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TAYLOR RULE IN A POLICY-MIX ANALYSIS FOR OPEN HETEROGENEOUS MONETARY UNIONS

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Abstract. The paper studies, at a purely theoretical level, the monetary-fiscal policy-mix in an open currency union with asymmetric monetary transmission, where the central bank follows an interest rate Taylor rule. It shows that under the optimal monetary policy regime, the fiscal policy can stimulate the output without any impact on inflation. However, if the monetary rule deviates from the optimum, a stabilization bias appears. It can be reduced by a tighter monetary policy, but the heterogeneous monetary transmission produces asymmetric national reactions to shocks. For asymmetric fiscal shocks, output divergences can increase permanently and only a union-wide fiscal strategy accounting for national structural asymmetries can avoid them.

1. Introduction

The paper uses a pure theoretical approach to study the monetary and fiscal policy in an open heterogeneous monetary union. The focus is on the asymmetry of the monetary transmission, when the common central bank takes its decisions for the union as a whole, by using an interest rate rule based on union-wide aggregates. A dynamic macroeconomic model is developed, searching to assemble the main features of the European Monetary Union (EMU).

Thus, the main source of heterogeneity is *the asymmetry of the interest rate transmission in the EMU*. It was widely discussed and empirically proved in the literature that the European Central Bank (ECB) decisions don't affect the EMU member countries in a symmetric way (Dornbusch et al., 1998; Penot & Pollin, 2001; Berben et al., 2005). Moreover, the reaction of the output to changes in the common interest rate comes from perpetual sources in the EMU, such as: the sensitivity of the banking system to changes in the common interest rate, the national particularities of the capital market and the sensitivity of households and firms to changes in the inter-banking interest rate – see Penot et al. (2000), Peersman (2004) or Clausen and Hayo (2006), for example.

From the point of view of the monetary policy in the context of the EMU, *"as laid down in the Treaty, each Member of the Governing Council is therefore well aware that he or she is not a representative of a country (...) but acts (...) in deciding the appropriate conduct of monetary policy for the euro area as a whole"(Governing Council meeting dated March, 30, 2000).* Focusing on the Euro area-wide macroeconomic variables, the ECB is unable to respond to differential output developments in the union. By integrating an interest rate Taylor rule

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based on union-wide variables, the present model is in keeping with this monetary policy decision making process.

Finally, speaking about its *external trade*, the EMU is open to foreign exchanges and this particularity is not insignificant. According to European Commission statistics, the shares of the extra-UE exports in the total UE exports and of the extra-UE imports in the total UE imports represent more than 30% every year. The model proposed in this paper distinguishes the extra-union trade from the intra-union trade and allows us to discuss the role of the real exchange rate in such an economy.

In the literature, Clausen and Wahltmann (2005) provide a quite similar analysis. However, their purpose was to investigate the dynamic effects of monetary and fiscal policy in a monetary union, supposing that the common central bank acts on the monetary aggregates and does not use an interest rate rule for the monetary policy. Their results are summarized as follows: 1) the asymmetric interest rate transmission gives rise to asymmetric adjustments within the union and to intertemporal reversals in the relative effectiveness of policy on member country outputs; 2) for the coordination between monetary and fiscal policy in the union, the monetary policy can completely stabilize the union output after unanticipated symmetric fiscal policy shocks.

As an extension of this work, the present paper seeks to integrate an interest rate rule for the monetary policy, in a dynamic macroeconomic context of a heterogeneous monetary union hit by unanticipated shocks. This step is motivated by the studies on the monetary policy which have proven that, in normal time, controlling the interest rate by an interest rule is more desirable for the central bank than controlling monetary aggregates (Rudebusch & Svensson, 2002; Pollin, 2003)[1]. Indeed, except for the recent particular context of liquidity trap that followed the 2008-2009 financial crisis, most of the central banks directly control nowadays the interest rate, paying less attention to monetary aggregates.

The study is conducted at two different levels: *union-wide level* and *national level*, under two alternative assumptions. First of all, it is supposed that, at every moment, the common central bank has perfect information about the potential output in the union and can adjust its policy according to it. But empirical evidences invalidate this assumption. The potential output is not observed by the monetary authority. The central bank bases its decisions on estimates of this unobservable variable and there are particular reasons to consider that these estimations are not perfect[2], above all in a heterogeneous monetary union where reliable national information is difficult to collect. By exploiting data on historical revisions to real-time estimates of the output gap Orphanides (2003) or Gerberding et al. (2005) have identified very persistent policy misperceptions, namely overestimations of the US or Germany potential output in 1970-1980, for example. This is the reason why, the discussion focuses, in the end of section 4, on the choice of the stabilization parameters in the monetary rule, when the central bank has a biased perception about the potential output and its monetary decisions can deviate from the optimum.

As for Clausen and Wahltmann (2005), the asymmetric interest rate transmission gives rise to asymmetric adjustments within the union and to an intertemporal reversal in the relative effectiveness of policy on member country outputs. The monetary policy can stabilize the union output after unanticipated symmetric fiscal shocks, but only if the central bank has a perfect knowledge on the potential output. In this case, the optimal monetary policy rule implies an adjustment of the output target to the endogenous potential output of the union, and a permanent increase in the government spending can stimulate the real activity without any impact on inflation.

[1]Consequently, the LM curve becomes less important for the macroeconomic analysis than before (Abraham-Frois, 2003; Pollin, 2003 or, for a more detailed discussion on the utility of the LM curve, see Villieu, 2004).

[2]It may come from the fact that "observable data do not always correspond to the data the central bank would like to have to produce measures of potential output" or because "initial estimates of observable data can subsequently be revised substantially, resulting in a very difficult picture of what is happening to potential output and the output gap" (F. Mishkin, Conference on Price Measurement for Monetary Policy, Federal Reserve Bank of Dallas, 24 May 2007)

However, if there are some errors in the estimated value of the potential output by the central bank, the stabilization will not be perfect in the union. It is shown that in order to limit the stabilization bias of the monetary policy, the central bank should be concerned essentially with the stabilization of inflation and less with the output stabilization. This result is in accordance and with the advice of cautious response of the central bank to noisy information on potential output, provided among others by Rudenbusch (2001), Ehrmann and Smets (2001) or Gaspar and Smets (2003).

But, whichever the behavior of the central bank, the fiscal policy can stimulate the real activity in each member country. If there is no constraint for the governments' policies the risk of asymmetric shocks on public expenditures increases, amplifying divergences in the union. To avoid that, a strong cooperation between governments or the presence of a multinational fiscal supervisor would be necessary.

The rest paper is organized as follows: Section 2 gives an overview of the model structure and resumes the methodology used in the analysis; Section 3 studies the long-run impact of monetary and fiscal policies at the union-wide level and in Section 4 the accent is on the dynamic effects of these policies for the union. The Section 5 discusses the policies' impact at national level, while Section 6 summarizes the main results and presents some concluding remarks.

2. **The Model**

The model used is quite similar to the Clausen and Wohltmann (2005) model. We consider a two countries monetary union, heterogeneous from the point of view of the monetary transmission. This asymmetry is introduced in the national *IS - equations*:

$$y_1 = a_0 + a_1 y_1 - a_{21}(i_1 - E(\dot{p}_1^c)) + g_1 + (b_0 - b_1 y_1 + b_2 y_2 + b_3 \tilde{y} - b_4(p_1 - p_2) - b_5 \tau_1) \tag{1a}$$

$$y_2 = a_0 + a_1 y_2 - a_{22}(i_2 - E(\dot{p}_2^c)) + g_2 + (b_0 - b_1 y_2 + b_2 y_1 + b_3 \tilde{y} - b_4(p_2 - p_1) - b_5 \tau_2) \tag{1b}$$

where y denotes the real output, i - the short-term nominal interest rate, g - real government expenditures, p - the price level of the domestically produced good, e - the common exchange rate with respect to the rest of the world, $\tilde{y}$ - the foreign output (of the rest of the world).

For each country, the demand for domestic output depends on private consumption, real interest sensitive investment demand, real government expenditure and the trade balance. Under rational inflation expectations and assuming that people do not make systematic errors when predicting the future (deviations from *perfect foresight* are only random:$E(\dot{p}_i^c) = \dot{p}_i^c, \forall i$), the real interest rate is: $r_i = i_i - \dot{p}_i^c$. The last term of the IS equation gives the trade balance: exports depend on the foreign output and on the output of the other country of the union, imports depend on the domestic output, and $p_i - p_j$, τ_i depict the intra/extra union terms of trade. All coefficients are identical for the two countries, the only exception being $a_{21} \neq a_{22}$, which give the interest rate sensitivity of domestic demands and sums up the asymmetry in the monetary transmission. The extra-union term of trade τ_i summarizes the impact of changes in the real exchange rate on the external trade of country i, e is the common nominal exchange rate of the euro and $\tilde{p}$ represents prices in the rest of the world.

$$\tau_i = p_i - (\tilde{p} + e) \tag{2}$$

To model the *aggregate supply*, we use a simple Cobb-Douglas supply function depending on labor ($Y_i = AL_i^{\mu}$). Expressed in a logarithmic form, it becomes:

$$y_i = a + l_i \mu \tag{3}$$

The prices of domestically produced goods follow the wages' dynamics described by the following augmented Phillips curve:

$$\dot{p}_i = \dot{w}_i = E\left(\dot{p}_i^c\right) + \delta\left(y_i - \bar{y}_i\right) \tag{4}$$

Wages' indexation takes into account the expected inflation based on the consumer price index and the current output gap (real output relative to its potential level).

The steady state level of the output, named *potential output*, is *endogenous* in the model and comes from the equilibrium on the labor market. It depends on the competitiveness of the country in the external trade[3]:

$$\bar{y}_1 = f_0 + f_1(\overline{p_1 - p_2}) + f_2\bar{\tau}_1 \tag{5a}$$

$$\bar{y}_2 = f_0 + f_1(\overline{p_2 - p_1}) + f_2\bar{\tau}_2 \tag{5b}$$

On the labor market, the labor demand negatively depends on the real wage calculated in terms of domestic price index, while the labor supply positively depends on the real wage calculated, this time, in terms of consumer price index. The consumer price index represents a weighted average of domestic prices index and imported prices indexes, describing the structure of domestic consumption: preference for domestically produced goods (α_1), for goods produced by the other country of the union (α_2) or outside the union (α_3).

$$p_1^c = \alpha_1 p_1 + \alpha_2 p_2 + \alpha_3(\tilde{p} + e) \tag{6a}$$

$$p_2^c = \alpha_1 p_2 + \alpha_2 p_1 + \alpha_3(\tilde{p} + e) \tag{6b}$$

The equilibrium condition on the labor market corresponds to a real wage in terms of domestic prices index which negatively depends on intra and extra-union terms of trade. Indeed, when these terms of trade appreciate, prices of imported goods become relatively lower compared to domestic prices and consumer prices inflation expectations move down. As described in relation (4), wages are indexed on the consumer prices expectations and it results in lower real wages, in terms of domestic prices. Consequently, the equilibrium level of employment $\bar{l}_i$ moves up, as well as the potential output in (3).

As usually in a two-country union model (Lane, 2001), we use the assumption of identical preferences for the final goods produced within the union ($\alpha_1 = \alpha_2$).

The behavior of the common central bank is described in the model by the following interest rate rule for the monetary policy *(MP)*:

$$\dot{i} = \omega\left[\hat{\dot{p}}^c + \bar{r} + \beta_1\left(\dot{p}^c - \hat{\dot{p}}^c\right) + \beta_2\left(y - \hat{y}\right) - i\right] \;, 0 < \omega < 1 \tag{7}$$

where $\dot{p}^c = \frac{1}{2}\left(\dot{p}_1^c + \dot{p}_2^c\right)$; $y = \frac{1}{2}\left(y_1 + y_2\right)$; $\bar{r}$ is the equilibrium real interest rate in the union, $\hat{\dot{p}}^c$, $\hat{y}$ represent the inflation/output target for the monetary policy and the stabilization coefficients β_1 and β_2 keep the Taylor's specifications: $\beta_1 > 1$[4] and $0 < \beta_2 < 1$.

Like the ECB, the central bank is interested, in this model, in the welfare of the union as a whole and uses as targets the union-wide macroeconomic variables, without explicitly controlling national variables. Moreover, recent studies like Clarida et al. (1998), Sack and Wieland (2000), Gerlach-Kristen (2003), Sauer and Sturm (2004), Carstensen (2006) find empirical signs of smoothing in the dynamics of the European interest rate. In this model, the presence of the coefficient $\omega \in [0, 1]$ in the monetary policy rule (7) allows us to add to the classical interest rate rule (Taylor, 1993) this empirical evidence.

[3]Details about the determination of (5a) and (5b) appear in our Technical Appendix (available on request).

[4]$\dot{i} = \omega\left[\dot{p}^c + \bar{r} + \tilde{\beta}_1\left(\dot{p}^c - \hat{\dot{p}}^c\right) + \beta_2\left(y - \hat{y}\right) - i\right] = \omega\left[\hat{\dot{p}}^c + \bar{r} + \beta_1\left(\dot{p}^c - \hat{\dot{p}}^c\right) + \beta_2\left(y - \hat{y}\right) - i\right]$ for $\beta_1 = 1 + \tilde{\beta}_1 > 1$.

In addition, we made the assumption of the *perfect international capital mobility.* The equilibrium on the balance of payments requires the uncovered interest parity condition (UIP): $i = i_1 = i_2 = \tilde{\imath} + E(\dot{e})$

which becomes under rational expectations hypothesis:

$$i = i_1 = i_2 = \tilde{\imath} + \dot{e} \tag{8}$$

$\tilde{\imath}$ is the foreign interest rate and $E(\dot{e})$ the expected fluctuations in the nominal exchange rate.

Short description of the method used in the following sections

In order to analyse the impact of different macroeconomic policies shocks in the union, we use the Aoki (1981) decomposition method and we define two sub-systems starting from our basic model: an aggregated system, whose variables are described, in a general manner, by: $x = \frac{x_1+x_2}{2}, \forall x$, very useful in the study of the global behaviour of the union (sections 3 and 4) and a difference system with variables such as: $x^d = \frac{x_1-x_2}{2}, \forall x$ that allows analysing the individual behaviour of the member countries by a simple combination of « aggregated » variables and « difference » variables: $x_1 = x + x^d, \forall x$ et $x_2 = x - x^d, \forall x$ (section 5).

3. Union-wide effect of fiscal and monetary policy in the long-run

To understand the long-run equilibrium, we firstly describe the aggregate supply (AS) and the aggregate demand (AD) in the union. The aggregate supply is given, in the long-run, by the potential output resulting from the full employment condition on labor markets (5a) and (5b): $y^S_{LT} = \bar{y} = \frac{1}{2}(\bar{y}_1 + \bar{y}_2)$. So, it depends in the model on the external competitiveness of the union:

$$\bar{y} = f_0 + f_2\bar{\tau} \tag{9}$$

The aggregate demand curve results from the movement of the equilibrium (UIP-MP-IS) in the (y, i) system, for different rate of inflation corresponding at given expectations about the futures changes in the nominal exchange rate. These expectations correspond, in the long-run, to the purchasing power parity condition: $\dot{e} = \dot{p}^c - \tilde{\dot{p}}^c$, where $\tilde{\dot{p}}^c$ denotes the foreign inflation rate in consumer prices, and to the equality of the real interest rate inside and outside the union.

The UIP-MP-IS equilibrium implies:

• IS equilibrium: $\eta y = [k - a_2(i - \dot{p}^c) + g - b_5\tau]$.

• $\dot{i} = 0$ in the monetary policy rule (MP):

$i = \hat{\dot{p}}^c + \bar{r} + \beta_1\left(\dot{p}^c - \hat{\dot{p}}^c\right) + \beta_2(y - \hat{y})$ or $i = i_a + \beta_1\dot{p}^c + \beta_2 y$, where $i_a = \hat{\dot{p}}^c(1 - \beta_1) + \bar{r} - \beta_2\hat{y}$ is an autonomous component of the common interest rate.

• The uncovered interest parity condition (UIP): $i = \tilde{\imath} + \dot{e}$.

Under the assumption of economic stability in the rest of the world, the interest rate (i) results exogenously from the *UIP* condition. The monetary policy is useless in choosing the interest rate, but the interest rate rule (MP) gives the equilibrium level of the aggregate demand. The equilibrium is determined by *UIP* and *MP*, while *IS* curve adjusts to reach this equilibrium, thanks to the "jump" of the external term of trade (τ). The long-run aggregate demand curve is described by the relation (10) and graphically deduced from *UIP-MP* equilibrium in Fig.1a.

$$y^D = \frac{1}{\beta_2}\left[i(1 - \beta_1) + \beta_1\tilde{r} - i_a\right] \tag{10}$$

where $\tilde{r}$ represents the foreign real interest rate.

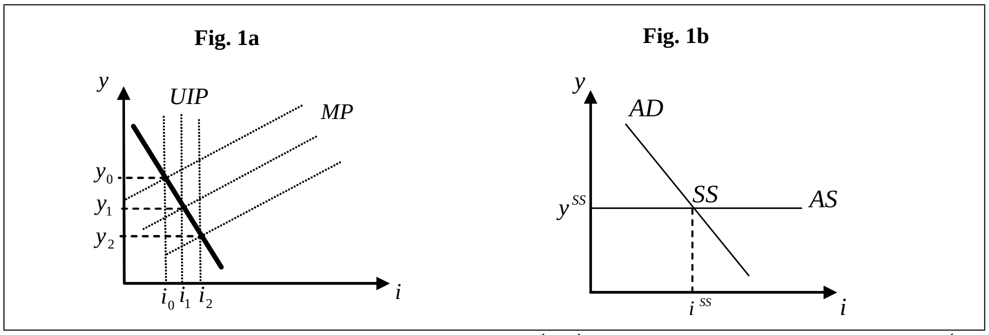

Fig.1 Long-run aggregate demand curve (1a) and long-run equilibrium (1b)

In the *UIP* condition, the equilibrium interest rate is proportionally related to the rate of inflation: $i^{Eq} = \tilde{\imath} + \dot{p}^c - \tilde{\dot{p}}^c$. A higher rate of inflation would correspond to a higher interest rate (passage from i_0 to i_1 and i_2 in Fig.1a). The *MP* equation can be rewritten as: $y^{Eq} = \frac{1}{\beta_2}[i - i_a] - \frac{\beta_1}{\beta_2}\dot{p}^c$. For $\beta_1/\beta_2 > 1$, a higher rate of inflation $(\dot{p}^c)$ results in a more than proportional decrease in the equilibrium demand $\left(y^{Eq}\right)$ - passage from y_0 to y_1 and y_2 in Fig.1a. Changes of the equilibrium (y, i) for different rates of inflation describe the long-run *aggregate demand curve*. At the steady-state (SS), the aggregate demand and supply (Fig. 1b) are equal.

The aggregate demand was obtained above from the *MP* equation. But, the external term of trade τ adjust the RHS of the *IS equation*, allowing *IS curve* to reach the equilibrium. It conducts to a positive relation between the external term of trade (τ) and the common interest rate (i), describing the aggregate demand side of the model (11). Any change in the interest rate gives rise to a variation in the external term of trade that changes the aggregate demand.

$$\tau = \frac{k + g - a_2\tilde{\imath}}{b_5} - \frac{\eta}{\beta_2 b_5}\left[\beta_1\tilde{r} + i\left(1 - \beta_1\right) - i_a\right] \tag{11}$$

The resolution of the *aggregate system*[5] gives the union-wide equilibrium **(A)**:

$$\begin{aligned}
&\bar{\tau} = \tfrac{1}{\eta f_2 + b_5}\left(k - a_2\tilde{r} + g - \eta f_0\right)\\
&\bar{\dot{p}}^c = \hat{\dot{p}}^c - \tfrac{\beta_2}{\beta_1 - 1}\left(\bar{y} - \hat{y}\right)\\
&\bar{y} = \tfrac{f_2(k - a_2\tilde{r} + g) + b_5 f_0}{\eta f_2 + b_5}\\
&\bar{r} = \tilde{r}\ ; \bar{\imath} = \tilde{r} + \bar{\dot{p}}^c\ ; \bar{\dot{e}} = \bar{\dot{p}} - \tilde{\dot{p}} = \bar{\dot{p}}^c - \tilde{\dot{p}}^c
\end{aligned} \tag{A}$$

In the long-run, the output and the competitiveness of the union depend only on changes in fiscal policy (government expenditures) or in the foreign interest rate $(\tilde{r})$. To be more precise, there is the external term of trade (τ) that changes and leads to the adjustment of the potential output in (9).

The long-run consumer prices inflation depends on the inflation target of the monetary policy and on the deviation of the output target from its potential level. All gap between domestic and foreign rate of inflation results in movements of the nominal exchange rate. Thus, if the domestic inflation is higher than the foreign inflation, the common currency depreciates at a rate $\bar{\dot{e}}$, allowing the equilibrium real interest rates to be identical inside and outside the union.

3.1. **Fiscal policy.** Fig. 2 depicts the movement of the equilibrium **(A)** subsequent to an increase in global government spending in the union.

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[5]presented in details in the Technical Appendix, paragraph 2.1, available on request.

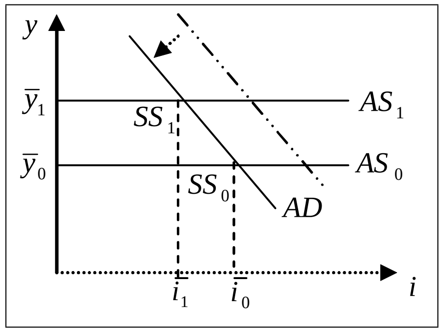

Fig. 2 Long-run equilibrium subsequent to an increase in government expenditures

The fiscal policy multiplier is positive and the fiscal effect on the interest rate is negative (see equation 12 below). Subsequently, a higher output and a lower nominal interest rate correspond to the new steady-state (SS_1).

$$\begin{array}{l} \frac{d\bar{y}}{dg} = \frac{f_2}{\eta f_2 + b_5} > 0 \\ \frac{d\bar{\imath}}{dg} = -\frac{\beta_2}{\beta_1 - 1}\frac{f_2}{\eta f_2 + b_5} < 0 \end{array} \qquad (12)$$

The government expenditures push up the long-run aggregate supply (from AS_0 to AS_1 in Fig. 2), by means of the real appreciation of the common currency in (9): $\uparrow g \Rightarrow \uparrow \bar{\tau} \Rightarrow \uparrow \bar{y}$. Indeed, under the assumption of perfect international capital mobility, the increase in government expenditures doesn't cause an increase in real interest rates, but the appreciation of the common currency. In an open economy, prices of imports fall relative to national prices and determine lower consumer prices inflation expectations. On the supply-side of the economy, wages are indexed on the consumer prices expectations. It results in lower real wages relative to domestic prices and higher employment which stimulates the aggregate supply in the union.

As for the aggregate demand, the effect of the additional government expenditures (which stimulates the aggregate demand) is suppressed by an opposite effect due to the appreciation of the real exchange rate, exactly like in the Mundell-Fleming model. In Fig. 2, AD curve temporary moves upwards after the increase in government spending, but it comes back to the initial position because of the exchange rate appreciation.

The difference to the Mundell-Fleming model comes from the aggregate supply, which reacts, in the present model, to the real appreciation of the common currency, explaining the effectiveness of the fiscal policy (see also Karayalcin (1999), Villieu (2004)). As a result, the real activity is stimulated, the long-run inflation and the common interest rate decrease, despite the expansionary fiscal shock. It is the consequence of the assumptions of perfect international capital mobility and rational exchange rate expectations: the interest rate does not rise in response to an increase in government spending, but the common currency appreciates and results in lower long-run inflation in the union. The common interest rate reacts to the fall in inflation, so that the long-run real interest rates are identical inside and outside the union.

In this model, the fiscal policy seems to be beneficial to the union as a whole, because it stimulates the long-run product, thanks to the openness to the external trade. The main role in explaining these effects goes to the external term of trade (τ). The real appreciation of the common currency makes possible the improvement in the natural output further to an increase in the union's government expenditures. The inconvenient is that the disinflation (second effect of this policy) is not always suitable beyond a certain level peculiar to the well-functioning of the economy (see the severe damage of the negative inflation in Japan); but it could however be managed by the monetary policy.

3.2. **Monetary policy.** In Section 2 we described the behavior of the central bank by using the interest rate monetary rule (7). The monetary authority can only conduct its policy by changing the exogenous terms of this rule that impact the steady-state level of the interest rate:

a) the targets of the monetary policy $\left(\hat{y}, \hat{p}^c\right)$ or *b)* the stabilization coefficients in the monetary rule (β_1, β_2).

By acting on the output or inflation targets, the central bank can conduct a more restrictive or a more expansionary monetary policy. Reducing one of the monetary targets, for example, thus describes restrictive monetary policy actions. By choosing the stabilization coefficients β_1, β_2, the central bank adopts a less or more tight monetary policy. For instance, a high coefficient of inflation stabilization β_1 relative to the output stabilization β_2 is sign of a tight monetary policy.

For the moment, let's consider the targets of the central bank as instruments of the monetary policy[6]. From (9) and (10), we deduce that a decrease in one of the monetary policy targets results is a higher autonomous component of the interest rate i_a. Consequently, the long-run aggregate demand curve moves to the left in Fig.3, while the aggregate supply doesn't change because the monetary policy has no effect on it. A restrictive monetary policy conducts the union towards a new steady state described by a lower inflation rate, for unchanged output.

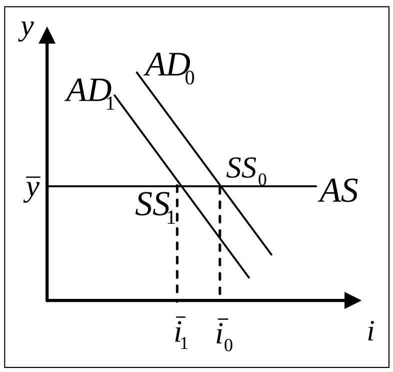

Fig. 3 Long-run equilibrium subsequent to a restrictive monetary policy

The multipliers of the monetary policy computed in **(A)** confirm this adjustment of the steady state: $\frac{d\bar{y}}{d\hat{y}} = \frac{d\bar{\tau}}{d\hat{y}} = 0$; $\frac{d\bar{y}}{d\hat{\bar{p}}^c} = \frac{d\bar{\tau}}{d\hat{\bar{p}}^c} = 0$; $\frac{d\bar{\imath}}{d\hat{y}} = \frac{d\bar{\bar{p}}^c}{d\hat{y}} = \frac{\beta_2}{\beta_1 - 1} > 0$; $\frac{d\bar{\imath}}{d\hat{\bar{p}}^c} = \frac{d\bar{\bar{p}}^c}{d\hat{\bar{p}}^c} = 1$. We obtain the expected effect of the restrictive monetary policy: a fall in the long-run inflation rate. There is no permanent effect on the real exchange rate or on the output; the monetary policy is able to reduce the inflation, but not to stimulate the real activity.

One question arises. Which of the two monetary targets is better to be used by the central bank? We note here that the main objective of the monetary policy is the prices stability and that the success of the central bank mission is essential in an inflation target strategy. So, the central bank is constrained to perfectly fulfill its inflation target. Looking to the equilibrium **(A)**, it is easy to see that this condition is verified if the output target does not deviate from the potential output of the union. Starting from this result, it seems clear that the central bank has no reason to let the output target deviating from the potential output.

Subsequently, each policy supposed to affect the real activity in the union should be accompanied by an appropriate monetary policy which consists in adjusting the output target of the central bank to the future potential output. Fig. 4 graphically resumes the long-run impact of the expansionary fiscal shock described in section 3.1, when it is supported by a monetary policy that adjusts the output target to its new potential level.

It appears that the mix of an expansionary fiscal policy and a monetary policy that perfectly adjust the output target to the potential output can stimulate the real activity in the long-run, without any negative impact on the prices stability. An increase in the aggregate demand due to the monetary policy adds to the increase in the aggregate supply due to the fiscal policy, giving rise to a new steady-state with unchanged inflation and a higher product.

[6]The importance of β_1, β_2 will be analyzed afterwards, in the following section of the paper.

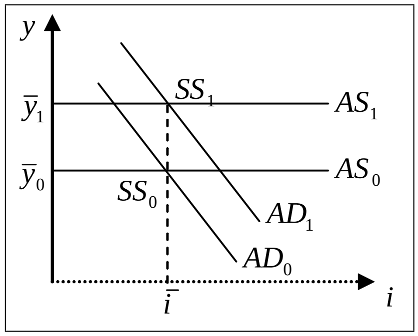

Fig. 4 Optimal policy-mix at the union-wide level

To resume, in this monetary union, a conflict between monetary and fiscal authorities is not justified in the long-run. An expansionary fiscal policy can stimulate the economic growth, and, to keep inflation at the target level, the common central bank must simply validate the fiscal policy by adjusting the output target to its new potential level $\bar{y}$. But how the union reacts to macroeconomic shocks in a less longer-run? Does the stabilizing policy-mix briefly discussed above still apply? To answer this question, we use below standard dynamic analysis tools, to study the union reaction to fiscal or monetary shocks.

4. Macroeconomic shocks and dynamic adjustments of the union

The *aggregate system* defined in Section 3 can be reduced to a two-equation dynamic system (13), whose state variables are the external term of trade τ and the common interest rate i.[7]

$$\begin{aligned} \dot{\tau} &= X(\tau - \bar{\tau}) \\ \dot{i} &= \omega \Psi (\tau - \bar{\tau}) + \omega(\beta_1 - 1)(i - \bar{\imath}) \end{aligned} \tag{13}$$

where: $X = -\frac{b_5 \delta}{\eta \alpha_3 - a_2(1-\alpha_3)\delta}$ and $\Psi = \frac{X}{\delta}[\beta_1 \delta(1-\alpha_3) + \beta_2 \alpha_3]$.

The determinant of the Jacobian Matrix corresponding to the *dynamic system* (13) is unambiguously negative so that there is one stable root: $\lambda_1 = X < 0$, and one unstable root: $\lambda_2 = \omega(\beta_1 - 1) > 0$. Corresponding to the Blanchard and Kahn (1980) Theorem, the aggregate system displays saddle path stability. The common interest rate i is here a predetermined variable, while the external term of trade "jumps". The predetermined character of the interest rate is explained by the presence of the coefficient ω in the monetary policy rule (7), while the nominal exchange rate e freely fluctuates and gives rise to the jump of τ. This allows the union to join a saddle path with positive slope, as confirmed by the sign of the stable eigenvector of the Jacobian matrix:

$$\upsilon_{11} = \frac{\delta[X - \omega(\beta_1 - 1)]}{X\omega[\beta_1 \delta(1-\alpha_3) + \beta_2 \alpha_3]} > 0 \tag{14}$$

To discuss the dynamic adjustment of the union after a macroeconomic shock, we suppose a given initial equilibrium $(\bar{\tau}_0, \bar{\imath}_0)$. We also suppose that the shock hitting the model at a moment T is *unanticipated*, so that the economy reaction is observed after T, and not before. The solution (15) of the *dynamic system* (13) helps us to compute the impact of fiscal or monetary shocks in the union:

$$\begin{pmatrix} \tau_t \\ i_t \end{pmatrix} - \begin{pmatrix} \bar{\tau}_1 \\ \bar{\imath}_1 \end{pmatrix} = C_1 \upsilon_1 \exp(\lambda_1 t), \forall t \geq T \tag{15}$$

where $\upsilon_1 = \begin{pmatrix} \upsilon_{11} \\ \upsilon_{21} \end{pmatrix}$, with $\upsilon_{21} = 1$, υ_{11} given in (14) and C_1 is a constant determined below.

From the equilibrium **(A),** we can easily compute the permanent (long-run) impact of shocks in the union; see the new steady-state variables $(\bar{\tau}_1, \bar{\imath}_1)$. Written in T, the dynamic equation of

[7] Details on the reduced form of this system are available on request in our Technical Appendix.

the predetermined interest rate in (15) conducts to: $C_1 = -d\bar{\imath}\exp(-\lambda_1 T)$. The jump of τ in T is then given by: $\tau(T+) = \bar{\tau}_1 + C_1 \upsilon_{11} \exp(\lambda_1 T)$.

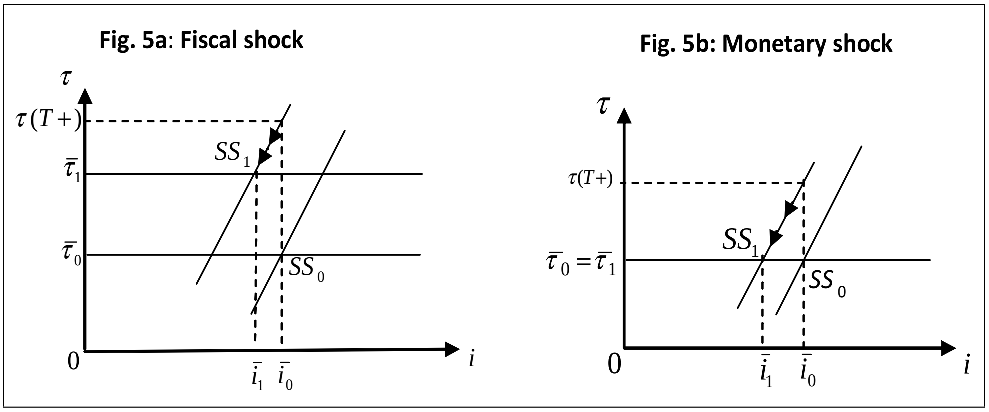

Fig. 5 Dynamic effects of macroeconomic policies

Fig. 5 resumes the dynamic adjustment of the union, face to an increase in global government spending, respectively to a decrease in one of the targets of the central bank. Lines with positive slope, in Fig. 5 and in the rest of the paper, represent the positively sloped saddle paths discussed above.

In the two cases, the policy shock gives rise to a dynamic adjustment of the union explained by an initial overshooting $\tau(T+)$ of the real exchange rate in T[8], like in Dornbusch (1976), and its subsequent adjustment towards the steady state ($\bar{\tau}_1 = \bar{\tau}$). The initial jump of the external term of trade proves that the common currency appreciates, and this appreciation is more than necessary to the equilibrium. Due to this overshooting of the real exchange rate, the competitiveness of the union declines, and the output is under its potential level. After the shock, the common currency depreciates, the union regains competitiveness and the output goes up, until the new steady state is reached.

In T, the nominal exchange rate overshoots and explains the jump of the external term of trade (τ). It corresponds to an initial appreciation of the real exchange rate necessary to insure the IS equilibrium, without permanent impact on the output. After that, the exchange rate depreciates and τ goes to its equilibrium, following a decreasing and convex path (since $C_1 > 0, \upsilon_{11} > 0, \lambda_1 < 0$, than: $\dot{\tau} = C_1 \upsilon_{11} \lambda_1 \exp(\lambda_1 t) < 0$ and $\ddot{\tau}_t = (\lambda_1)^2 C_1 \upsilon_{11} \exp(\lambda_1 t) > 0$).

Similarly, after a negative initial jump in T: $y(T+) = \bar{y} + \frac{\alpha_3 \lambda_1 C_1 \upsilon_{11} \exp(\lambda_1 T)}{\delta} < \bar{y}$, the output converges towards the steady state following an increasing and concave path ($\dot{y}_t > 0$, $\ddot{y}_t < 0$, $(\forall)\ t > T$). The initial loss of competitiveness in the external trade, followed by gains of competitiveness during the adjustment period, explains the output dynamics in Fig.6. These gains of competitiveness are due to the nominal depreciation of the common currency and to the fall in the inflation rate (first graph in Fig.6). Unlike the Dornbusch (1976) model, there is no downward adjustment of the prices level in this model, but a more realistic downward adjustment of the inflation rate.

These adjustments are graphically represented in the last two graphs of Fig. 6, when a restrictive monetary shock hits the union.

[8]Actually, as $\upsilon_{11} > 0$ and $C_1 > 0$, for $d\bar{\imath} < 0$, the initial jump of τ exceeds its steady state level: $\tau(T+) - \bar{\tau} = C_1 \upsilon_{11} \exp(\lambda_1 T) > 0$.

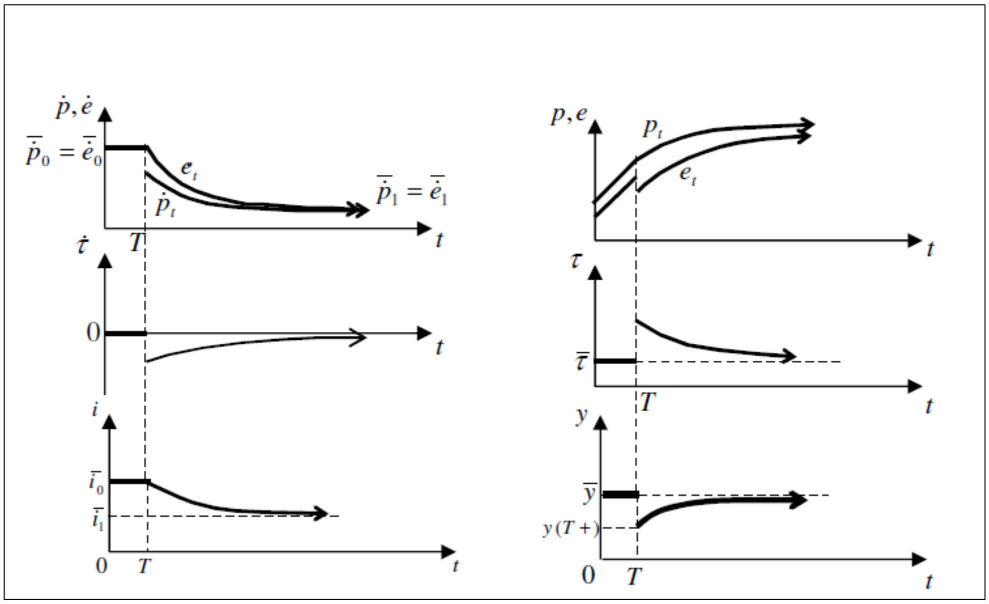

Fig. 6 Dynamic adjustments in the union after a restrictive monetary shock on $\hat{\dot{p}}^c$or $\hat{y}$

The initial overshooting of the exchange rate consequent to the shock results in expectations of a lower consumer price inflation, which implies a smaller indexation of wages and explains the negative jump of the inflation rate ($\dot{p}$) in T. During the adjustment path, the inflation continues to fall because the common currency is still strong relative to the equilibrium. However, until the steady-state, wages are insufficiently indexed to domestic inflation; domestic prices fall relative to foreign prices and the common currency depreciates. The exchange rate depreciation is always more important than the fall in the inflation rate and insures the convergence of the external term of trade τ. The common interest rate decreases during the adjustment path[9]; it stimulates the aggregate demand and supports the dynamics of the future exchange rate expectations (in the *UIP* condition (8)).

All these results of the dynamic analysis argue why a restrictive monetary policy can be successfully used in the fight against inflation, having only short-run effect on the output.

Extending this analysis to the case of the fiscal policy, it appears that expansionary fiscal shocks and restrictive monetary shocks have similar dynamic effects on the main variables of the union, relative to the steady-state. So, any conflict between the monetary and the fiscal policy no longer exists: a stabilizing policy-mix for the union can combine an expansionary fiscal policy with an expansionary monetary policy. Under the perfect capital mobility assumption, higher government expenditures do not increase the nominal interest rate, but cause pressures to disinflation that could be stabilized by the monetary policy. We recognize the so-called "optimal policy-mix" in the previous sections of the paper, which refers to the fact that the monetary policy can completely stabilize the union after an increase in government spending by simply adjusting its output target to the higher new potential level of the output. In this case, the two policies have complementary effects on the union. The increase in government expenditures would change the steady state from SS_0 to SS_1, after an initial real appreciation of the exchange rate given by$d$in Fig.7. Thus, the adjustment path of the union subsequent to the fiscal shock would be: $SS_0 - d - SS_1$. As for the monetary policy, the change of the output target to the new higher potential level gives rise to an initial depreciation of the real exchange rate corresponding to d' in Fig.7 and to a movement of the steady state from SS_0 to SS_1'.

[9]In (15), for all $t > T$: $i_t - \bar{\imath}_1 = C_1 \exp(\lambda_1 t) > 0$, $\dot{i} = C_1 \lambda_1 \exp(\lambda_1 t) < 0$ and $\ddot{\imath} > 0$.

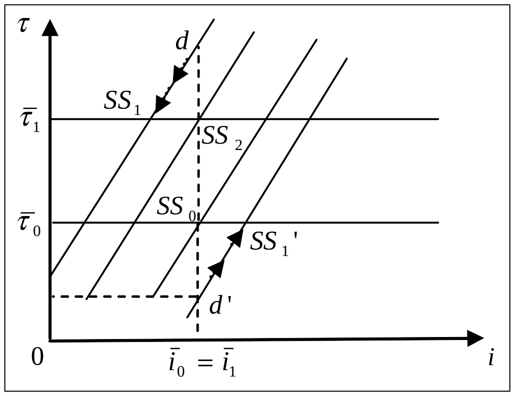

Fig. 7 Optimal stabilizing policy-mix for the union

The adjustment path after the monetary shock would be: $SS_0 - d' - SS_1'$. Taken simultaneously, the dynamic effect of the monetary policy perfectly suppresses the effect of the fiscal policy, and the union jumps straight from SS_0 to SS_2, which is a steady state described by higher output ($\bar{y}_1$) and an unchanged interest rate ($\bar{\imath}_0 = \bar{\imath}_1$).

The jump of the nominal exchange rate in T is such that τ finds spontaneously the new steady state. The real appreciation of the common currency due to the fiscal policy instantaneously stimulates the aggregate supply, while the real depreciation due to the monetary policy instantaneously stimulates the aggregate demand insuring the equilibrium of the union. This result extends the conclusion of the static study on the long-run equilibrium in section 3 to a dynamic context: the optimal policy mix described above stabilizes the union in the long-run, as well as in shorter-run.

However, as discussed in the introduction of the paper, supposing that the central bank perfectly knows the potential output represents an optimistic, but unrealistic scenario. The choice of coefficients β_1, β_2 in the monetary policy rule has no influence on the stabilizing effectiveness of the policy-mix, because the output target of the central bank corresponds to the potential output of the union. But empirical evidences have proven that the estimates of the potential output made by the central bank are actually biased because of the lack of observable data necessary to the estimations, or because of frequent revisions of data initially used in these evaluations. The risk of misperception of the potential output increases in a monetary union where, without cooperating with the national governments, an independent central bank must collect different national data, less or more available to it, in order to estimate the union-wide potential output. In this case, the output target of the monetary policy will deviate from the real potential output of the union and the stabilizing policy-mix described in the previous optimistic scenario no longer applies. The reaction of the union to all macroeconomic shocks depends on the stabilization coefficients β_1, β_2 of the monetary rule and the question is what position must adopt the central bank to better stabilize macroeconomic aggregates in the union?

We firstly analyze this question by simulating the reaction of a hypothetical union to a 1% increase in government spending, when the common central bank overestimates the potential output.[10] Two degrees of tightness of the monetary policy are analyzed in fig. 8: a tight policy (high β_1 and/or low β_2) or a more accommodating one (low β_1 and/or high β_2).

[10]See the empirical results of Orphanides (2003) or Gerberding et al. (2005), who found that the potential output was systematically over-evaluated by the central banks in US or Germany.

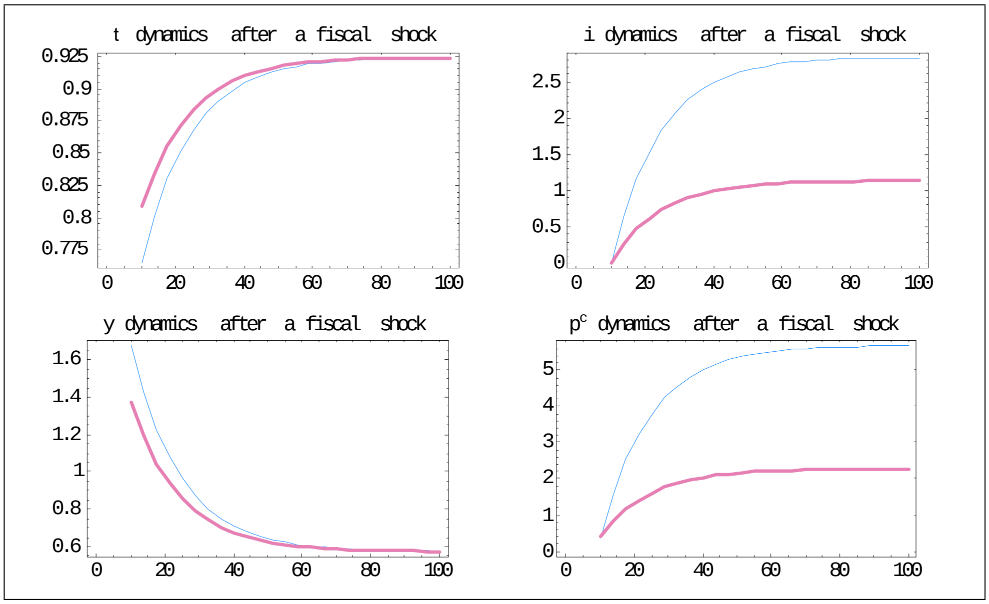

Fig. 8 Monetary policy and the transmission of an expansionary fiscal shock

In the simulations, the union's reaction to the fiscal shock is depicted by a thick line under the tight monetary policy (for $\beta_1 = 1.5$ and $\beta_2 = 0.5$), while it is depicted by a thin line under a more accommodating monetary policy (for $\beta_1 = 1.2$ and $\beta_2 = 0.5$). Most coefficients correspond to estimations found in the literature for the EMU coefficients, in papers like Sauer and Sturm (2003), Hofmann and Remsperger (2004) or Goodhart and Hofmann (2005). So, we use in simulations: $\delta = 0.125, \omega = 0.85, a_2 = 0.06, b_5 = 0.03$. We also consider acceptable values for: $a_1 = 0.75, \alpha_3 = 0.2, b_1 = 0.25, b_2 = 0.2, b_3 = 0.04$. The foreign interest rate $(\tilde{\imath})$ and the output growth in the rest of the world $(\tilde{y})$ are both 2% in these simulations, while the foreign inflation rate is taken to 0. $a_0 = 0.025, b_0 = 0.05$ and $f_0 = f_2 = 0.01$ in order to insure an inflation rate and an output growth of the union in the steady state close to 2%. Moreover, we assume that the common central bank, who initially targeted the potential level of output, overestimates the potential output after the fiscal shock, choosing a 2.7% output growth target $(\hat{y} > \bar{y})$ and a 2% inflation target $\left(\hat{p}^c\right)$.

At every moment, each variable is computed in a relative deviation from the initial steady state. Thus, a policy-mix described in Fig. 8 gives rise to 0.925 % appreciation of the real exchange rate in the long-run and to a rough 0.6 % increase in the natural output. The long-run inflation and the long-run interest rate go up, being explained by the misperception of the central bank to the potential output, which results in a more expansionary monetary policy than necessary for the stabilization of the fiscal shock. However, under the tight monetary policy, the increases in inflation and interest rate are less important than under the more permissive one (in fig. 8, roughly 2% compared to more than 5% increase in the inflation rate, and 1% compared to 3% increase in the common interest rate, respectively). The initial jumps of the real exchange rate, of the output and of the inflation rate are always closer to the final steady state under the tight monetary policy. It seems that a tight monetary policy would be beneficial to the stabilization of the adjustment paths in the union. So, to manage the risk of misperception of the potential output, the common central bank must react less to the output gap relative to the inflation gap in the union (it must choose a less coefficient β_2 compared to β_1). This conclusion supports the results of other papers in the literature which recommend a cautious response of the central bank to output if the information on potential output is noisy (Rudenbusch 2001; Ehrmann & Smets, 2001 or Gaspar & Smets, 2003, for example).

A generalization

It is important to mention that this result doesn't depend on the numerical values used in the simulations above. The following analytical proof, using a simple sensitivity analysis of the initial jumps to β_1 and β_2 coefficients, confirms this fact.

The initial jump of τ is computed by: $\tau(T+) = \bar{\tau}_1 + C_1 \upsilon_{11} \exp(\lambda_1 T)$. This jump depends on β_1, β_2 because υ_{11} depends on these coefficients in (14) and $C_1 = -d\bar{\imath} \exp(-\lambda_1 T)$ also depends on them. If we consider the case of a shock on the government spending, $d\bar{\imath} = -\frac{\beta_2}{(\beta_1 - 1)} \left[\frac{f_2}{(\eta f_2 + b_5)} d\bar{g} - d\hat{y}\right] = -\frac{\beta_2}{(\beta_1 - 1)} (d\bar{y} - d\hat{y})$.

The sensitivity of the initial jump to β_1, β_2 corresponds to the sensitivity of the product $C_1 \upsilon_{11} \exp(\lambda_1 T) = \upsilon_{11} \frac{\beta_2}{(\beta_1 - 1)} (d\bar{y} - d\hat{y})$ to these coefficients. Since $(d\bar{y} - d\hat{y})$ does not depend on the stabilizing coefficients, we can analyze this sensitivity by computing the first order derivatives of $R = \upsilon_{11} \frac{\beta_2}{(\beta_1 - 1)}$ to β_1 and β_2 respectively:

$$\frac{\partial R}{\partial \beta_2} = -\frac{(\alpha_3 - 1)\beta_1 \delta^2 [X + \omega(1 - \beta_1)]}{X(\beta_1 - 1)[\beta_1 \delta + \alpha_3(\beta_2 - \beta_1 \delta)]^2 \omega} > 0,$$

for $d\bar{y} > d\hat{y}$

$$\frac{\partial R}{\partial \beta_1} = \frac{\beta_2 \delta \left[-\beta_2 \alpha_3 X + X(\alpha_3 - 1)(2\beta_1 - 1)\delta - (\alpha_3 - 1)(1 - \beta_1)^2 \delta \omega\right]}{X(\beta_1 - 1)^2 [\beta_1 \delta + \alpha_3(\beta_2 - \beta_1 \delta)]^2 \omega} < 0,$$

for $d\bar{y} > d\hat{y}$.

If $d\bar{y} > d\hat{y}$, as supposed in the previous simulations, the first derivative of the initial jump $C_1 \upsilon_{11} \exp(\lambda_1 T)$ is negative for $\beta_1$and it is positive for β_2. Since the initial jump (relative to the final steady-state) is positive in this case ($d\bar{y} > d\hat{y} \Rightarrow -\frac{\beta_2}{(\beta_1 - 1)} (d\bar{y} - d\hat{y}) < 0 \Rightarrow C_1 > 0$ and $\tau(T+) - \bar{\tau}_1 > 0$), a tight monetary policy (see a high β_1 and/or a small β_2) is suitable for a better stabilization of the union.[11]

We can resume this 4th section of the paper as follows. To sustain the real activity in the union, the common central bank should simply adjust its output target to the potential output of the union, taking into account the ability of different other policies (such as the fiscal policy) to affect this variable. In order to reduce a possible stabilization bias in the union due to the limited capacity of the central bank to adjust its target to the potential level of output, monetary decisions must be taken under the 'caution principle', by choosing to conduct a tight monetary policy, mainly oriented towards the price stability in the Union.

5. **Fiscal and monetary policy implications at national level**

Until now, we focused on the behavior of the union as a whole face to macroeconomic shocks. But, since asymmetries exist among member countries, national reactions to shocks are expected to deviate from the union-wide behavior. This section highlights these deviations face to symmetric or asymmetric shocks in the union.

Using the Aoki decomposition discussed in the 2nd section, the national potential outputs are found by adding to (by subtracting from) the union-wide output ($\bar{y}$), the equilibrium level of output in the difference system ($\bar{y}_d$). So, the asymmetry in the national potential output can be attributed only to the difference component $\bar{y}_d$.

The initial hypothesis on the consumption preferences ($\alpha_1 = \alpha_2$) in (6a) and (6b) corresponds to equal consumer price index in the two countries, as well as to identical consumer price inflation. Under a common monetary policy for the union, the real interest rates will always be identical between countries: $i - \dot{p}_1^c = i - \dot{p}_2^c$. So, the different sensitivity of the national demand to the real interest rate ($a_{21} \neq a_{22}$ in equations (1a) and (1b)) will be the only reason for asymmetries within the union. To discuss the importance of this sensitivity of the national

[11] For $d\bar{y} > d\hat{y}$ or $dg < 0$, the conclusion on the type of the preferred monetary policy is unchanged. The sign of the first order derivatives change, but the negative initial jump still made a tight monetary policy better than a more accommodating one, from the point of view of the macroeconomic stability.

demand to the common interest rate, we suppose hereafter that the country 1 is more sensitive to the real interest rate than the country 2: $a_{21} > a_{22}$.

The resolution of the difference system conducts to the following steady-state **(B)**:

$$\begin{array}{l} \bar{y}_d = \frac{(2f_1+f_2)(g_d-\tilde{a}_2\tilde{\imath})}{\mu(2f_1+f_2)+2b_4+b_5} \\ \bar{p}_d = \bar{\tau}_d = \frac{g_d-\tilde{a}_2\tilde{\imath}}{\mu(2f_1+f_2)+2b_4+b_5} \end{array} \qquad (\mathbf{B})$$

Monetary policy multipliers in **(B)** are equal to zero; so, the monetary policy has no long-run effect on output divergences in the union. If persistent output asymmetries exist in the union, the central bank is useless in the fight against them. Unlike the monetary policy, asymmetric actions on the governments' spending could modify such output divergences.

To depict the individual reaction of the member countries to common macroeconomic shocks, we use a two-equation "difference dynamic system", based both on the difference system and the aggregate system discussed in the previous section of the paper. The first equation concerns the external terms of trade τ, while the second one introduces the prices differential in the union:

$$\begin{array}{l} \dot{\tau} = X\left(\tau - \bar{\tau}\right) \\ \dot{p}_d = -\frac{\lambda_0 X\tilde{a}_2(1-\alpha_3)}{2b_4+b_5}\left(\tau - \bar{\tau}\right) + \lambda_0\left(p_d - \bar{p}_d\right) \end{array}$$

The solution of this system gives the price differential p_{d_t} at time t, for each $t > T$:

$$p_{dt} = \bar{p}_{d_1} - d\bar{p}_d \exp\left[\lambda_0\left(t-T\right)\right] + C_1\upsilon_{11}\frac{\lambda_0\lambda_1\tilde{a}_2\left(1-\alpha_3\right)}{\left(\lambda_0-\lambda_1\right)\left(2b_4+b_5\right)}\left\{\exp\left(\lambda_1 t\right) - \exp\left[\left(\lambda_1-\lambda_0\right)T\right]\exp\left(\lambda_0 t\right)\right\} \tag{16}$$

This result is very important to the dynamic analysis, because the output divergences in the union are deeply linked to the dynamics of prices differential: $y_d = \bar{y}_d + \frac{\dot{p}_d}{\delta}$. We than easily obtain the individual reaction of member countries to macroeconomic shocks. In order to emphasize the role of structural asymmetries (here, the national demand sensitivity to the common interest rate: $a_{21} \neq a_{22}$), we start by studying the simplest case of a union hit by a symmetric shock. In order to facilitate the comparison between the national dynamics, we still represent the relative deviation of the output from the initial steady state, denoted hereafter by dy. We thus ignore the gap between the initial steady-state of the two economies, which has no influence on the form of the adjustment paths towards the final steady-state.

Fig. 9 compares the national dynamic paths after a symmetric increase in governments' spending (Fig. 9a) or after a restrictive monetary shock (Fig. 9b). We remark that asymmetries occur in the union during the adjustment towards the steady state. The initial negative jump of dy_d at the moment T, followed by a gradual movement towards positive values, and then, by a return to zero in the long-run, confirms the existence of divergences in the union during the adjustment process.

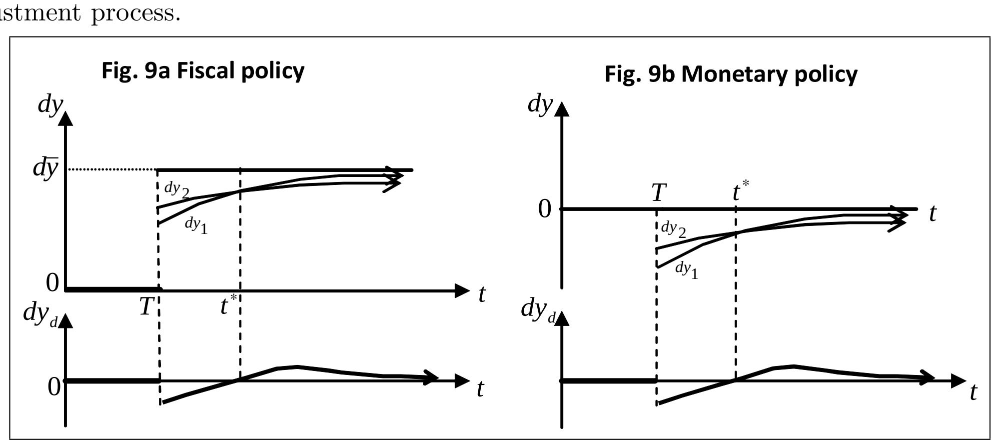

Fig. 9 Individual dynamic adjustments within the union

The two countries react differently to the symmetric shock. A symmetric increase in public expenditures, in Fig. 9a, initially stimulates the output in country 2 more than in country 1 ($dy_2 > dy_1$). But the situation changes after the moment $t^* = T + \frac{1}{\lambda_1 - \lambda_0} \ln \left(\frac{\lambda_0}{\lambda_1} \right) > T$[12], when the output becomes higher in country 1 than in 2, before reaching the same level in the steady state. This t^* perfectly corresponds to the moment of reversal in the relative effectiveness of the common policy on output, initially highlighted in Clausen and Wolhtmann (2005). The same form of adjustments appears in Fig. 9b, for a restrictive monetary shock, the only difference coming from the steady state, which changes in the fiscal policy case, but not in the case of a monetary shock. Here, the real activity is initially more affected by the shock in country 1 (the more sensitive to changes in the real interest rate) than in country 2 and a reversal produces in t^*.

The asymmetric transmission of the interest rate in the union explains these asymmetric reactions. As proven in the previous sections, an expansionary fiscal shock, as well as a restrictive monetary shock, impacts the union by means of a spontaneous overshooting of the real exchange rate, followed by a real depreciation of the common currency until the steady state. When the shock arises, the jump of τ is the same in the two countries of the union: $p_d\left(T+\right) = \tau_d\left(T+\right) = \frac{C_1 v_{11} \lambda_1 \lambda_0 \tilde{a}_2 (1-\alpha_3)}{(\lambda_0 - \lambda_1)(2b_4 + b_5)} \left(\exp\left(\lambda_1 T\right) - \exp\left(\lambda_1 T\right)\right) = 0$. So, the initial real appreciation of the common currency is symmetric within the union (Fig. 10). Subsequently, the real depreciation of the common currency ($\dot{\tau} < 0$) is associated to a real interest rate in the union higher than the steady state level:

$$i - \dot{p}^c = \tilde{r} - (1 - \alpha_3)\,\dot{\tau} \tag{17}$$

The dynamic adjustment of $\dot{\tau}$ corresponds to a decrease in the real interest rate during the adjustment process. The asymmetric transmission of this interest rate within the union explains why the output increases more quickly in country 1 than in 2, which is the reason of the reversal in the relative effectiveness of the common policy on output, in t^*.

As the producer prices dynamics depends, in each country, on the domestic output gap, the asymmetric reaction of national output to the fall in the real interest rate results in different adjustments of domestic inflation ($\dot{p}_i$). Consequently, the national inflation falls more quickly in country 1 than in country 2, explaining the dynamic path of $\dot{\tau}_i$ in Fig.10.

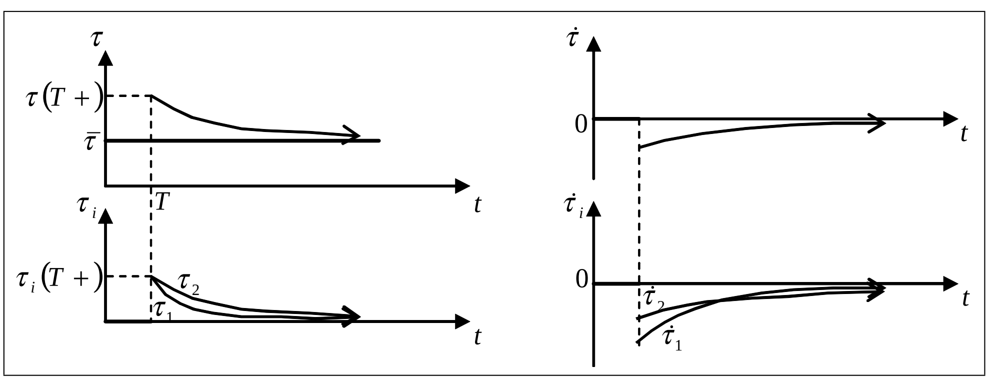

Fig. 10 National adjustment of the real exchange rate after a restrictive monetary shock

Using this simplest example of symmetric shocks for the two countries member of the union, we have highlighted that asymmetries in the interest rate transmission channels cause asymmetric propagation of macroeconomic impulses within the Union. In this case, the "optimal

[12]Details on the computation of t^* appear in the Technical Appendix that can be produced on request.

policy-mix" discussed at union-wide level is efficient at national level too: the effects of a symmetric increase in government spending within the union are perfectly suppressed by a monetary policy that adjusts its output target to the potential output of the union[13].

However, this is not true if asymmetric fiscal policies hit the union. This is a more realistic assumption when fiscal policy is conducted at a national level, like in the euro area. From the equilibrium **(B)**, it is clear that permanent asymmetric increases in government spending could persistently increase the output divergences in the union. Moreover, the fact that the central bank could react to fiscal shocks by adjusting its target to a mean potential output of the union does not insure the stabilization at the national level ($g_d \neq 0$ results in $\bar{p}_{d_1} \neq 0$ and, from (16), $\dot{p}_{dt} = d\bar{p}_d \lambda_0 \exp\left[\lambda_0 (t - T)\right] \neq 0$ even if $C_1 = 0$, giving rise to different national adjustments of the output towards the steady-state).

Consequently, more dangerous than the asymmetry in the interest rate transmission is the asymmetry of fiscal shocks because it may cause persistent real divergences among member countries. That's why unconstrained fiscal policies, independently conducted by each national government, are not the better choice for the union. Some constraints that take into account structural asymmetries in the union should be necessary in this case.

Indeed, let's leave the representation of output in deviation from the initial steady state. Initial output divergences in the union are entirely due, in the model, to different sensitivity of the national demand to the common interest rate. Symmetric fiscal policies are useless to permanently reduce these divergences. But fiscal policies, which accurately take into account structural asymmetries, may act in this direction. A simple glance on the equations (1a) and (1b) or in equilibrium **(B)** allows concluding that coordinated asymmetric fiscal policy can suppress the transmission channel of divergences (a_{2i}), if: $g_d = \tilde{a}_2 \tilde{\bar{i}} \Leftrightarrow g_1 - g_2 = (a_{21} - a_{22})\tilde{\bar{i}}$. A particular fiscal rule for each government, taking into account the national specificities, could thus be: $g_i = g_a + a_{2i}\tilde{\bar{i}}$, where g_a represents an autonomous (symmetric) component of the government expenditures, common to all countries of the union.

6. **Conclusion**

This paper analyses, at a pure theoretical level, the effects of fiscal and monetary policy in an open currency union with heterogeneous monetary policy transmission, perfect capital mobility and flexible exchange rate. Governments act on public expenditures financed by taxes and the common central bank takes its decisions by means of an interest rate rule for the monetary policy. In such a context, no conflict between governments and the common central bank should appear in the long-run. An expansionary fiscal policy could stimulate the economic growth and the common central bank must simply validate the government policy by adjusting the output target to the endogenous potential output$\bar{y}$. This action insures the respect of the monetary inflation target and the stability of macroeconomic variables in the union.

However, this situation corresponds to an ideal case where the common central bank is perfectly informed on the potential level of the output. If the central bank perception on the potential output is noisy, then the monetary policy output target can deviate from the potential output, giving rise to a stabilization bias in the union. In order to limit this stabilization bias, a tight monetary policy (more inflation stabilization-oriented) is recommended by our model. If national aggregates are also better stabilized under a tight monetary policy compared to an accommodating one, asymmetries occur between their adjustment paths because of the heterogeneous monetary transmission. National fiscal policies that take into account structural asymmetries would be useful to avoid them.

But, in a monetary union where the fiscal policies are independent, conducted at a national level, the risk of asymmetric fiscal shocks should also be considered. Face to the positive effect of government expenditures on the real activity, some member states could be encouraged to

[13] If $\hat{y} = \bar{y}$ and a fiscal shock strikes the union, $C_1 = 0$ and $p_{d_t} = 0, \forall t$ and no divergences occur in the union, because the new steady state is reached spontaneously after the shock, by all member countries.

excessively use their national fiscal policies, increasing thus output divergences in the union. A fiscal coordination is necessary at the union-wide level. But, the Growth and Stability Pact in the European Union, which simply limits national fiscal deficits to 3% of GDP seems to be insufficient to reduce long-run output divergences. As proven in the 5th section, the union must consider the structural asymmetries when defining the constraints for the national governments.

This study asks for further research, notably on the consideration of nominal rigidities. The role of taxes and of the foreign debt should also be discussed in more depth, with the introduction of an eventual national risk premium which limits the access of member countries to foreign capital inflows.

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