta_{(k)}(n_k\text{-}n_k\tau_{(p)}+n_p\tau_{(p)})$ and/or:
$\eta_{(k)}(n_k\text{-}1)\beta_{(p)}n_p(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) <\eta_{(p)}^2n_k\beta_{(k)}(1\text{-}\tau_{(k)})(n_k\text{-}1+\tau_{(k)})$.

y_t(indep) > y_t(coop) if: $\eta_{(k)}>\eta_{(p)}$, $\beta_{(k)}>\beta_{(p)}$,$n_k>n_p$ or $\tau_{(k)}>\tau_{(p)}$.

y_t(indep) > y_t(partial) if and only if: $\eta_{(p)}(1\text{-}\tau_{(k)})(n_p\text{-}1+\tau_{(p)}) < (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_p\text{-}1)$.

y_t(partial) > y_t(coop) if and only if: $\eta_{(k)}(1\text{-}\tau_{(p)})(n_k\text{-}1+\tau_{(k)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1)$.