The short run costs of a reduction in tax distortions in a monetary union

Séverine MENGUY [*]

We use a dynamic New-Keynesian macroeconomic model of a monetary union including tax distortions. We show that in the short run, reducing tax distortions would always be inflation stabilizing but would usually be output destabilizing in the event of demand shocks. Indeed, the critical and optimal level of tax distortions below which increasing them is output stabilizing seems quite high. Furthermore, in the event of positive supply shocks, a further increase in tax distortions still improves the stabilization of economic activity levels in the short run. Besides, increasing tax distortions would also be inflation stabilizing if these distortions are already large. Therefore, a fiscal policy intending to reduce tax distortions would have non negligible short run costs in a monetary union where, as in Europe, the central bank values much more than national governments price stability, where prices are rigid, where the share of private consumption in GDP is high, and where openness to trade of the member countries is high.

Keywords: tax distortions; demand shocks; supply shocks; monetary union
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1. Introduction

In a single country as well as in a federal context and in a monetary union, fiscal policy has traditionally three functions: efficient allocation of resources, wealth and revenues redistribution, and stabilization of economic activity. This last function operates firstly through the action of automatic stabilizers. Indeed, when the economic activity increases (decreases), taxes collected and fiscal resources also increase (decrease), whereas transfer payments and unemployment benefits paid to the neediest persons decrease (increase). This contributes to increase the fiscal surplus (deficit), to moderate the increase (decrease) in economic activity, and to smooth and stabilize the cyclical conjuncture. Therefore, weak taxation rates would reduce the capacity of automatic stabilizers to stabilize economic activity in case of huge shocks. In particular, in the European Economic and Monetary Union (EMU), the European Central Bank conducts a common monetary policy for all member countries of the Euro-zone. Therefore, these countries have lost their independence to conduct independent monetary and exchange rates policies. In these conditions, autonomous and active budgetary policies seem necessary to stabilize asymmetric shocks, and they shouldn't be heavily constrained. That is why in the framework of the Stability and Growth Pact and afterwards of the Fiscal Compact, European countries were supposed to reach a medium term budgetary position 'close to balance or in surplus', in order to let enough autonomy to automatic stabilizers to play their role in case of cyclical economic volatility. Preserving autonomous fiscal policies and automatic stabilizers' flexibility seems all the more important and necessary in the context of a monetary union. Therefore, a reduction in tax distortions could have stronger and more damageable consequences for the member countries of a monetary union, if it hardly damages the economic stabilization capacity of these countries, which have already lost some of their adjustment mechanisms.

However, the risks of active budgetary policies for the global economic framework, in particular for financial stability, have been underlined, for example with the Fiscal Theory of the Price Level. Therefore, it has been assumed that the autonomy of budgetary policy should be limited to the working of automatic stabilizers in a symmetric way over the economic cycle, without being discretionary. Furthermore, the efficiency of budgetary policies in order to stabilize economic activity and the validity of the Keynesian framework have been put into question. It is well known since Laffer that beyond a given level, taxation rates may be too high. Instead of increasing fiscal resources, they could then be counterproductive for the economic activity, and their increase could reduce global public resources. So, taxation rates shouldn't probably be increased beyond a given level in order to preserve economic efficiency. Indeed, strong automatic stabilizers may prevent economic agents from a fast adjustment to shocks, as their effects are smoothed by labor market institutions, the social security and the taxation system.

Regarding the empirical analysis, Gali (1994) studies the impact of government size on macroeconomic stability in the context of a Real Business Cycle model. His observations on 22 OECD countries during the period 1960-1990 show that empirically, a larger size of the government is always associated with less output variability. Higher taxation rates would be empirically stabilizing, and therefore, reforms aiming at enhancing economic efficiency by reducing the size of the public sector may come at the cost of cyclical stabilization. Lowering taxes may boost efficiency and output, and improve market adjustment to shocks. But by reducing the size of automatic stabilizers, it may also imply less cyclical smoothing. However, Hairault, Langot and Portier (2001) show that in the framework of a monopolistic economy, introducing some distortive taxation can increase both allocation efficiency and stabilization. Buti and Van den Noord (2003) and Buti *et al.* (2003) also assume that the trade-off may not exist. If the initial level of the tax burden is high, reducing it may not only yield better efficiency, but also improve economic stabilization. In the same way, Crespo-Cuaresma *et al.* (2003) study the impact of fiscal stabilizers on business volatility for a panel of 14 European countries in the period 1970-99. Then, they show the non linear effect of fiscal stabilizers: the diminishing returns to the stabilizing property of government spending, possibly even reverting. More precisely, government size could have a negative growth impact and increase the cyclical volatility when it exceeds a threshold around 38% of GDP. Thus, the common recommendation of international institutions to let automatic stabilizers play fully shouldn't avoid considering also the absolute level of fiscal expenditures or revenues. Martinez-Mongay and Sekkat (2003) also study 25 OECD countries for the period 1960-1999. They show that lowering taxes for efficiency purposes may not be damageable in terms of stabilization, depending on the structure of the taxation system. Indeed, distortive taxes on labor and capital might modify the supply function and have negative effects on macroeconomic stability.

More precisely, traditional macroeconomic models are based on a separation between demand and supply-side adjustments to macroeconomic shocks. The former would be concerned with the cyclical conjuncture in the short run, whereas the latter would be concerned with the trend of economic growth and potential output in the long run. However, Kienzler and Schmid (2010) mention that this asymmetry doesn't take into account the demand-side stimulus on an economy's productive capacity. Indeed, variations on the utilization of production capacities and fiscal policies have long run consequences on the production factors' efficiency and utilization, on potential output and on economic growth, in a longer term perspective. There is a pro-cyclical adjustment of potential output due to labor market hystereris and investment-induced technological progress. That is why the New-Keynesian framework is augmented to take into account this supply-side effect of demand-side stimulus. Therefore, this framework seems to us the most relevant in order to study the short run costs of a variation in tax distortions in a monetary union. But what are these tax distortions?

For example, a reduction in labor income tax rates can increase real wages, employment and then also consumption; or a reduction in capital income tax rates can increase investment; and both can contribute to increase the global economic activity level. In this context, Eurostat (2008) underlines the fact that the European Union is a high-tax area, in comparison with all other OECD countries. Indeed, in 2006, the sum of taxes and social security contributions in the 27 Member States amounted to 39.9 % of GDP (in the weighted average), against about 28% in the United States and in Japan. In particular, labor taxation appears much higher in the EU than in the other major industrialized economies. Besides, on average, about two thirds of the overall taxation rate on labor consisted of non-wage labor costs paid by both employees and employers (this share is only weak in Denmark, Ireland and the United Kingdom). So, Lieb (2012) insists on the necessity to include real wage rigidities in the models representing a monetary union. Indeed, in the Economic and Monetary Union in Europe in particular, high firing costs, minimum wages, size and duration of unemployment benefits or collective wage bargaining prevent wages from adjusting instantaneously. What can then be the consequences of such tax distortions on the stabilization of supply or demand shocks in a monetary union?

Ferrero (2009) studies the role of distortive taxation in a two-country DSGE framework with nominal debt, from a union-wide perspective. In his setting, monetary policy should achieve aggregate price level stability, while fiscal policy should stabilize country-specific shocks via

permanent variations of government spending and tax gaps. Indeed, fiscal rules that respond to a measure of real activity (real debt could respond to departure from output to its targeted level) and budgetary flexibility imply large welfare gains in comparison with balanced budget rules in a monetary union. To the contrary, with a dynamic general equilibrium currency union model, Forni *et al.* (2010) show that in Italy, a fiscal consolidation strategy intended to reduce the indebtedness level would be welfare improving. The best strategy would be to reduce distortive taxes (in particular on labor or capital income) and simultaneously, to compensate this policy by a reduction in public expenditures, mostly in purchases of goods and services or in public employment in order to preserve transfers to households. Furthermore, spillovers to the rest of the Euro Area would then be expansionary and sizeable.

Therefore, empirical or theoretical studies have mixed results. Usually, they conclude that fiscal consolidation has long run benefits. For example, Coenen *et al.* (2008) use the New Area Wide Model (NAWM) of a two countries open economy model of the Euro-Area to study macroeconomic effects of alternative fiscal consolidation policies. Then, they show that this fiscal consolidation has positive long run effects on output and consumption, notably when the resulting improvement in the budgetary position is used to lower distortive taxes. However, fiscal consolidation has also noticeable short run adjustment costs, depending on the timing and horizon of its implementation. Nevertheless, with a micro-founded theoretical model, Bokan and Hughes-Hallett (2008) show that the long run gains of structural reforms out-weight their short run costs. More precisely, tax reforms would be more effective for welfare gains, but market liberalization would be more valuable for generating employment. Nevertheless, in Europe, there are large short term costs in economic performance due to labor or product market deregulation, which are made sharper by the presence of budget constraints. This might thus be enough to block some reforms of the European countries which could be beneficial in the long term.

Therefore, the aim of the current paper is to contribute to the theoretical debate on the short run costs on welfare and economic stabilization of a fiscal policy intended to reduce the intensity of tax distortions in a monetary union. Indeed, we want to shed light on the structural characteristics which could prevent the introduction of reforms minimizing the strength of inefficient tax distortions because they have short run costs, even if there is a large consensus on the long term benefits of such reforms. To this aim, we use a New-Keynesian macroeconomic model of a monetary union, which includes tax distortions in the supply function, and the rest of the paper is organized as follows. The second section describes the dynamic New-Keynesian model that we have used to derive our theoretical results. The third and fourth sections study respectively the stabilization of demand and supply shocks, and the implications of a variation in tax distortions on the stabilization of various shocks. The fifth section derives empirical implications of our model, and the sixth section concludes the paper.

2. The Model

We consider a dynamic New-Keynesian model of a monetary union with two small open countries. The monetary union in made of two different countries, each one composed of two sectors: households and firms, and of a fiscal authority. We suppose a closed monetary union vis-à-vis the rest of the world, whose countries face symmetric or asymmetric supply or demand shocks. Besides, we suppose that symmetric and asymmetric components of each shock are independently distributed. Anticipations are rational; each economy produces a single perfectly substitutable good. All variables are expressed in deviations from their long run equilibrium values, and the model is therefore in a log-linearized form. Monetary policy is defined by a central bank common to all the monetary union, which stabilizes average variables. Budgetary policies are set by the decentralized governments at the national level. Financial markets are supposed to be perfect, whereas goods markets are characterized by nominal price rigidities.

2.1. The Basic Equations

We use a stylized dynamic New-Keynesian model, that is to say which is broadly consistent with this literature, even if we don't detail here its underlying micro-economic structure [see Kienzler and Schmid (2010) or Lieb (2012) for the micro-foundations of the model]. The demand function is the following:

$$y^d_{i,t} = E_t(y_{i,t+1}) - \sigma[i_t - E_t(\pi_{i,t+1}) - \bar{r}] + \eta E_t(\pi_t - \pi_{i,t}) - (1-\sigma)E_t(\Delta g_{i,t+1}) + d_{i,t} \quad (1)$$

With, in period (t) in country (i): ($y_{i,t}$): output or economic activity level; ($\pi_{i,t}$): inflation rate; ($g_{i,t}$): public expenditure; ($d_{i,t}$): positive demand shock, which is a white noise;

(i_t): common nominal interest rate ; $\bar{r}$: real equilibrium interest rate (time discount rate); $E_t()$: rational anticipation operator.

$0<\sigma<1$: share of private consumption in GDP in the efficient steady-state, in comparison with the share of public consumption (1- σ).

$0<\eta<1$: openness to trade of the member countries.

Traditionally, in New-Keynesian models, aggregate demand is driven by the optimizing behavior of households, which maximize an intertemporal utility function. Thus, output depends on expected future output, because rational agents can maximize their decisions inter-temporally and smooth their consumption. The variation in demand is also an increasing function of the variation in public expenditure in a given country in comparison with what is expected for the following period[1]. It is a decreasing function of the excess of the anticipated real interest rate in the monetary union in comparison with its equilibrium value. Besides, net exports of the country (i) are an increasing function of its price competitiveness[22]. Finally, the variation in demand is an increasing function of a national positive demand shock (d_i).

The supply function is represented by an augmented New Keynesian Phillips curve:

$$\pi_{i,t} = bE_t(\pi_{i,t+1}) + k(y_{i,t} - y^P_{i,t}) - s_{i,t} = bE_t(\pi_{i,t+1}) + k(y_{i,t} - \lambda g_{i,t}) - s_{i,t} \quad (2)$$

With, in period (t) in country (i): ($y^P_{i,t}$) : equilibrium level of output: potential output if prices were fully flexible; ($s_{i,t}$): positive supply or productivity shock, or negative cost-push shock, which is a white noise.

$0<b<1$: discount rate of the future; $k>0$; $0<\lambda<1-\sigma$ (a potential output which is much smoother than public expenditure reveals the existence of tax distortions).

Indeed, in New-Keynesian models, aggregate supply results from the behavior of firms that set prices for their products so as to maximize profits in a monopolistic competition setting. Inflation then depends on expectations about future prices, because of learning effects. Besides, the output gap expresses the demand-pull factor and tensions on the utilization of productive capacities. Let's mention that potential output is endogenous in our model, as it depends on fiscal policy. Finally, ($s_{i,t}$) captures a deflationary shock unrelated to excess demand (mark-up, etc.).

(k) is a parameter representing the degree of price flexibility in the monetary union. It is an increasing function of the sensitivity of prices to marginal costs, of the sensitivity of real wages to the number of workers and to unemployment. On the contrary, more price rigidity in the labor market implies a lower value of (k).

(λ) is a parameter representing the intensity of tax distortions in the monetary union. Indeed, market imperfections in the wage bargaining process increase real wages; there are social security and non-wage costs imposed on employers, costs related to the job protection legislation imposed on producers. Because of these tax distortions, there is then a negative relationship between public spending and prices. Indeed, given the output, an increase in government spending crowds out private consumption and/or decreases the price competitiveness of the country, and thus it implies an appreciation of the real exchange rate. This decrease in the real exchange rate tends to reduce real wages and real marginal costs, and therefore to moderate the inflationary tensions. Tax distortions (λ) would then increase with the share of public consumption in GDP (1-σ) [see: Lieb (2012), Gali and Monacelli (2008) for a precise micro-foundation of equation (2)].

Indeed, Auerbach and Feenberg (2000) have shown that in a federal country like the United-States, the effects of changes in taxation on labor supply may be as important as their consequences on aggregate demand through the automatic stabilizers usually considered. The empirical study of Carone and Salomäki (2001) also assumes that labor costs (in particular, personal income tax) can rely more or less unto employers, according to many institutional factors: union wage-setting mechanisms, unemployment benefits and minimum wage, which affect the degree of labor market flexibility. More precisely, distortive taxation affects the level of equilibrium unemployment and potential output, because of 'real wage resistance' in an imperfect labor market [Buti *et al.* (2003), Martinez-Mongay and Sekkat (2003)]. In the same way, Buti and Van den Noord (2003) have shown that the reaction of the supply function to an inflation surprise was smaller in countries with larger governments and higher taxation rates. Indeed, inflationary tensions increase real wage claims from the salaries; however, the effective cost of these wage claims is accentuated for the firms if tax rates are high, which reduces the increase in employment and in production supply. When output rises (falls), the higher (lower) marginal tax rates could discourage (encourage) labor supply. Furthermore, the supply function is also steeper in countries where the tax system is very progressive, and where an increase in taxes implies more important wage claims from the salaries seeking to maintain the level of their real revenues. Thus, in our model, the taxation system influences not only the demand side and disposable income in the economy, but also the supply behavior of firms.

2.2. Loss Functions of the Economic Authorities

We suppose that economic policies are endogenous, and are the result of a strategic game (Nash equilibrium) between the economic authorities. The preferences of the common central bank are given by the following quadratic loss function:

$$L^M = \frac{1}{2}E_t\{\sum_{T=0}^{\infty} b^T[a^M\pi^2_{t+T} + y^2_{t+T} + \P^M(i_{t+T} - i_{t+T-1})^2]\} \quad (3)$$

[1] As global demand is positively related to the level of public expenditure, in proportion to the share of public spending in GDP, [$y_{i,t}$-$E_t(y_{i,t+1})$] is positively related to [$g_{i,t}$-$E_t(g_{i,t+1})$].

[2] In the traditional demand function, net exports depend on prices differentials. But in comparison with the steady state equilibrium, we suppose that a higher inflation rate damages the relative competitiveness of a country.

where the parameters (a^M) and (a^G) express the weights of the price stability goal and the parameters (ξ^M) and (ξ^G) express the weights of instrument smoothing relative to the output goal normalized to unity, respectively for the central bank and for the governments.

Indeed, the central bank mostly aims at stabilizing inflation but also output around their potential levels in the whole monetary union. Besides, we also suppose that price stability is more important for the central bank than for national governments ($a^M > a^G$). Furthermore, the minimization of fluctuations in interest rates is usually justified by the empirical smoothing of interest rates conducted by central banks, and by the necessity to avoid large fluctuations which could be damageable for the stability of financial markets.

The preferences of the government (i) are given by the following quadratic loss function:

$$L_i^G = \frac{1}{2} E_t \{\sum_{T=0}^{\infty} b^T \left[a^G \pi_{i,t+T}^2 + y_{i,t+T}^2 + \P^G \left(g_{i,t+T} - g_{i,t+T-1}\right)^2\right]\} \quad (4)$$

Therefore, the government (i) stabilizes asymmetric business cyclical fluctuations in its country. As for the central bank, for the country (i), welfare losses increase with the deviation of inflation and output from their targets. For convenience, the inflation target can be set equal to zero, in conformity with the price stability goal. The activity target is also supposed to be null; the governments try to stabilize output around its potential and equilibrium level without inflation bias. Furthermore, the governments' losses also increase with variations in budgetary expenditures. The minimization of fluctuations in public expenditures can be justified by the political pressure on governments to continue fundamental expenditures and to provide some level of public services. It can also be justified by the empirical delays by which these expenditures can effectively be modified and for the implementation of fiscal measures, as well as by the desire to avoid an increase in public debts. In order to simplify the model, we also assume that the preferences of the governments of the various countries in the monetary union are identical.

2.3. Derivation of Economic Policies and Variables

By combining equations (1) to (4), we obtain the optimal monetary and budgetary policies conducted by the economic authorities: (i_t) and ($g_{i,t}$). The monetary authority conducts the optimal union-wide monetary policy in conformity with its preferences in equation (3), whereas each government conducts its optimal decentralized and country-specific budgetary policy according to its own preferences in equation (4). By combining these economic policies, we can obtain the Nash equilibrium of our model, the monetary and budgetary policies if the authorities don't cooperate. Afterwards, we can obtain the optimal inflation and economic activity levels in the monetary union according to various kinds of shocks (see Appendix A). Let's mention that in the framework of our model, the global social welfare is supposed to depend on the prices and economic activity levels in the monetary union. However, as the latter are liable to vary in opposite direction, the rest of the paper will precise separately the consequences of variations in economic policies and in structural parameters as tax distortions on each economic variable of the social well-being: inflation and economic activity.

If the average real interest rate [$E_t(i_{t+T+1}-\pi_{t+T+1})$] is anticipated to exceed in the future its equilibrium level ($\bar{r}$), monetary policy is expected to be contractionary in the future. Thus, in order to compensate for this recessive future policy, the current common interest rate decreases and budgetary expenditures increase in all member countries of the monetary union. These expansionary economic policies can't avoid deflationary tensions in all the monetary union.

Nevertheless, their consequences on current economic activity levels are more ambiguous. Economic activity decreases (increases) in all the monetary union only if smoothing public expenditures (ξ^G) is more (less) important than price stability (a^G) for the governments, as the increase in budgetary expenditures is then more limited (accentuated).

Besides, if average economic activity is expected to grow in the private sector in the future [$E_t(y_{t+T+1}-\lambda g_{t+T+1})>0$], the current interest rate increases in order to compensate for these expansionary tendencies. However, the current budgetary policy is more ambiguous in each member country of the monetary union. Public expenditures tend to decrease if the weight given by the central bank to interest rate smoothing (ξ^M) or by the governments to price stability (a^G) are high. Indeed, the share of the stabilization effort borne by the governments is then higher. On the contrary, public expenditures tend to increase if price stability (a^M) is fundamental for the central bank. Indeed, budgetary policies then have to compensate for the consequences of a very contractionary monetary policy. However, in both cases, economic activity tends to decrease whereas prices tend to increase in all the monetary union. Let's now study the consequences of demand or supply shocks.

3. Stabilization of Demand Shocks

In the specific framework of our model, including supply-side distortions by the way of the parameter (λ) in a dynamic context, we now want to study the efficiency of economic policies on the economic stabilization of various kinds of shocks. Contrary to Martinez-Mongay and Sekkat (2003), Buti and Van den Noord (2003) or Buti *et al.* (2002), our model is dynamic, and we consider asymmetric but also symmetric shocks. Furthermore, for our theoretical estimations as well as for the graphs, we will use the following calibration:

- Share of private consumption in GDP (σ): Gali and Monacelli (2008) or Lieb (2012) consider a high value for this parameter: σ=0.75. Vogel *et al.* (2006) suppose: σ=0.73. This is in conformity with the values reported in table 1. Therefore, we will take the following value for this parameter: σ=0.75.
- Openness to trade: (η): Gali and Monacelli (2008) or Lieb (2012) consider a moderate openness: η=0.3. On the contrary, Vogel *et al.* (2006) suppose a much higher value for this parameter: η=0.73. In fact, the situation of the European countries is very heterogeneous regarding their degree of openness (see table 1). Thus, we will take an intermediary value for this parameter: η=0.5.
- Price flexibility (k): Kienzler and Schmid (2010): k=0.13, or Vogel *et al.* (2006): k=0.26 consider moderate values for price flexibility in Europe. However, Gali and Monacelli (2008) or Lieb (2012) consider a much higher value: k=1.04. Thus, we will take an intermediary value for this parameter: k=0.5.
- Intensity of tax distortions (λ): Vogel *et al.* (2006) consider: λ=0.12, whereas Gali and Monacelli (2008) or Lieb (2012) take: λ=0.08. Therefore, we will suppose: λ=0.1.
- Discount rate of the future (b): Vogel *et al.* (2006), Gali and Monacelli (2008), Kienzler and Schmid (2010) or Lieb (2012) all consider a high discount factor: b=0.99.
- Finally, regarding the preferences of the economic authorities, we will suppose: a^M=2 and ξ^M=1, as the main goal of the European Central Bank, for example, is to preserve price stability; a^G=1 and ξ^G=0.5, as governments mainly aim at stabilizing economic variables.

In the framework of our model, what are then the consequences of tax distortions for the stabilization of symmetric or asymmetric demand shocks?

Table 1
Share of Private Consumption in GDP and Openness to Trade

	Private consumption /GDP (1)	Openness to trade (2)
EMU 17	**78.1 %**	**40,1 %**
Belgium	75.7 %	79.8 %
France	75.2 %	26.7 %
Germany	80.6 %	43.5 %
Greece	81.1 %	25.2 %
Ireland	80.3 %	93.5 %
Italy	78.8 %	27.7 %
Portugal	78.6 %	34.6 %
Spain	79.2 %	27.4 %
Japan	79.9 %	14.7 %
Poland	81.2 %	42.0 %
Sweden	72.8 %	47.1 %
United-Kingdom	76.9 %	31.1 %
United-States	82.8 %	14.5 %

Source: *Eurostat.*
(1): 1 –(Final consumption expenditure of general government / GDP), in 2010
(2): (Exportations +Importations of goods and services) / (2*GDP), in 2010

3.1. Symmetric Demand Shocks

After a symmetric positive demand shock, the central bank increases the common interest ($\partial i_t/\partial d_t>0$) in order to reduce the expansionary consequences of the shock. Public expenditures are also reduced in the same proportions in all member countries ($\partial g_{i,t}/\partial d_t<0$) (see Appendix A). Economic policies are therefore complementary, without conflict of goals between the economic authorities. Nevertheless, despite these contractionary economic policies, prices increase ($\partial \pi_{i,t}/\partial d_t>0$) in the member countries of the monetary union. Indeed, the central bank is constrained in the use of its interest rate in order to stabilize economic variables ($\xi^M>0$), which prevents a perfect stabilization of symmetric demand shocks by the monetary authority. Variations in economic activity are more ambiguous; however, the member countries also experiment economic growth as soon as smoothing public expenditures (ξ^G) is a non negligible goal for the governments, and for plausible values of our parameters.

$$\frac{\partial i_t}{\partial d_t}=\frac{(1+k^2a^M)(1+k\eta)\xi^G+k^2\lambda[a^M(1-\sigma+k\eta\lambda)-a^G(1-\sigma-{}^{a})]}{m_4}>0 \quad (5)$$

$$\frac{\partial g_{i,t}}{\partial d_t}=\frac{-\xi^M[(1-\sigma+k\eta\lambda)+a^Gk^2(1-\sigma-\lambda)]}{m_4}<0 \quad (6)$$

$$\frac{\partial y_{i,t}}{\partial d_t}=\frac{\partial y_t}{\partial d_t}=\frac{\xi^M[(1+k\eta)\xi^G-a^Gk^2\lambda(1-\sigma-{}^{a})]}{m_4} \quad (7)$$

$$\frac{\partial \pi_{i,t}}{\partial d_t}=\frac{\partial \pi_t}{\partial d_t}=\frac{k\xi^M[(1+k\eta)\xi^G+\lambda(1-\sigma+k\eta\lambda)]}{m_4}>0 \quad (8)$$

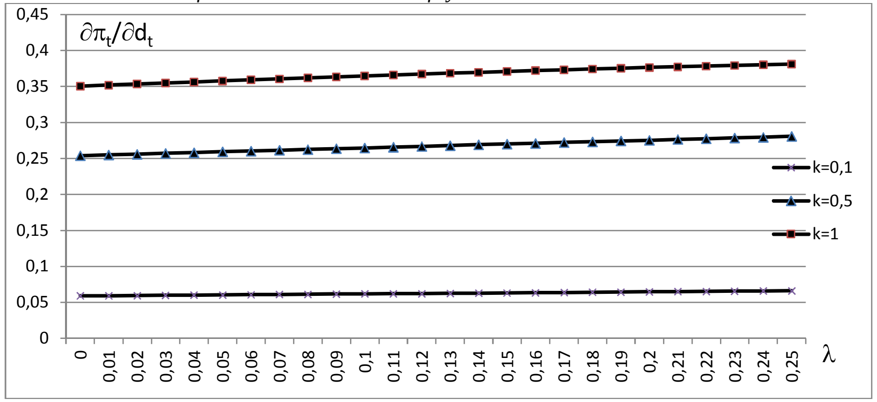
More precisely, if the central bank highly values price stability (a^M is high) in comparison with smoothing interest rates (ξ^M is small), it bears the biggest share in the stabilization of symmetric demand shocks. The interest rate highly increases in order to stabilize prices, whereas the decrease in public expenditures can remain moderate. Increases in prices and in economic activity levels then remain limited. If variations in interest rate were without costs for the central bank ($\xi^M=0$), economic variables could even be perfectly stabilized without variations in public expenditures. On the opposite, if stabilizing prices is valuable for the governments (a^G is high) and if the costs of variations in public expenditures, in particular in terms of public debt, are limited (ξ^G is small), the governments bear the biggest share in the stabilization of symmetric demand shocks. Then, the variation in interest rate remains limited whereas the decrease in public expenditures is larger, which allows a good stabilization of prices and economic activity levels. Therefore, inflation and economic activity levels are all the more stabilized in the monetary union as the economic authorities care more about price stability (a^M and a^G are high) and less about instrument smoothing (ξ^M and ξ^G are small).

Besides, if the share of private consumption in GDP is high (that is to say around $0.5<\sigma<1$), an increase in this share still improves the efficiency of monetary policy. Therefore, economic policies can be less contractionary (smaller increase in interest rates and smaller decrease in public expenditures), whereas prices and economic activity levels are better stabilized. On the opposite, higher openness to trade (η) slightly increases inflation rates and economic activity levels in the monetary union. Indeed, national budgetary policies are then less efficient and less active, whereas the monetary authority is more active but is constrained in the use of its interest rate ($\xi^M>0$). Thus, higher openness to trade would mostly be destabilizing for the monetary union in the event of symmetric demand shocks.

Furthermore, Brunila *et al.* (2003) find that a flatter supply function [a higher (k)] would be destabilizing for demand shocks. In the same way, in the framework of our model, we find that higher price flexibility (k) or larger tax distortions (λ) necessitate a more contractionary monetary policy (increase in interest rates) in order to stabilize symmetric demand shocks and to avoid the inflationary out-burst. The decrease in public expenditures can then be more limited; and in both cases, inflationary tensions are more accentuated, even if economic activity levels are better stabilized in the monetary union. Therefore, in the framework of our model, higher taxation rates and larger tax distortions (λ) would always be inflation destabilizing in the monetary union in the event of symmetric demand shocks (see figure 1). Indeed, $\partial[\frac{\partial \pi_t}{\partial d_t}]/\partial\lambda>0$ for any plausible values of our parameters. Furthermore, they would be all the more inflation destabilizing as price flexibility is sizeable (k is high) in the monetary union.

Figure 1

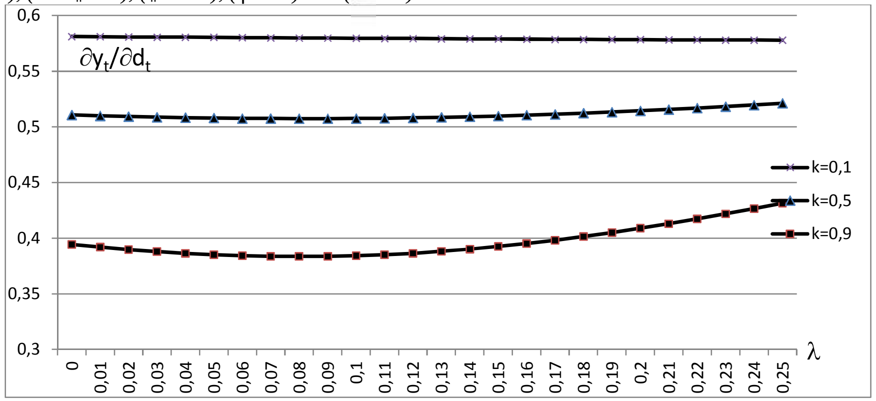
Tax distortions and inflation rates in the event of symmetric demand shocks



On the contrary, higher taxation rates and larger tax distortions (λ) would usually be output stabilizing in the event of symmetric demand shocks. Furthermore, this efficiency of the taxation policy to stabilize economic activity levels would be all the more accentuated as prices are flexible (k is high). Nevertheless, the introduction of distortive taxation effects on the supply curve implies, in the dynamic framework of our model, the existence of a critical level of tax distortions (λ_{ydt}^*) where taxation could become output destabilizing (see figure 2). Buti and Van den Noord (2003) or Martinez-Mongay and Sekkat (2003) have tried to define a critical tax level beyond which increasing taxation rates would become inflation destabilizing in the event of demand shocks. Quite differently, in this paper, we can define a critical level of tax distortions preventing the efficiency of the taxation policy to stabilize output in the event of symmetric demand shocks, i.e. for which: $\partial[\frac{\partial y_t}{\partial d_t}]/\partial\lambda > 0$ [see section 3.3].

Figure 2

Tax distortions and activity levels in the event of symmetric demand shocks
(a^G=1.5), (a^M=¶^{M}=2), (¶^{G}=0.1), (¦ =0.3) and (σ=0.8)



3.2. Asymmetric Demand Shocks

After an asymmetric positive demand shock in a country (i) member of a monetary union, the interest rate doesn't vary, as this shock doesn't affect average variables in the monetary union if the countries are structurally homogeneous. The positive demand shock allows a reduction in public expenditures in the country (i) positively affected by the shock [$\partial g_{i,t}/\partial(d_{i,t}-d_t)<0$], whereas prices increase in this country [$\partial\pi_{i,t}/\partial(d_{i,t}-d_t)>0$]. In these conditions, the country (i) also generally experiences economic growth, as in order to smooth public expenditures (ξ^G), the limited decrease in these expenditures doesn't compensate for the expansionary consequences of the shock. However, this economic growth is all the more limited as the budgetary authorities value price stability (a^G), and as the decrease in public expenditures in thus sizeable.

$$\frac{\partial g_{i,t}}{\partial(d_{i,t}-d_t)} = \frac{-[(1-\sigma+k\eta\lambda)+a^G k^2(1-\sigma-\lambda)]}{[(1+k\eta)^2\xi^G+(1-\sigma+k\eta\lambda)^2+a^G k^2(1-\sigma-\lambda)^2]} < 0 \quad (9)$$

$$\frac{\partial y_{i,t}}{\partial(d_{i,t}-d_t)} = \frac{[(1+k\eta)\xi^G-a^G k^2\lambda(1-\sigma-\lambda)]}{[(1+k\eta)^2\xi^G+(1-\sigma+k\eta\lambda)^2+a^G k^2(1-\sigma-\lambda)^2]} \quad (10)$$

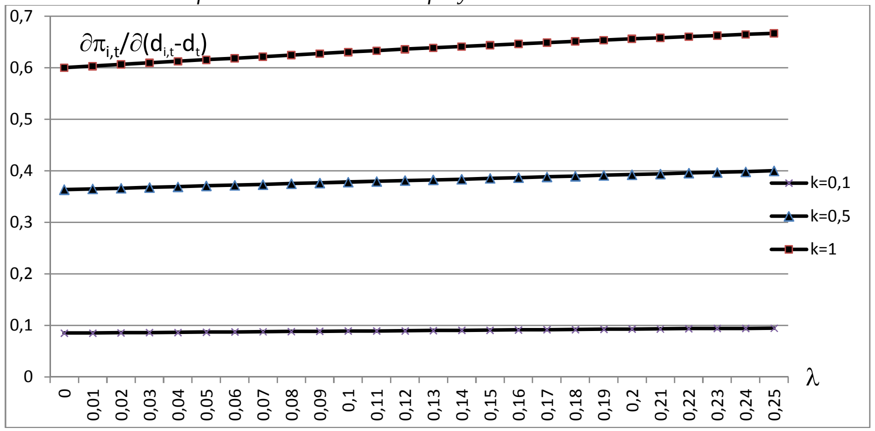
$$\frac{\partial \pi_{i,t}}{\partial(d_{i,t}-d_t)} = \frac{k[(1+k\eta)\xi^G+\lambda(1-\sigma+k\eta\lambda)]}{[(1+k\eta)^2\xi^G+(1-\sigma+k\eta\lambda)^2+a^G k^2(1-\sigma-\lambda)^2]} > 0 \quad (11)$$

Of course, we find that if the budgetary authority gives a higher preference to public expenditures smoothing (ξ^G is high) and if it values less price stability (a^G is small), the budgetary policy is less active and thus, budgetary expenditures decrease less in the country (i) affected by an asymmetric positive demand shock. Therefore, increases in economic activity and in prices are more accentuated in this country (i).

Besides, if openness to trade (η) is high, budgetary policies are less active in the monetary union. Indeed, higher openness to trade is rather stabilizing in the event of an asymmetric demand shock. Indeed, the decrease in the price-competitiveness and in the net exports of the country (i) positively affected by the shock can contribute to compensate for the expansionary consequences of the shock; increases in economic activity and in prices are then more limited in this country. Therefore, budgetary policies can also be less active in the monetary union. On the contrary, if the share of private consumption in GDP is high in the member countries of the monetary union (that is to say around $0.5<\sigma<1$), an increase in this share still reduces the efficiency of national budgetary policies in order to influence demand; public expenditures decrease thus less strongly in order to compensate for an asymmetric positive demand shock. Moreover, as the national budgetary policy is less efficient, the asymmetric shock is less well stabilized: so, economic activity and prices increase more in the positively affected country.

Furthermore, as for symmetric demand shocks, we find that the decrease in public expenditures can be more limited in the country affected by an asymmetric positive demand shock if price flexibility (k) is higher as well as if tax distortions (λ) are stronger in the monetary union. Nevertheless, in both cases, inflationary tensions are more accentuated in the affected country, even if its economic activity level is then better stabilized. Therefore, in the framework of our model, higher taxation rates and larger tax distortions would always be inflation destabilizing in the event of an asymmetric demand shock (see figure 3). Indeed, $\partial[\frac{\partial \pi_{i,t}}{\partial(d_{i,t}-d_t)}]/\partial\lambda > 0$ for any plausible values of our parameters. Furthermore, they would be all the more destabilizing as price flexibility is sizeable (k is high) in the monetary union.

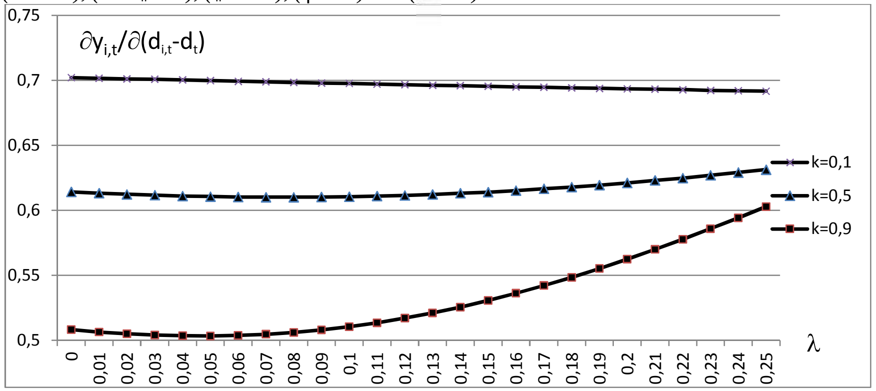
Figure 3
Tax distortions and inflation rates in the event of asymmetric demand shocks



On the contrary, we find that higher taxation rates and larger tax distortions (λ) would usually be output stabilizing in the event of asymmetric demand shocks. Furthermore, this efficiency of the taxation policy to smooth economic activity would be all the more accentuated as prices are flexible (k is high). However, the introduction of distortive taxation effects on the supply curve implies that there is a critical level (λ_{ydit}^*) of tax distortions where taxation could become output destabilizing in the event of asymmetric demand shocks (see figure 4). There

would be a critical level of tax distortions preventing the efficiency of the taxation policy to stabilize output in the event of asymmetric demand shocks, i.e. for which: $\partial[\frac{\partial y_{i,t}}{\partial(d_{i,t}-d_t)}]/\partial\lambda > 0$. It is this critical level (λ_{ydit}^*) that we are now going to study in the following section 3.3.

Figure 4
Tax distortions and activity levels in the event of asymmetric demand shocks
(a^G=1.5), (a^M=¶^{M}=2), (¶^{G}=0.1), (¦=0.3) and (σ=0.8)



3.3. Critical Levels of Tax Distortions

The previous sections have shown that in the framework of our model, higher tax distortions would be output stabilizing in the event of symmetric or asymmetric demand shocks below critical levels (if: $0<\lambda<\lambda^*$), and would only become destabilizing beyond high values of tax distortions and beyond critical levels (if: $\lambda^*<\lambda<1-\sigma$), which are given in Appendix B. These critical levels: (λ_{ydt}^*) in the event of symmetric and (λ_{ydit}^*) in the event of asymmetric demand shocks, are therefore the optimal values of tax distortions in the event of demand shocks. They would be very high with the basic calibration of our parameters. Thus, high levels of tax distortions would always be output stabilizing according to this calibration, and they could even be beneficial in the event of demand shocks.

However, (λ_{ydt}^*) is a decreasing function of the importance of interest rate smoothing for the central bank (ξ^M). Furthermore, (λ_{ydt}^*) as well as (λ_{ydit}^*) are decreasing functions of the importance of price stability for the governments (a^G). Indeed, if these weights are high, budgetary policies are more active in the event of demand shocks, which accentuate the harmful consequences of distortive taxes. (λ_{ydt}^*) and (λ_{ydit}^*) are also decreasing functions of the degree of price flexibility (k) in the monetary union, which increases the inflationary consequences of demand shocks. Therefore, in the event of demand shocks, tax distortions could become output destabilizing in the framework of governments taking care more about inflation than about economic growth, with a central bank strongly smoothing interest rates, and in a monetary union where price flexibility is very high.

On the contrary, (λ_{ydt}*) is an increasing function of the priority of price stability (a^M) for the central bank. Besides, (λ_{ydt}*) and (λ_{ydit}*) are also increasing functions of the importance of smoothing public expenditures for the governments (ξ^G). Indeed, monetary policy is then more active; thus, the central bank compensates more intensively for the inflationary effects of automatic stabilizers, which reduces their potential destabilizing consequences. (λ_{ydt}*) and (λ_{ydit}*) are also increasing functions of openness to trade of the member countries of the monetary union (η), and of the share of private consumption in GDP (σ) in these countries. Indeed, budgetary policies are then less efficient and less active, which reduces the harmful consequences of distortive taxes. For example, if (a^G=1.5), (a^M=ξ^M=2), (ξ^G=0.1), (k=0.9), (η=0.3) and (σ=0.8), the optimal levels of tax distortions in order to stabilize output would only be: (λ_{ydt}^*=0.08) and (λ_{ydit}^*=0.05); they would become destabilizing beyond these levels, respectively in the event of symmetric and asymmetric demand shocks (see figures 2 and 4).

4. Stabilization of Supply Shocks

In the framework of our model, what are the consequences of tax distortions for the stabilization of supply shocks? According to Brunila *et al*. (2003), automatic stabilizers would not be very useful to smooth the consequences of supply shocks. Furthermore, their efficiency is all the more limited as the effects of these shocks are permanent, and as they delay the necessary adjustment of basic economic variables and output to the new structural environment and to their new potential levels. Does our theoretical model strengthen these conclusions?

4.1. Symmetric Supply Shocks

After a symmetric positive supply shock, the central bank reduces the common interest ($\partial i_t/\partial s_t<0$) in order to compensate for the deflationary tensions implied by the shock. Nevertheless, variations in public expenditures are then more ambiguous. Indeed, if the central bank highly values price stability (a^M is high), the large decrease in interest rates strongly reduces the public expenditures necessary to stabilize the expansionary tensions implied by shock. On the contrary, if monetary activism is more limited (ξ^M is high) or if the governments highly value price stability (a^G is high), the decrease in public expenditures is more reduced. However, a symmetric positive supply shock remains deflationary and expansionary: prices decrease and economic activity levels increase in the same proportions in all member countries of the monetary union ($\partial\pi_{i,t}/\partial s_t<0$ and $\partial y_{i,t}/\partial s_t>0$).

$$\frac{\partial i_t}{\partial s_t}=\frac{-\sigma k[a^M(1+k\eta)\xi^G+(1-\sigma)a^M(1-\sigma+k\eta\lambda)-(1-\sigma)a^G(1-\sigma-\lambda)]}{m_4}<0 \quad (12)$$

$$\frac{\partial g_{i,t}}{\partial s_t}=\frac{-k\left[a^M\sigma^2(1-\sigma+k\eta\lambda)-a^G(1-\sigma-\text{a})\left(\xi^M+\sigma^2\right)\right]}{m_4} \quad (13)$$

$$\frac{\partial y_{i,t}}{\partial s_t}=\frac{\partial y_t}{\partial s_t}=\frac{k\left[a^M\sigma^2(1+k\eta)\xi^G+a^G\xi^M(1-\sigma)(1-\sigma-\text{a})\right]}{m_4}>0 \quad (14)$$

$$\frac{\partial\pi_{i,t}}{\partial s_t}=\frac{\partial\pi_t}{\partial s_t}=\frac{-\left[(1-k\eta)(\P^M+\sigma^2)\xi^G+(1-\sigma)(1-\sigma+k\eta\lambda)\P^M\right]}{m_4}<0 \quad (15)$$

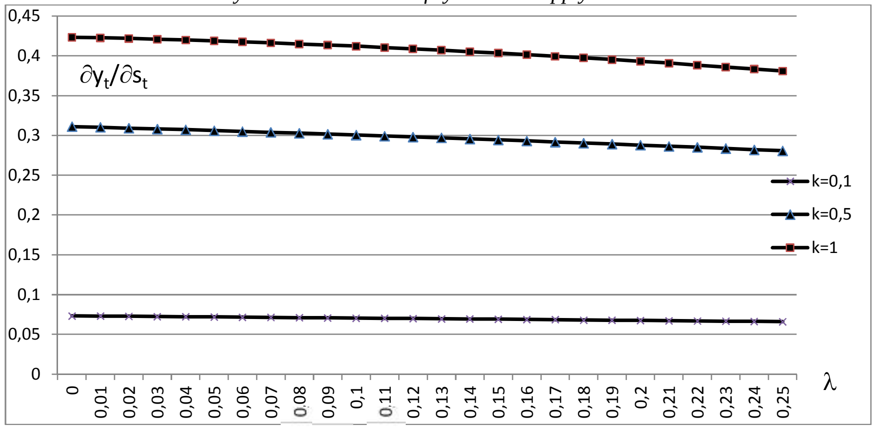
In these conditions, in the event of symmetric positive supply shocks, there is usually a trade-off between stabilizing inflation and the economic activity level. Moreover, there is also usually a conflict of goals between the economic authorities. Indeed, if the central bank is very active in the stabilization of positive supply shocks (a^M is high and ξ^M is small), if the decrease in interest rates is more accentuated, budgetary expenditures have to decrease more strongly in order to compensate for this monetary policy and for the expansionary consequences of the shock. To the contrary, if budgetary activism is more limited (a^G and ξ^G are high), the decrease in interest rates is also more reduced. However, in both cases, stabilization of deflation is improved whereas on the opposite, economic growth is more acute in both countries.

Besides, if the share of private consumption in GDP is already high (that is to say around 0.5<σ<1), an increase in this share usually accentuates the decrease in budgetary expenditures in the event of a symmetric supply shock, whereas the consequences are more ambiguous on monetary policy. Prices would then be better stabilized whereas on the opposite, economic growth would be accentuated in all the monetary union. In the same way, if openness to trade (η) of the member countries of the monetary union is higher, the activism of economic authorities would be slightly increased, but with only minor consequences on the stabilization of economic variables. Furthermore, in the event of a symmetric supply shock, an increase in price flexibility (k) necessitates a more active monetary policy and a stronger decrease in interest rates in order to compensate for the deflationary consequences of the shock. The economic overheating would be accentuated in this situation, despite the stronger decrease in public expenditures. However, the decrease in prices would then be more limited; our result is thus in conformity with Brunila *et al.* (2003), who find that a higher (k) (a flatter supply function) is stabilizing for supply shocks.

Finally, in the event of symmetric supply shocks, the decrease in budgetary expenditures is more accentuated in case of higher tax distortions (λ), as well as the decrease in the common interest rate. In these conditions, the efficiency of stabilization of the deflationary and expansionary tensions implied by the shock depends on the parameters of our model. With plausible values of our parameters, a further increase in these distortions still improves the stabilization of economic activity levels (see Appendix B). Indeed, whatever the parameters of our model, higher taxation rates and larger tax distortions would be output stabilizing $[\partial[\frac{\partial y_t}{\partial s_t}]/\partial\lambda<0]$ in the monetary union in the event of symmetric supply shocks (see figure 5). Furthermore, they would then be all the more stabilizing as price flexibility is sizeable (k is high) in the member countries of the monetary union.

Figure 5

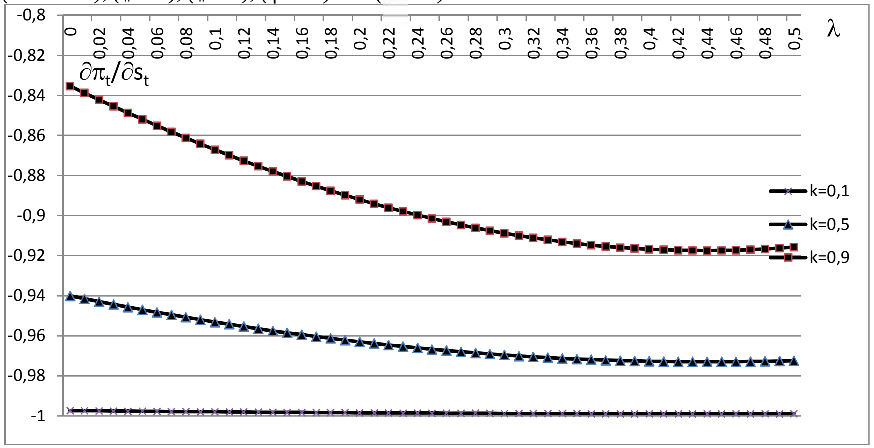
Tax distortions and activity levels in the event of symmetric supply shocks



Nevertheless, prices stabilization is more ambiguous. Higher tax distortions can be slightly inflation destabilizing [$\partial[|\frac{\partial \pi_t}{\partial s_t}|]/\partial\lambda > 0$] in the framework of the basic calibration of our parameters. However, in the dynamic framework of our model, the introduction of distortive taxation effects on the supply curve implies that there is a critical level ($\lambda_{\pi st}^*$) of tax distortions above which increasing these distortions would improve inflation stabilization in the event of symmetric supply shocks [see section 4.3]. It is thus only for initially small values of tax distortions that we would meet the results of Buti and Van den Noord (2003) or Martinez-Mongay and Sekkat (2003), who find that increasing taxation rates would be inflation destabilizing in the event of supply shocks [see figure 6].

Figure 6

Tax distortions and inflation rates in the event of symmetric supply shocks
(a^G=a^M=1), (¶^{M}=2), (¶^{G}=1), (¦=0.3) and (σ=0.5)



4.2. Asymmetric Supply Shocks

After an asymmetric positive supply shock in the country (i), the monetary authority is inefficient to stabilize country specific variables and thus, it doesn't modify the interest rate. Therefore, the positive supply shock implies a reduction in public expenditures in the country (i) affected by the expansionary consequences of the shock, provided prices stability (a^G) has not an excessive weight for the governments. In this context of conflict of goals for the country (i)'s government, the weak budgetary activism doesn't avoid the deflationary and expansionary consequences due to the positive supply shock [$\partial\pi_{1,t}/\partial(s_{i,t}-s_t)<0$ and $\partial y_{1,t}/\partial(s_{1,t}-s_t)>0$].

$$\frac{\partial g_{i,t}}{\partial(s_{i,t}-s_t)} = \frac{-[(1-\sigma+k\eta\lambda)\eta - a^G k(1-\sigma-\lambda)]}{[(1+k\eta)^2\xi^G + (1-\sigma+k\eta\lambda)^2 + a^G k^2(1-\sigma-\lambda)^2]} \quad (16)$$

$$\frac{\partial y_{i,t}}{\partial(s_{i,t}-s_t)} = \frac{[\eta(1+k\eta)\xi^G + a^G k(1-\sigma-\lambda)(1-\sigma)]}{[(1+k\eta)^2\xi^G + (1-\sigma+k\eta\lambda)^2 + a^G k^2(1-\sigma-\lambda)^2]} > 0 \quad (17)$$

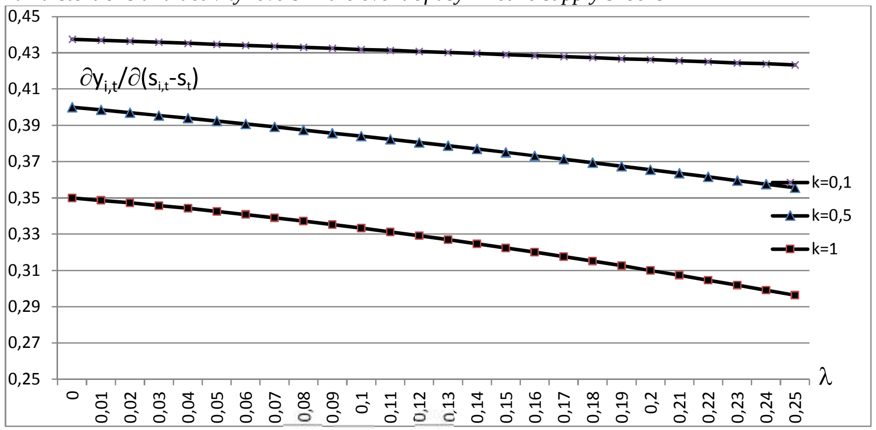
$$\frac{\partial \pi_{i,t}}{\partial(s_{i,t}-s_t)} = \frac{-[(1+k\eta)\xi^G + (1-\sigma)(1-\sigma+k\eta\lambda)]}{[(1+k\eta)^2\xi^G + (1-\sigma+k\eta\lambda)^2 + a^G k^2(1-\sigma-\lambda)^2]} < 0 \quad (18)$$

So, in the event of an asymmetric positive supply shock, the government of the country (i) usually faces a trade-off between stabilizing inflation and the economic activity level. Indeed, if the budgetary activism is more limited (a^G and ξ^G are high), deflation is more reduced whereas economic growth is more accentuated in the country (i) affected by the shock. On the contrary, if the decrease in public expenditures is more accentuated (a^G and ξ^G are small), deflation gets worse, even if the expansionary tensions are reduced.

Besides, an increase in the share of private consumption in GDP (σ) or a higher openness to trade (η) of the member countries of the monetary union tends to accentuate the decrease in budgetary expenditures in the country (i) affected by an asymmetric supply shock. In both situations, prices would then be better stabilized whereas economic growth would be accentuated in the country (i) positively affected by the shock. Moreover, in the event of an asymmetric supply shock, an increase in price flexibility (k) necessitates a more reduced decrease in public expenditures. Nevertheless, despite a limited budgetary activism, the decrease in prices and the expansionary tensions would then be weaker in the country (i).

Finally, in the event of an asymmetric supply shock, the decrease in budgetary expenditures in the country (i) is more accentuated in case of higher tax distortions (λ). In these conditions, the efficiency of stabilization of the deflationary and expansionary tensions implied by the shock depends on the parameters of our model. With plausible values of our parameters, a further increase in these distortions still improves the stabilization of economic activity in the country (i) (see Appendix B). Indeed, whatever the parameters of our model, higher taxation rates and larger tax distortions would be output stabilizing $[\partial[\frac{\partial y_{i,t}}{\partial(s_{i,t}-s_t)}]/\partial\lambda < 0]$ in the country (i) in the event of asymmetric supply shocks (see figure 7). Furthermore, they would then be all the more stabilizing as price flexibility is sizeable (k is high) in the member countries of the monetary union.

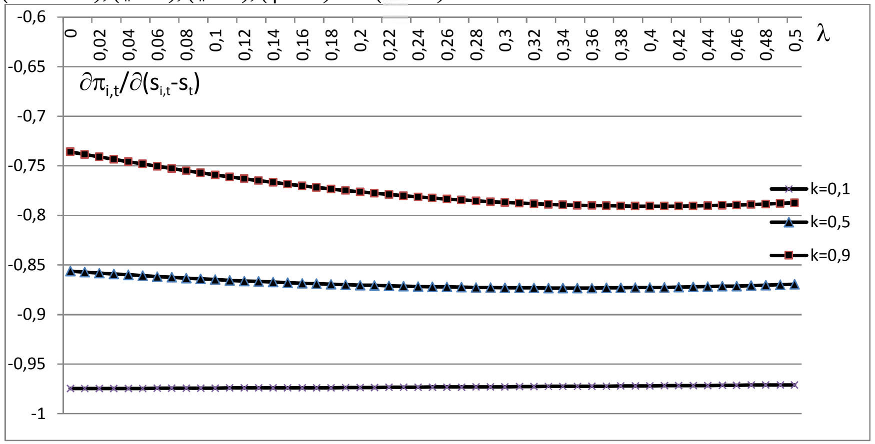
Figure 7
Tax distortions and activity levels in the event of asymmetric supply shocks



Nevertheless, prices stabilization is more ambiguous. Higher tax distortions can be slightly inflation destabilizing $[\partial[|\frac{\partial \pi_{i,t}}{\partial(s_{i,t}-s_t)}|]/\partial\lambda > 0]$ in the country (i) in the framework of the basic calibration of our parameters. However, in the dynamic framework of our model, the introduction of distortive taxation effects on the supply curve implies that there is a critical level ($\lambda_{\pi sit}^*$) of tax distortions above which increasing these distortions would improve inflation

stabilization in the event of asymmetric supply shocks [see figure 8]. It is this critical level ($\lambda_{\pi sit}^*$) that we are now going to study in the following section 4.3.

Figure 8
Tax distortions and inflation rates in the event of asymmetric supply shocks
(a^G=a^M=1), (¶^{M}=2), (¶^{G}=1), (¦=0.3) and (σ=0.5)



4.3. Critical Levels of Tax Distortions

In the event of symmetric or asymmetric supply shocks, our results show that there are two stable solutions for tax distortions (λ) that allow a good stabilization of prices. Indeed, there are critical levels of these distortions, ($\lambda_{\pi st}$*) for symmetric and ($\lambda_{\pi sit}$*) for asymmetric supply shocks, where prices stabilization is the worse in the event of supply shocks (see Appendix B); but these solutions are unstable. Indeed, below these critical levels ($0<\lambda<\lambda^*$), the governments have interest in reducing tax distortions in order to improve price stability; (λ=0) is thus an optimal solution. To the contrary, beyond these critical levels ($\lambda^*<\lambda<1-\sigma$), they have interest in increasing tax distortions to improve price stability; ($\lambda=1-\sigma$) is thus another optimal solution for prices stabilization. Therefore, our results show that in the event of supply shocks, the governments would have interest in reducing and even in removing all tax distortions if they are already weak; to the contrary, they would have interest in increasing further these distortions if they are already large. So, this result could explain the temptation of governments to increase tax distortions, in the countries where these distortions are already large and beyond critical levels.

More precisely, in the framework of our model and according to our basic calibration, the benchmark levels of tax distortions would be ($\lambda_{\pi st}$*=0.11) and ($\lambda_{\pi sit}$*=0.12) respectively for symmetric and asymmetric supply shocks. Therefore, beyond these quite limited levels, increasing tax distortions until (λ=0.25) would be beneficial for the budgetary authorities and would improve prices stabilization. However, ($\lambda_{\pi st}$*) is an increasing function of the weight given to interest rate smoothing (ξ^M) and a decreasing function of the weight given to price stability

(a^M) by the central bank. ($\lambda_{\pi st}$*) and ($\lambda_{\pi sit}$*) are also increasing functions of the weight given by the governments to price stability (a^G) or to budgetary expenditures smoothing (ξ^G), whereas they are decreasing functions of the share of private consumption in GDP (σ) and of openness to trade of the member countries of the monetary union (η). Finally, ($\lambda_{\pi st}$*) is a decreasing function whereas ($\lambda_{\pi sit}$*) is an increasing function of price flexibility (k) in the monetary union. Indeed, the previous sections have shown that in all these economic configurations, budgetary activism and the decrease in budgetary expenditures are more reduced in the event of positive supply shocks. Harmful and distortive consequences of the taxation policies are thus more limited.

Therefore, in these conditions, increasing tax distortions would more likely be inflation destabilizing in a monetary union where the governments care as much as the central bank about price stability, if instrument smoothing is important for the economic authorities, if the countries are weakly open and if the share of public consumption in GDP is large. For example, if (a^G=a^M=1), (ξ^M=2), (ξ^G=1), (η=0.3), (k=0.5) and (σ=0.5), below the levels ($\lambda_{\pi st}$*=0.44) for symmetric and ($\lambda_{\pi sit}$*=0.34) for asymmetric supply shocks, increasing tax distortions would always be inflation destabilizing. Increasing tax distortions could then only be inflation stabilizing in a very narrow extent of possibilities and when these distortions are already very strong, that is to say between ($\lambda_{\pi st}$*=0.44<λ<0.5) for symmetric or ($\lambda_{\pi sit}$*=0.34<λ<0.5) for asymmetric supply shocks (see figures 6 and 8). On the contrary, increasing tax distortions would always be inflation stabilizing in a monetary union where price stability is much more important for the central bank than for the governments (a^M>>a^G). For example, if (a^G=0.37) (a^M=2), (ξ^M=1), (ξ^G=0.5), (η=0.5), (k=0.5) and (σ=0.75), increasing tax distortions would always be inflation stabilizing.

5. Empirical Implications

To sum up, our model shows that in the short run, in the event of demand shocks, reducing tax distortions would always be inflation stabilizing. Nevertheless, it is more likely to be output destabilizing in a monetary union where monetary policy is very active; that is to say, if the central bank values price stability (a^M) rather than interest rate smoothing (ξ^M), whereas the governments value public expenditures smoothing (ξ^G) rather than price stability (a^G). In the event of demand shocks, reducing tax distortions is also more likely to be output destabilizing in a monetary union where prices are quite rigid (k is small), and where the share of private consumption in GDP (σ) and openness to trade (η) of the member countries are high. Besides, in the short run, in the event of supply shocks, reducing tax distortions is always output destabilizing. Furthermore, it is more likely to be also inflation destabilizing in a monetary union where the central bank favors much more than the governments price stability (a^M is high and a^G is small), if instrument smoothing is secondary for the economic authorities (ξ^M and ξ^G are small), if the member countries of the monetary union are strongly open and if the share of private consumption in GDP is large (η and σ are high) in these countries. Moreover, in the event of asymmetric supply shocks, reducing tax distortions is also more likely to be inflation destabilizing in a monetary union where prices are quite rigid (k is small). What are then the consequences of these theoretical results, for the member countries of the European Economic and Monetary Union (EMU)?

First, in the short run, the costs of a fiscal policy intending to reduce tax distortions are

higher in a monetary union where a common conservative central bank values much more than national governments price stability. Therefore, we can mention that the predominance of the price stability goal in the statutes of the European Central Bank could strengthen the costs of such a policy, for the member countries of the EMU. Besides, the costs of a fiscal policy intending to reduce tax distortions are also higher in a monetary union where prices are rigid, where the share of private consumption in GDP is high, and where openness to trade of the countries is high. Regarding these criteria, many studies show that price rigidity is quite high in Europe. For example, Dhyne *et al.* (2005) find that on average, the monthly frequency of price change in the Euro area is around 15%, and the weighted median price duration is 10.6 months. The results of Bils and Klenow (2004) for the United States, based on a comparable set of product categories, show an average monthly frequency of price change around 25% and a weighted median price duration of 4.6 months. Therefore, Euro area prices appear far stickier than US prices. In the same way, a recent study by Verhelst (2010) shows, with high-frequency scanner data, that regular prices are far more flexible in the US than in Europe, pointing to a more aggressive short-term pricing strategy in the US. Indeed, half of prices last less than 1.5 months in Europe, against 1.3 months in the US. This relative higher price rigidity in Europe could thus be a factor of higher costs of a fiscal policy intending to reduce tax distortions in the European countries.

Besides, European statistics show that the share of private consumption in GDP is generally smaller in the member countries of EMU than in the United States or in Japan, for example (see table 1). However, this share is quite high in countries such as Greece (81.1%) or Ireland (80.3%), which could harden a budgetary policy of fiscal consolidation, limitation of tax distortions and reduction of the problems of public indebtedness in these countries. In the same way, the openness to trade of the member countries of EMU are usually very high, especially in the smallest countries as Ireland (93.5%). In comparison, Japan or the United-States are countries that are very much closed. Buti *et al.* (2002), Buti *et al.* (2003) and Martinez-Mongay and Sekkat (2003) assume that in equilibrium and in the long run, taxation rates could be higher in less open, big and large countries, whereas they must remain lower in the smallest open countries. Our dynamic model also shows that the short run costs of a fiscal policy intending to reduce tax distortions are heavier in the most open member countries of the monetary union.

Finally, in the event of supply shocks, our model shows that in the short run, a supplementary increase in tax distortions would more likely be inflation stabilizing in a monetary union where these distortions are already large and beyond a given critical level. In this context, Bokan and Hughes-Hallett (2008) assume that on average, tax distortions would be about twice higher in Europe than in other OECD countries as the United-States, Australia or Japan. More precisely, tax distortions would be the highest in core European and first EMU member countries: Belgium, Germany, Italy and France, whereas they would be more moderate in Spain, in Greece and in Portugal, and they would only be weak in Ireland. Therefore, according to our model, the high levels reached by tax distortions in the European countries could be another obstacle, in the short run and in the event of supply shocks, to the reduction of these distortions.

6. Conclusion

Our dynamic model shows that in the short run, reducing taxes and tax distortions would always be inflation stabilizing in the monetary union in the event of symmetric or asymmetric demand shocks. Furthermore, it would be all the more inflation stabilizing as price flexibility is sizeable in the monetary. Nevertheless, higher taxation rates and larger tax distortions are usually output stabilizing in the short run in the event of demand shocks, and all the more as prices are flexible. Indeed, there exists a critical and optimal level of tax distortions which could be bearable without accentuating the recessionary risks in the event of demand shocks, below which increasing tax distortions is output stabilizing; and this level seems quite high in the framework of our model. More precisely, increasing tax distortions could only become output destabilizing beyond this critical level, in the framework of governments taking care more about inflation than about economic growth, with a central bank strongly smoothing interest rates, and in a monetary union where price flexibility would be very high.

Furthermore, in the event of positive symmetric or asymmetric supply shocks, the efficiency of the stabilization of the deflationary and expansionary tensions implied by the shocks depends on the parameters of our model. With plausible values of our parameters, in the short run, a further increase in tax distortions still improves the stabilization of economic activity levels. Besides, it would be all the more output stabilizing as price flexibility is sizeable in the member countries of the monetary union. Nevertheless, prices stabilization is more ambiguous. The introduction of distortive taxation effects on the supply curve implies that there is a critical level of tax distortions below which increasing these distortions would worsen the stabilization of inflation in the event of supply shocks. For initially small values of tax distortions, increasing them would thus be inflation destabilizing in the event of supply shocks, whereas it would be inflation stabilizing if these distortions are already high. More precisely, increasing tax distortions would more likely be inflation destabilizing in a monetary union where the governments value price stability as much as the central bank, if instrument smoothing is important for the economic authorities, if the countries are weakly open and if the share of public consumption in GDP is large.

Finally, in the short run, the costs of a fiscal policy intending to reduce tax distortions are higher in a monetary union where a common conservative central bank values much more than national governments price stability; and the main goal of the ECB is to preserve price stability. Besides, the costs of a fiscal policy intending to reduce tax distortions are also higher in a monetary union where prices are rigid, where the share of private consumption in GDP is high, and where the openness to trade of the member countries is high; and these criteria seem also to characterize the European Economic and Monetary Union. Therefore, our paper shows that if the reduction of tax distortions is often considered as necessary in the long run for the European countries, such a policy would have non negligible short run costs for the governments. This could contribute to explain the reticence and the lack of enthusiasm of the European countries to conduct such policies of fiscal stabilization.

APPENDIX A: Determination of economic policies and variables

Solving equations (1) and (2) forwards, and under the assumption that: $\lim_{T\to\infty} y_{i,t+T} = \lim_{T\to\infty} g_{i,t+T} = 0$, we have:

$$(1+k\eta)y_{i,t} = -\sigma(1+k\eta)i_t - \sigma(1+k\eta)\{\sum_{T=0}^{\infty} E_t[i_{t+T+1} - \pi_{t+T+1} - \bar{r}] - \bar{r}\} + k\eta(1-\sigma-{}^{\mathrm{a}})g_t$$
$$+(1-\sigma+k\eta\lambda)g_{i,t} + (\sigma - |)\sum_{T=0}^{\infty} E_t\left[\pi_{i,t+T+1} - \pi_{t+T+1}\right] + \eta(s_{i,t} - s_t)$$
$$+k\eta\sum_{T=0}^{\infty} b^{T+1}E_t[(y_{t+T+1} - \lambda g_{t+T+1}) - (y_{i,t+T+1} - \lambda g_{i,t+T+1})] + k\eta d_t + d_{i,t} \quad (A1)$$

$$(1+k\eta)\pi_{i,t} = -\sigma k(1+k\eta)i_t - \sigma k(1+k\eta)\{\sum_{T=0}^{\infty} E_t[i_{t+T+1} - \pi_{t+T+1} - \bar{r}] - \bar{r}\} - k\eta s_t - s_{i,t}$$
$$+k(\sigma-\eta)\sum_{T=0}^{\infty} E_t\left[\pi_{i,t+T+1} - \pi_{t+T+1}\right] + k(1-\sigma-\lambda)g_{i,t} + k^2\eta(1-\sigma-\lambda)g_t$$
$$+k\sum_{T=0}^{\infty} b^{T+1}E_t[k\eta(y_{t+T+1} - {}^{\mathrm{a}}g_{t+T+1}) + (y_{i,t+T+1} - {}^{\mathrm{a}}g_{i,t+T+1})] + k^2\eta d_t + kd_{i,t} \quad (A2)$$

The central bank minimizes its loss function. Therefore, $\partial L^M/\partial i_t = 0$ implies:

$$[\xi^M + \sigma^2(1+k^2a^M)]i_t = \xi^M i_{t-1} - \sigma^2(1+k^2a^M)\{\sum_{T=0}^{\infty} E_t[i_{t+T+1} - \pi_{t+T+1} - \bar{r}] - \bar{r}\} - \sigma k a^M s_t$$
$$+\sigma^2k^2a^M\sum_{T=0}^{\infty} b^{T+1}E_t[y_{t+T+1} - {}^{\mathrm{a}}g_{t+T+1}] + \sigma[1-\sigma+k^2a^M(1-\sigma-{}^{\mathrm{a}})]g_t + \sigma(1+k^2a^M)d_t \quad (A3)$$

With : $\partial E_t(\pi_{t+T+1})/\partial i_t = \partial E_t(y_{t+T+1})/\partial i_t = 0$ and $E_t(i_{t+T+1}) = E_t(i_{t+T})$ if $T \geq 0$

$\partial E_t(\pi_{i,t+T+1})/\partial g_{i,t} = dE_t(y_{i,t+T+1})/\partial g_{i,t} = 0$ and $E_t(g_{i,t+T+1}) = E_t(g_{i,t+T})$ if $T \geq 0$

The government (i) minimizes its loss function. Thus, $\partial L_i^G/\partial g_{i,t} = 0$ implies:

$$m_1 g_{i,t} = (1+k\eta)m_2\{\sum_{T=0}^{\infty} E_t[i_{t+T+1} - \pi_{t+T+1} - \bar{r}] - \bar{r}\} + km_3\sum_{T=0}^{\infty} b^{T+1}E_t[y_{i,t+T+1} - {}^{\mathrm{a}}g_{i,t+T+1}]$$
$$+(1+k\eta)m_2 i_t - k\eta m_2\sum_{T=0}^{\infty} b^{T+1}E_t[y_{t+T+1} - \lambda g_{t+T+1}] + (1+k\sigma)\eta m_2\sum_{T=0}^{\infty} E_t[\pi_{i,t+T+1} - \pi_{t+T+1}]$$
$$+ (1+k\eta)^2\xi^G g_{i,t-1} - m_2(k\eta d_t + d_{i,t}) + \eta m_2 s_t - m_3 s_{i,t} - k\eta(1-\sigma-{}^{\mathrm{a}})m_2 g_t \quad (A4)$$

So, by combining these loss functions, we have:

$$m_4 i_t = -\sigma^2 m_5\{\sum_{T=0}^{\infty} E_t[i_{t+T+1} - \pi_{t+T+1} - \bar{r}] - \bar{r}\} + \sigma k^2 m_6\sum_{T=0}^{\infty} b^{T+1}E_t[y_{t+T+1} - {}^{\mathrm{a}}g_{t+T+1}]$$
$$+m_5 d_t - \sigma k m_6 s_t + f(i_{t-1}, g_{t-1}) \qquad (A5)$$

$$m_1 m_4 g_{i,t} = \sigma\xi^M m_1 m_2\{\sum_{T=0}^{\infty} E_t[i_{t+T+1} - \pi_{t+T+1} - \bar{r}] - \bar{r}\} + (\iota - \sigma)m_2 m_4\sum_{T=0}^{\infty} E_t(\pi_{i,t+T+1} - \pi_{t+T+1})$$

$$+k\sum_{T=0}^{\infty} b^{T+1}E_t\left[m_3m_4\left(y_{i,t+T+1}-\lambda g_{i,t+T+1}\right)-m_2m_7(y_{t+T+1}-\lambda g_{t+T+1})\right]-\xi^M m_1m_2d_t$$
$$-m_2m_4\left(d_{i,t}-d_t\right)+km_1m_8s_t-m_3m_4(s_{i,t}-s_t)+f\left(i_{t-1},g_{i,t-1},g_{t-1}\right) \quad \text{(A6)}$$

Then, by combining (A5) and (A6) with the economic variables (A1) and (A2), we have:

$$m_1m_4y_{i,t}=-\sigma\xi^M m_1m_9\{\sum_{T=0}^{\infty}E_t[i_{t+T+1}-\pi_{t+T+1}-\bar r]-\bar r\}-m_4m_{10}\sum_{T=0}^{\infty}E_t[\pi_{i,t+T+1}-\pi_{t+T+1}]$$
$$-k\sum_{T=0}^{\infty}b^{T+1}E_t\left[m_4m_{11}\left(y_{i,t+T+1}-\lambda g_{i,t+T+1}\right)+m_9m_{12}(y_{t+T+1}-\lambda g_{t+T+1})\right]+\xi^M m_1m_9d_t$$
$$+m_9m_4(d_{i,t}-d_t)+km_1m_{13}s_t+m_4m_{11}(s_{i,t}-s_t)+f\left(i_{t-1},g_{i,t-1},g_{t-1}\right) \quad (A7)$$

$$m_4y_t=-\sigma\xi^M m_9\{\sum_{T=0}^{\infty}E_t[i_{t+T+1}-\pi_{t+T+1}-\bar r]-\bar r\}-k^2m_{13}\sum_{T=0}^{\infty}b^{T+1}E_t[y_{t+T+1}-\lambda g_{t+T+1}]$$
$$+\xi^M m_9d_t+km_{13}s_t+f(i_{t-1},g_{t-1}) \qquad (A8)$$

$$m_1m_4\pi_{i,t}=-\sigma k\xi^M m_1m_{14}\{\sum_{T=0}^{\infty}E_t[i_{t+T+1}-\pi_{t+T+1}-\bar r]-\bar r\}-km_4m_{15}\sum_{T=0}^{\infty}E_t[\pi_{i,t+T+1}-\pi_{t+T+1}]$$
$$+k\sum_{T=0}^{\infty}b^{T+1}E_t\left[m_4m_{16}\left(y_{i,t+T+1}-\lambda g_{i,t+T+1}\right)+km_7m_{14}(y_{t+T+1}-\lambda g_{t+T+1})\right]+k\xi^M m_1m_{14}d_t$$
$$+km_{14}m_4(d_{i,t}-d_t)-m_1m_{17}s_t-m_4m_{16}(s_{i,t}-s_t)+f\left(i_{t-1},g_{i,t-1},g_{t-1}\right) \quad (A9)$$

$$m_4\pi_t=-\sigma k\xi^M m_{14}\{\sum_{T=0}^{\infty}E_t[i_{t+T+1}-\pi_{t+T+1}-\bar r]-\bar r\}+km_{17}\sum_{T=0}^{\infty}b^{T+1}E_t[y_{t+T+1}-\lambda g_{t+T+1}]$$
$$+k\xi^M m_{14}d_t-m_{17}s_t+f(i_{t-1},g_{t-1}) \quad \text{(A10)}$$

With: $m_1=(1+k\eta)^2\xi^G+(1-\sigma+k\eta\lambda)^2+a^Gk^2(1-\sigma-\lambda)^2>0$
$m_2=(1-\sigma+k\eta\lambda)+a^Gk^2(1-\sigma-\lambda)>0$
$m_3=(1-\sigma+k\eta\lambda)\eta-a^Gk(1-\sigma-\lambda)$
$m_4=(1+k\eta)\xi^M\xi^G+\xi^M(1-\sigma)(1-\sigma+k\eta\lambda)+\xi^Ma^Gk^2(1-\sigma-\lambda)^2$
$\quad+\sigma^2k^2\lambda[a^M(1-\sigma+k\eta\lambda)-a^G(1-\sigma-\lambda)]+\sigma^2(1+k\eta)(1+k^2a^M)\xi^G>0$
$m_5=(1+k^2a^M)(1+k\eta)\xi^G+k^2\lambda[a^M(1-\sigma+k\eta\lambda)-a^G(1-\sigma-\lambda)]>0$
$m_6=a^M(1+k\eta)\xi^G+(1-\sigma)[a^M(1-\sigma+k\eta\lambda)-a^G(1-\sigma-\lambda)]>0$
$m_7=\eta(1+k\eta)\xi^M\xi^G+\xi^M\eta(1-\sigma)(1-\sigma+k\eta\lambda)-(ka^M-\eta)\sigma^2(1+k\eta)\xi^G$
$\quad-\sigma^2k(1-\sigma)[a^M(1-\sigma+k\eta\lambda)-a^G(1-\sigma-\lambda)]$
$m_8=a^G(1-\sigma-\lambda)\left(\xi^M+\sigma^2\right)-a^M\sigma^2(1-\sigma+k\eta\lambda)$
$m_9=(1+k\eta)\xi^G-a^Gk^2\lambda(1-\sigma-\lambda)$
$m_{10}=(1-\sigma+k\eta\lambda)^2+\xi^G\eta(1+k\sigma)(1+k\eta)-a^Gk^2(\eta\lambda-\sigma+\sigma^2)(1-\sigma-\lambda)$
$m_{11}=\xi^G\eta(1+k\eta)+a^Gk(1-\sigma)(1-\sigma-\lambda)>0$
$m_{12}=\left[(1-\sigma)(1-\sigma+k\eta\lambda)+\xi^G(1+k\eta)\right]\left(ka^M\sigma^2-\xi^M\eta-\sigma^2\eta\right)$
$\quad+(1-\sigma)\sigma^2[(1-\sigma+k\eta\lambda)\eta-a^Gk(1-\sigma-\lambda)]$
$m_{13}=\sigma^2a^M\xi^G(1+k\eta)+a^G\xi^M(1-\sigma)(1-\sigma-\lambda)>0$
$m_{14}=\xi^G(1+k\eta)+\lambda(1-\sigma+k\eta\lambda)>0$

$m_{15}=\sigma(1-\sigma+k\eta\lambda)^2-\lambda(1-\sigma+k\eta\lambda)(\sigma-\eta)+a^Gk^2\sigma(1-\sigma-\lambda)^2$
$\quad+\eta(1+k\sigma)\xi^G(1+k\eta)>0$
$m_{16}=\xi^G(1+k\eta)+(1-\sigma)(1-\sigma+k\eta\lambda)>0$
$m_{17}=(\xi^M+\sigma^2)\xi^G(1+k\eta)+\xi^M(1-\sigma)(1-\sigma+k\eta\lambda)>0$

APPENDIX B : Calculation of the derivatives

- $\partial\left[\frac{\partial y_t}{\partial d_t}\right]/\partial\lambda<0$ if: $0<\lambda<\lambda^*_{y,dt}$ $\quad\partial\left[\frac{\partial y_t}{\partial d_t}\right]/\partial\lambda>0$ if: $\lambda^*_{y,dt}<\lambda<1-\sigma$ (B1)

$$\lambda^*_{y,dt}=\frac{\sqrt{\Delta_{y,dt}}+k\sigma^2\xi^Ga^M(1+k\eta)(\eta-ka^G)-\xi^Ma^G(1-\sigma)^2(1+a^Gk^2)}{k(1-\sigma)a^G[\xi^M(\eta-ka^G)+k\sigma^2a^M(1+k\eta)]}$$

$$\Delta_{y,dt}=(1+k\eta)[a^G(1-\sigma)^2(1+a^Gk^2)+\xi^G(\eta-ka^G)^2]$$
$$\left[\xi^Ma^G(1-\sigma)^2\left(\xi^M+a^Mk^2\sigma^2\right)+k^2\sigma^4\xi^Ga^{M2}(1+k\eta)\right]>0$$

- $\partial\left[\frac{\partial y_{i,t}}{\partial(d_{i,t}-d_t)}\right]/\partial\lambda<0$ if: $0<\lambda<\lambda^*_{y,dit}$ $\quad\partial\left[\frac{\partial y_{i,t}}{\partial(d_{i,t}-d_t)}\right]/\partial\lambda>0$ if: $\lambda^*_{y,dit}<\lambda<1-\sigma$ $(B2)$

$$\lambda^*_{y,dit}=\frac{(1+k\eta)\sqrt{\Delta_{y,dit}}+\xi^G\eta(1+k\eta)(\eta-ka^G)-a^G(1-\sigma)^2(1+a^Gk^2)}{k(1-\sigma)a^G[(\eta-ka^G)+\eta(1+k\eta)]}$$

$$\Delta_{y,dit}=a^{G2}k^2(1-\sigma)^2\left[a^G(1-\sigma)^2+\xi^G(\eta^2+a^G)\right]+[a^G(1-\sigma)^2+\xi^G\eta(\eta-ka^G)]^2>0$$

- $\partial\left[\frac{\partial y_t}{\partial s_t}\right]/\partial\lambda<0 \quad \forall\ 0<\lambda<1-\sigma$ (B3)
- $\partial\left[\left|\frac{\partial\pi_t}{\partial s_t}\right|\right]/\partial\lambda>0$ if: $0<\lambda<\lambda^*_{\pi,st}$ $\quad\partial\left[\left|\frac{\partial\pi_t}{\partial s_t}\right|\right]/\partial\lambda<0$ if: $\lambda^*_{\pi,st}<\lambda<1-\sigma$ (B4)

$$\lambda^*_{\pi,st}=-\frac{\left[\xi^M(1-\sigma)^2+(\xi^M+\sigma^2)\xi^G(1+k\eta)\right]}{k\eta(1-\sigma)\xi^M}+\frac{\sqrt{\Delta_{\pi,st}}}{k\eta(1-\sigma)\xi^M\sqrt{\sigma^2(a^Mk\eta+a^G)+a^G\xi^M}}$$

$$\Delta_{\pi,st}=(1+k\eta)[\xi^M\xi^Ga^G+\xi^G(\eta ka^M+a^G)\sigma^2+\xi^Ma^G(1-\sigma)^2]$$
$$[\xi^{M2}(1+k\eta)(1-\sigma)^2+(\xi^M+\sigma^2)^2\xi^G(1+k\eta)+\xi^M\sigma^2(1-\sigma)^2]>0$$

- $\partial\left[\frac{\partial y_{i,t}}{\partial(s_{i,t}-s_t)}\right]/\partial\lambda<0 \quad \forall\ 0<\lambda<1-\sigma$ (B5)
- $\partial\left[\left|\frac{\partial\pi_{i,t}}{\partial(s_{i,t}-s_t)}\right|\right]/\partial\lambda>0$ if: $0<\lambda<\lambda^*_{\pi,sit}$ $\quad\partial\left[\left|\frac{\partial\pi_{i,t}}{\partial(s_{i,t}-s_t)}\right|\right]/\partial\lambda<0$ if: $\lambda^*_{\pi,sit}<\lambda<1-\sigma$ $(B6)$

$$\lambda^*_{\pi,sit}=-\frac{\left[(1-\sigma)^2+\xi^G(1+k\eta)\right]}{k\eta(1-\sigma)}+\frac{(1+k\eta)\sqrt{\Delta_{\pi,sit}}}{k\eta(1-\sigma)\sqrt{\eta^2+a^G}}$$

$$\Delta_{\pi,sit}=\xi^G(1-\sigma)^2(2a^G+\eta^2)+\xi^{G2}(\eta^2+a^G)+a^G(1-\sigma)^4>0$$

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