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Structural Heterogeneity and Partial Budgetary Cooperation in a Monetary Union

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

JEL E61, E63, F41, F42

Keywords Economic stabilization; monetary union; budgetary cooperation; demand shocks; supply shocks; structural heterogeneity

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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 exchange rates and in interest rates. According to the Optimal Currency Area theory, 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 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 long run budgetary sustainability. This institutional framework aims at insuring fiscal discipline in the EMU, and therefore, at preventing lax fiscal policies which could endanger the price stability goal of the European Central Bank (ECB). However, in the framework of the ECOFIN Council, or in the more informal context of the Euro-group, 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 asymmetric 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 symmetric shocks whereas the governments stabilize the asymmetric 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, European countries are very heterogeneous regarding their openness to trade and regarding the sensitivity 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, 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 became even more significant and therefore, they 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 the 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 fiscal cooperation can improve 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 symmetric and asymmetric 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 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 fiscal authorities have an incentive to increase their public expenditures to boost welfare, 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 monetary unification, the higher budgetary decentralization increases the optimal average inflation and implies an inefficient budgetary reaction to symmetric 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 asymmetric demand shocks, and may then constitute a good substitute for fiscal coordination.

Therefore, fiscal policy coordination can have various effects according to the type of shocks affecting the economy. For example, Uhlig (2002) assumes that specialization between the economic authorities is beneficial. The monetary authority should stabilize symmetric shocks, and the budgetary authorities asymmetric shocks. Furthermore, the Stability and Growth Pact is beneficial as implicit coordination mechanism between the budgetary authorities, in order to improve 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, 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 (symmetric) 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 asymmetric shocks, but that it can be useless and even detrimental in order to stabilize symmetric shocks. The conclusions of the existing studies regarding the usefulness of the fiscal coordination remain, therefore, very mixed.

As regards the nature of this budgetary coordination, Mundschenk and Von Hagen (2003) claim that 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 fiscal policies that could improve the efficiency of 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 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 perfect structural homogeneity within the monetary Union. They consider countries which are fully identical, whereas it is also necessary to integrate 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 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 distinct 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 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 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 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 sub-groups. However, 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 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 deficit and in 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 symmetric or asymmetric 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. Production is determined by the demand, but 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 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 the 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, variation in demand is firstly a function of the lagged variation in economic activity. Then, it is an increasing function of the variation in net public expenditures in the country, but a decreasing function of the lagged interest rate[1]. Net public expenditures are supposed to be the budgetary instrument in the hands of 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 sensitivity to the price competitiveness is then (β), whereas the sensitivity to the variation in foreign economic activity is (τ). Finally, the demand is also an increasing function of positive demand shocks.

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 lagged inflation and of lagged output. In our model, monetary policy needs then two periods to influence inflation by the way of the aggregated demand channel, as in Ball (1998) or Svensson (2000). Moreover, inflation is an increasing function of lagged inflation in the foreign countries (ϕ), by the mean of 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 symmetric 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 asymmetric 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 squared deviations of each objective from its equilibrium value. The main objective of the common central bank is to maintain 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 variations in interest rates (weight: ξ^M), which

[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.

[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.

introduce some harmful uncertainty for private agents. Furthermore, we suppose that the government of each country (h) has mostly an immediate horizon, and tries to reduce current fluctuations in the economic variables. The governments are mainly looking to ameliorate the immediate living conditions of economic agents, and to sustain the current level of economic activity (γ^G is high). However, they also try to reduce current variations in prices (weight: α^G), and to reduce 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 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 instrument smoothing.

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 make the hypothesis of a Stackelberg equilibrium in our dynamic model, as monetary policy always takes more time to influence economic activity and then inflation than the budgetary policies. More precisely, $dL^M/di_t = 0$ 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 future economic variables, budgetary authorities take into account the former monetary reaction function to define their optimal budgetary expenditures. The monetary authority then has to adapt itself to these existing budgetary policies. Thus, the increase in interest rates is the strongest and monetary policy is all the more contractionary as the budgetary policies are expansionary ($di_t/dg_t > 0$). 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,

[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 given level of public goods and services, and rising because of the necessity to avoid aggravating the public deficits.

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 reduces the harmful consequences that budgetary policies can have on the conduct of monetary policy by the common central bank.

4 Three degrees of budgetary cooperation

The reference situation is the one in which all budgetary authorities cooperate, those from the group (p) as well as those from the group (k). Indeed, in a framework of global cooperation, the budgetary authorities minimize a 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 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 symmetric or asymmetric demand or supply shocks. Nevertheless, this section aims at studying analytically the stabilization of 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 economic activity level, 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 monetary unification, $dL^G_{h(p)}/dg_{h,t(p)} = 0$ implies:

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

Therefore, average economic activity in the monetary union cannot generally fully be stabilized, as it depends on the symmetric and asymmetric components of demand and supply shocks. Symmetric positive demand shocks always imply an increase in economic activity, whereas regarding the supply or asymmetric

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 previous inflation rates and interest rates, of previous variations in economic activity, and of the reference values for economic activity and public expenditures.

4.2 Cooperation inside each group of countries (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:

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

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:

$$\begin{aligned}
&2n_p n_k\{\xi^{G2}(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})^2 + \xi^G\gamma^G\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(1\text{-}\tau_{(p)}) \\
&\quad +\xi^G\gamma^G\eta^2_{(p)}(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})^2 + \gamma^{G2}\eta^2_{(p)}\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(k)})\}\ y_{t,partial} \\
&=\xi^G\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1+\tau_{(k)})[n_p n_k(2-\tau_{(p)}-\tau_{(k)}) + n_p^2\tau_{(p)} + n_k^2\tau_{(k)}] \\
&\qquad +\gamma^G n_p n_k \eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) + \gamma^G n_p n_k \eta^2_{(p)}(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})\}d_t \\
&+\xi^G\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1+\tau_{(k)})(n_k-n_p)(n_p\tau_{(p)} + n_k\tau_{(k)})
\end{aligned}$$

$$+\gamma^G n_p n_k \eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) - \gamma^G n_p n_k \eta^2_{(p)}(n_k\text{-}1\text{+}\tau_{(k)})(1\text{-}\tau_{(k)})\}\overline{d_t}$$
$$+\xi^G\{\xi^G(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1\text{+}\tau_{(k)})[\beta_{(p)}(n_p\text{-}n_p\tau_{(k)}\text{+}n_k\tau_{(k)})\text{-}\beta_{(k)}(n_k\text{-}n_k\tau_{(p)}\text{+}n_p\tau_{(p)})]$$
$$+\gamma^G n_p \eta_{(k)}\beta_{(p)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\text{-}\gamma^G n_k \eta^2_{(p)}\beta_{(k)}(1\text{-}\tau_{(k)})(n_k\text{-}1\text{+}\tau_{(k)})\}[(n_p\text{-}n_k)s_t\text{-}n\overline{s_t}]$$
$$+f(\pi_{t-1}, \overline{\pi_{t-1}}, y_{t-1}, \overline{y_{t\text{-}1}}, i_{t-1}, g^*, y^*) \quad (9)$$

So, for any kind of shock, stabilization of 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, partial cooperation limited to the group (p) or cooperation in both groups of countries diminishes with the importance given to the stabilization of 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 average variations 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 (symmetric or asymmetric, 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 budgetary authorities were not constrained in the use of their instrument (ξ^G=0). However, the existence of constraints limiting budgetary expenditures prevents the perfect stabilization of these shocks. Therefore, in the framework of a monetary union, is budgetary cooperation, even between only a small number and a sub-group of countries, really beneficial for the stabilization of symmetric or asymmetric demand shocks?

5.1 Stabilization of symmetric demand shocks (d_t)

In case of budgetary constraints ($\xi^G \neq 0$), the interest of 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 stabilization provided by 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 symmetric positive demand shock, which improves much the stabilization of economic activity. Thus, stabilization doesn't depend on the parameter (β), but it seems to be improved with budgetary cooperation, at least for sufficiently high and plausible values of budgetary multipliers and openness to trade [$\eta_{(p)}>B$ and $\tau_{(p)}>E$] (see Appendix B). More precisely, we have[4]:

If $\eta_{(p)}<$A: $0<y_{t,indep}<y_{t,coop}<y_{t,partial}$ with: $y_{t,indep}>y_{t,coop}$ if $\eta_{(p)}>$A

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

If B$<\eta_{(p)}$: $0<y_{t,coop}<y_{t,partial}<y_{t,indep}$.

Therefore, partial cooperation limited to the countries of the group (p) is beneficial only if the sensitivity of economic activity to public expenditures ($\eta_{(p)}$) is sufficiently high in this group (p). Otherwise, independent budgetary policies can be more appropriate to stabilize symmetric demand shocks, as more cooperative and active budgetary policies are not really efficient anyway to avoid variations in economic activity. In the same way, stabilization is only improved by budgetary cooperation beyond a given value of the sensitivity of the exports to 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 budgetary cooperation beneficial between these countries. More precisely, we have:

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

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

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

If E $<\tau_{(p)}$: $0<y_{t,coop}<y_{t,partial}<y_{t,indep}$.

In case of symmetric demand shocks, budgetary coordination can have counterproductive consequences, according to Beetsma *et al.* (2001). Indeed, it increases 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 fiscal coordination is all the more limited and overcome as governments have (as 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 Cate-

[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.

naro 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 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 sensitivity of the economic activity to public expenditures and to 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 asymmetric demand shocks ($\overline{d_t}$)

According to Beetsma *et al.* (2001), fiscal coordination may be mostly beneficial in case of asymmetric shocks. Indeed, the global effect on average variables in then very limited, which implies a mild monetary reaction of the common central bank, and fiscal coordination then avoids an excessive response of the budgetary authorities to compensate for this monetary policy. The cooperation thus reduces 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 asymmetric shocks, but for opposite reasons! Indeed, they assume that without coordination, budgetary policies are excessively cautious and not enough active, for fear that these policies imply an opposite and compensatory monetary response. Our model also assumes that fiscal cooperation reduces the free-riding behavior on foreign budgetary policies and increases budgetary activism. However, it is much more ambiguous on the usefulness of budgetary cooperation in case of asymmetric demand shocks if the member countries of a monetary union are heterogeneous. Indeed, our results tend to support 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 fiscal policies can be flexibly adjusted.

More precisely, 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 asymmetric 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 symmetric). Otherwise, the structural heterogeneity between the countries often makes detrimental a partial cooperation limited to a sub-group of countries. Indeed, the stabilization of demand shocks doesn't depend on the parameter (β). Nevertheless, in case of an asymmetric positive demand shock ($\overline{d_t}>0$) affecting the countries from the group (p), 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 idiosyncratic demand

shocks. In these conditions, budgetary cooperation can often be detrimental to the stabilization of asymmetric demand shocks in case of heterogeneity in fiscal multipliers (η) or in openness to trade (τ).

For example, after a positive demand shock affecting the countries from the group (p), if the sensitivity of economic activity to public expenditures is smaller in this group (p) ($\eta_{(p)}<\eta_{(k)}$), average economic activity increases in the monetary union because of the more expansionary budgetary policies in the group (k), whereas it decreases if the sensitivity 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 asymmetric 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 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 average economic activity. More precisely, we have:

If $\eta_{(p)}<B$: $0 <y_{t,indep} <y_{t,partial} <y_{t,coop}$

If $B<\eta_{(p)}<F$: $0<y_{t,partial}<y_{t,indep}<y_{t,coop}$ $\quad F=\sqrt{\frac{\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})}{(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})}}$

If $F<\eta_{(p)}<\eta_{(k)}$: $y_{t,partial} <0 <y_{t,indep} <y_{t,coop}$

If $\eta_{(k)}<\eta_{(p)}$: $y_{t,partial} <y_{t,coop} <y_{t,indep} <0$.

In the same way, if the member countries of a monetary union haven't the same sensitivity of their exports to foreign economic activity, their budgetary policies have often interest in remaining independent. Indeed, we have:

If $\tau_{(p)}<C$, $y_{t,indep} <0 <y_{t,coop} <y_{t,partial}$.

If $C<\tau_{(p)}<G$: $y_{t,indep}<0<y_{t,partial}<y_{t,coop}$ $\quad G=\frac{(1\text{-}\tau_{(k)})[\eta_{(k)}(n_k\text{-}1)\text{-}\eta^2_{(p)}(n_k\text{-}1+\tau_{(k)})]}{(n_k\text{-}1)\eta_{(k)}}$

If $G<\tau_{(p)}<E$: $y_{t,indep}<y_{t,partial} <0 <y_{t,coop}$

If $E<\tau_{(p)}<\tau_{(k)}$: $y_{t,partial} <y_{t,indep} <0 <y_{t,coop}$

If $\tau_{(k)}<\tau_{(p)}<0.5$: $y_{t,partial} <y_{t,coop} <0 <y_{t,indep}$.

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

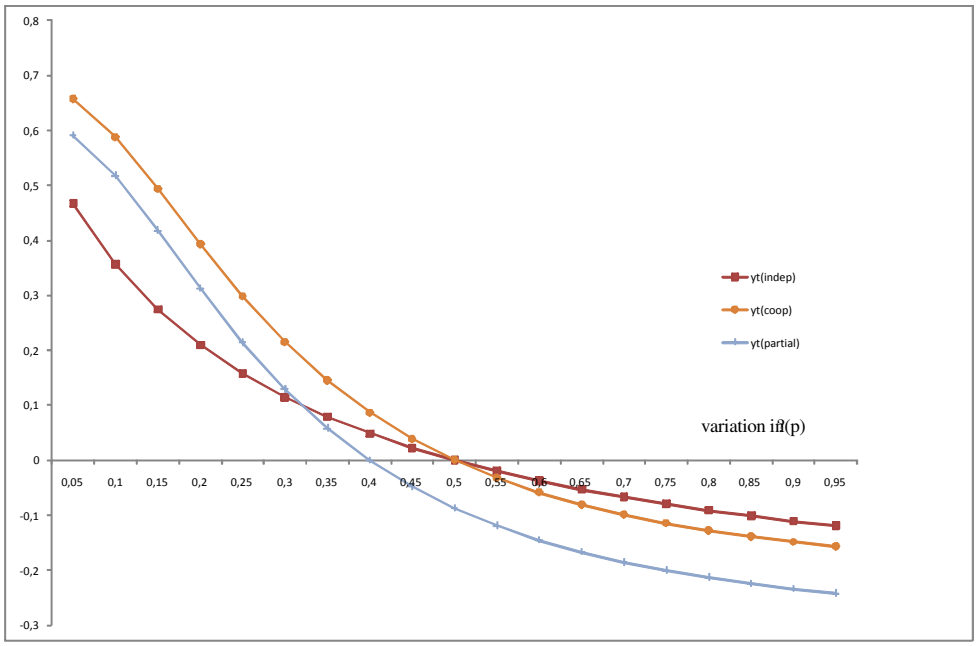
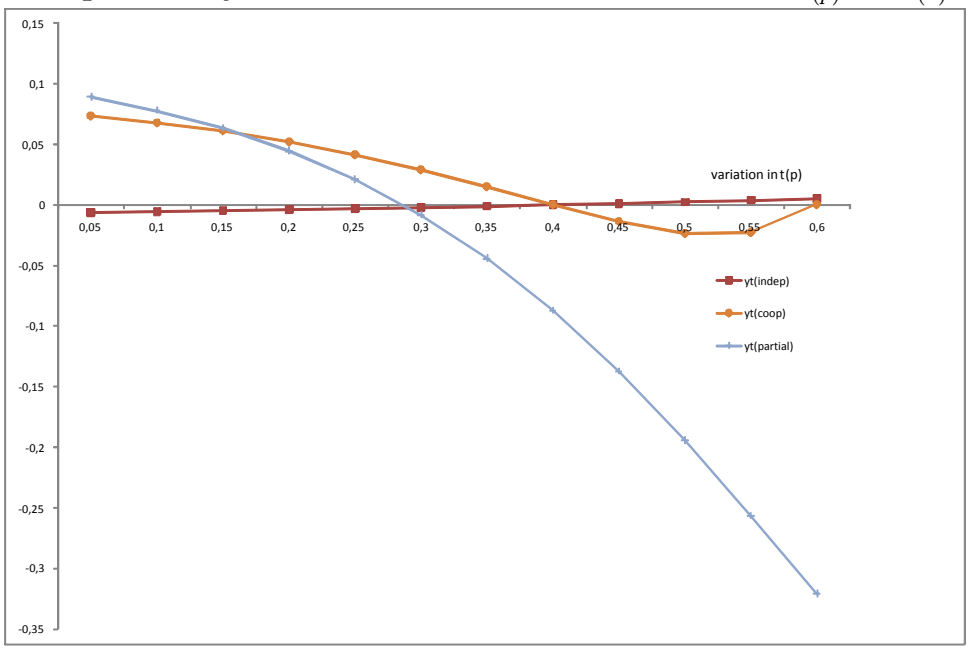


Figure 2: Asymmetric demand shock and variation in $\tau_{(p)}$ for $\tau_{(k)}$=0.4.



Moreover, a partial cooperation appears as beneficial if the number of countries in favor of this budgetary cooperation (n_p) is relatively small. On the contrary, cooperation between more than half of the countries of the monetary union (n_k<n_p) is detrimental to 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 asymmetric positive demand shock cooperate, their budgetary poli-

cies are more active and contractionary. Therefore, if the group (p) is very small, average economic activity increases only moderately in the monetary union, the small size of the group (p) compensating its too active budgetary policy. On the contrary, if the group (p) is very large, the decrease in 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 budgetary cooperation in order to stabilize symmetric or asymmetric supply shocks, in the framework of a heterogeneous monetary union.

6.1 Stabilization of symmetric supply shocks (s_t)

The stabilization of symmetric supply shocks is perfect whatever the heterogeneity in (η), (τ) or (β) and whatever the respective weights given to the stabilization of public expenditures or of economic activity, if the groups of cooperating countries have the same size ($n_p=n_k$). So, to stabilize symmetric 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, symmetric 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 average 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, budgetary policies must be more expansionary in the group (k) and contractionary in the group (p). However, an increase in average 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, budgetary cooperation would always be beneficial if, except regarding their size, countries were 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 symmetric supply shocks. More precisely, we have:
If $n_p < n_k$: $0 < y_{t,coop} < y_{t,indep} < y_{t,partial}$
If $n_k < n_p$: $0 < y_{t,partial} < y_{t,coop} < y_{t,indep}$.

However, if 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 asymmetric supply shocks ($\overline{s_t}$)

If the countries were structurally homogeneous in all the monetary union, and if the groups (p) and (k) both represented half of the countries of the monetary union ($n_p=n_k$), the consequences on economic activity of an asymmetric 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 asymmetric 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 exports and economic activity in this group (p). On the contrary, 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 heterogeneity in (τ) or in (η), budgetary cooperation is generally detrimental for the stabilization of asymmetric supply shocks, as it tends to increase the intensity of the stabilization effort in the most flexible countries, and to increase the absolute value of the variation in average economic activity.

In particular, if the sensitivity of economic activity to public expenditures is smaller in the group (p) ($\eta_{(p)}<\eta_{(k)}$) but if the groups of countries are otherwise homogeneous, average 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 sensitivity of economic activity to public expenditures is higher in the group (p) ($\eta_{(p)}>\eta_{(k)}$), average 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 $\eta_{(p)}<B$: $y_{t,coop} < y_{t,partial} < y_{t,indep} < 0$
If $B<\eta_{(p)}<I$: $y_{t,coop}<y_{t,indep}<y_{t,partial}<0$ $\quad I=\sqrt{\dfrac{\eta_{(k)}(n_k\text{-}1)(1\text{-}\tau_{(p)}\text{-}\tau_{(k)})\beta_{(p)}n_p}{(n_k\text{-}1+\tau_{(k)})(1\text{-}\tau_{(k)})\beta_{(k)}n_k}}$
If $I<\eta_{(p)}<\eta_{(k)}$: $y_{t,coop} < y_{t,indep} < 0 < y_{t,partial}$

If $\eta_{(k)}<\eta_{(p)}$: $0 < y_{t,indep} < y_{t,coop} < y_{t,partial}$.

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

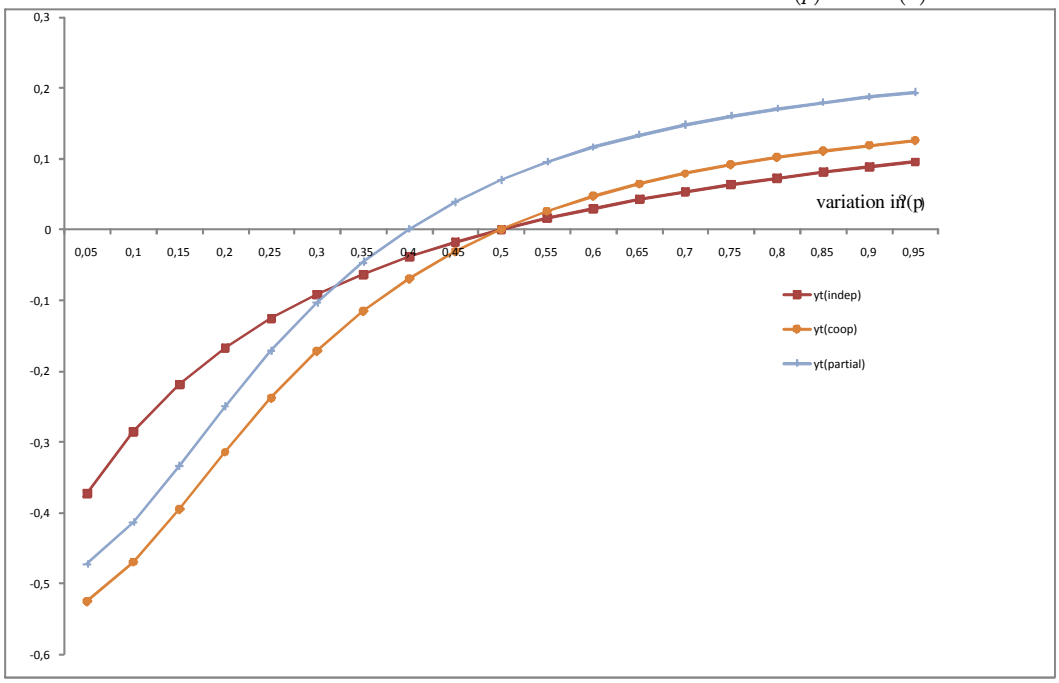
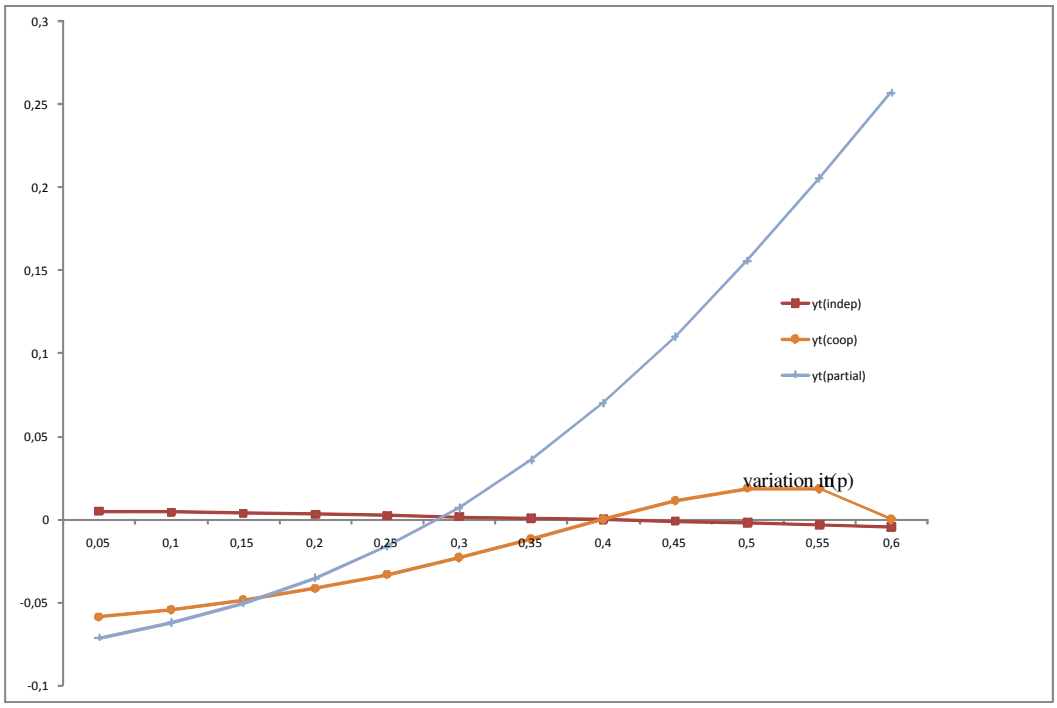


Figure 4 : Asymmetric supply shock and variation in $\tau_{(p)}$ for $\tau_{(k)}$=0.4.



In the same way, as regards the sensitivity of the exports to 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 <$y_{t,coop}$ <$y_{t,partial}$.

However, a partial budgetary cooperation can be beneficial for the stabilization of asymmetric supply shocks if it concerns a group of countries (p) where the sensitivity of the exports to 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, average 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, 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 sensitivity of the exports to price competitiveness is higher in the group (p) ($\beta_{(p)}$>$\beta_{(k)}$) affected by the shock, average 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 <$y_{t,coop}$ < $y_{t,indep}$ < $y_{t,partial}$
If $\beta_{(k)}$<$\beta_{(p)}$<K: $y_{t,indep}$<$y_{t,coop}$<0<$y_{t,partial}$ with: $y_{t,partial}$>0 if $\beta_{(p)}$<K
If K <$\beta_{(p)}$: $y_{t,indep}$ < $y_{t,coop}$ < $y_{t,partial}$ <0.Budgetary cooperation must also concern a sufficiently large number of countries (n_p) to improve the stabilization of asymmetric supply shocks. Indeed, average 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, average 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. Indeed, we obtain:
If n_p <n_k: 0< $y_{t,coop}$ < $y_{t,indep}$ < $y_{t,partial}$
If n_k<n_p<L: $y_{t,indep}$<$y_{t,coop}$<0<$y_{t,partial}$ with: $y_{t,partial}$>0 if n_p<L
If L <n_p : $y_{t,indep}$ < $y_{t,coop}$ < $y_{t,partial}$ <0.

7 Conclusion

The aim of this paper was to study whether 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 structural heterogeneity between the member coun-

tries of the monetary union can affect the relative benefit of such a budgetary cooperation as regards the macroeconomic stabilization. Cooperation between the budgetary policies of some member countries of a heterogeneous monetary union could be sometimes an efficient institutional mechanism to improve the smoothing of shocks; nevertheless, our model shows that the conditions of its efficiency are in fact quite restrictive. To sum up, fiscal cooperation could often be efficient to stabilize symmetric shocks, whereas asymmetric shocks would better be stabilized without any cooperation.

More precisely, in the framework of budgetary constraints, budgetary cooperation is usually beneficial to stabilize symmetric demand shocks, as it suppresses the 'free riding' problem in 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 sensitivities of economic activity to public expenditures and to foreign economic activity are sufficiently high. Besides, budgetary cooperation is beneficial to stabilize symmetric supply shocks only if concerns a sufficiently large number of member countries of the monetary union. On the contrary, budgetary cooperation is often detrimental to stabilize asymmetric demand shocks. In particular, it is detrimental as soon as the sensitivity of economic activity to 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. Budgetary cooperation is also generally useless, and even detrimental, to stabilize asymmetric supply shocks, if the structural heterogeneity in the monetary union concerns the sensitivity of economic activity to budgetary expenditures or to foreign economic activity. Nevertheless, a partial budgetary cooperation to stabilize the idiosyncratic supply shocks can be beneficial between a sufficiently large number of countries where the sensitivity of the exports to 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}} \\
\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)}) \\
\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)}) \\
\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}
$$

$$
\begin{aligned}
y_{t(p)} = {} & m_{yt(p),gt}\ g_t + m_{yt(p),\overline{gt}}\ \overline{g_t} + m_{yt(p),dt}\ d_t + m_{yt(p),\overline{dt}}\ \overline{d_t} \\
& + m_{yt(p),st}\ s_t + m_{yt(p),\overline{st}}\ \overline{s_t} + m_{yt(p),yt-1}\ y_{t-1} + m_{yt(p),\overline{yt-1}}\ \overline{y_{t-1}} \\
& + m_{yt(p),it-1}\ i_{t-1} + m_{yt(p),\pi t-1}\ \pi_{t-1} + m_{yt(p),\overline{\pi t-1}}\ \overline{\pi_{t-1}} \\
\mathrm{m}_{yt(p),gt} = {} & n[n_k\eta_{(p)}(1 - \tau_{(k)}) + n_p\eta_{(k)}\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)}) \\
\mathrm{m}_{yt(p),\overline{gt}} = {} & n[n_k\eta_{(p)}(1 - \tau_{(k)}) - n_p\eta_{(k)}\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)}) \\
\mathrm{m}_{yt(p),dt} = {} & n[n_k(1 - \tau_{(k)}) + n_p\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)}) \\
\mathrm{m}_{yt(p),\overline{dt}} = {} & n[n_k(1 - \tau_{(k)}) - n_p\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)}) \\
\mathrm{m}_{yt(p),st} = {} & n[\beta_{(p)}(1 - \tau_{(k)}) - \beta_{(k)}\tau_{(p)}](n_p - n_k)\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)}) \\
\mathrm{m}_{yt(p),\overline{st}} = {} & -n^2[\beta_{(p)}(1 - \tau_{(k)}) - \beta_{(k)}\tau_{(p)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})
\end{aligned}
$$

$$
\begin{aligned}
y_t = {} & m_{yt,gt}\ g_t + m_{yt,\overline{gt}}\ \overline{g_t} + m_{yt,dt}\ d_t + m_{yt,\overline{dt}}\ \overline{d_t} \\
& + m_{yt,st}\ s_t + m_{yt,\overline{st}}\ \overline{s_t} + m_{yt,yt-1}\ y_{t-1} + m_{yt,\overline{yt-1}}\ \overline{y_{t-1}} + m_{yt,it-1}\ i_{t-1} \\
& + m_{yt,\pi t-1}\ \pi_{t-1} + m_{yt,\overline{\pi t-1}}\ \overline{\pi_{t-1}} \\
\mathrm{m}_{yt(p),gt} = {} & [n_k\eta_{(p)}(n_p\text{-}n_p\tau_{(k)}\text{+}n_k\tau_{(k)})\text{+}n_p\eta_{(k)}(n_k\text{-}n_k\tau_{(p)}\text{+}n_p\tau_{(p)})]\ /\ 2n_pn_k(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) \\
\mathrm{m}_{yt(p),\overline{gt}} = {} & [n_k\eta_{(p)}(n_p\text{-}n_p\tau_{(k)}\text{+}n_k\tau_{(k)})\text{-}n_p\eta_{(k)}(n_k\text{-}n_k\tau_{(p)}\text{+}n_p\tau_{(p)})]\ /\ 2n_pn_k(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) \\
\mathrm{m}_{yt(p),dt} = {} & [n_pn_k(2 - \tau_{(p)} - \tau_{(k)}) + n_p^2\tau_{(p)} + n_k^2\tau_{(k)}]\ /\ 2n_pn_k(1 - \tau_{(p)} - \tau_{(k)})
\end{aligned}
$$

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

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

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

Appendix B: Comparison between the various equilibria

In case of a positive symmetric 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 asymmetric 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 symmetric 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 asymmetric 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:
$\eta_{(k)}(n_k\text{-}1)\beta_{(p)}n_p(1\text{-}\tau_{(p)}\text{-}\tau_{(k)}) < \eta_{(p)}^2 n_k\beta_{(k)}(1\text{-}\tau_{(k)})(n_k\text{-}1+\tau_{(k)})$.

$y_{t,indep} > y_{t,coop}$ 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: $\eta_{(k)}(1\text{-}\tau_{(p)})(n_k\text{-}1+\tau_{(k)}) > (1\text{-}\tau_{(p)}\text{-}\tau_{(k)})(n_k\text{-}1)$.