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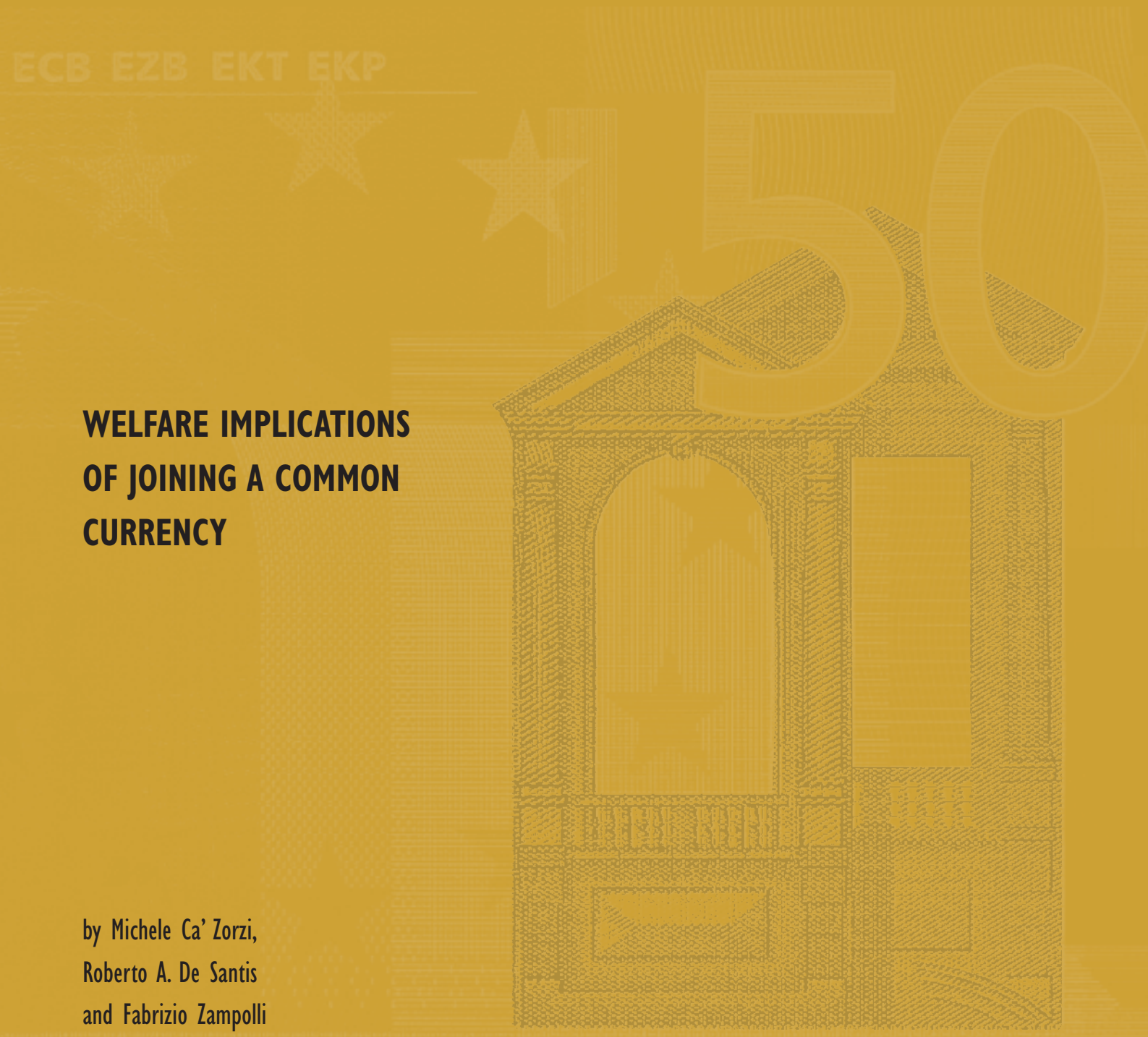

WELFARE IMPLICATIONS OF JOINING A COMMON CURRENCY

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1 The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank. All errors are our responsibility.

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Abstract

This paper examines the welfare implications of a country joining a currency union as opposed to operating in a flexible exchange rate regime. At the country level, the suboptimal response to domestic and foreign shocks and the inability of setting inflation at the desired level may be offset by a positive impact on potential output. We show that for entry to be welfare enhancing, the potential output gain must be the larger, the smaller the country, the larger the difference between the standard deviation of supply shocks across the participating countries, the smaller the correlation of countries' supply shocks and the larger the variance of real exchange rate shocks.

JEL classification: E52, E58, F33, F40.

Keywords: Balassa-Samuelson Effect, Currency Union, Monetary Policy, Welfare.

Non-Technical Summary

The birth of a single currency in Europe and the prospects for future expansions of the euro area shed a new light over the debate on the optimal composition of currency unions.

The traditional view, inspired by the early optimal currency area literature (see Mundell, 1961; McKinnon, 1963; Kenen 1969), stresses the importance that countries belonging to a common currency area are highly integrated among each other. The motivation for this is that a high degree of integration, for example in terms of trade, might help reduce the likelihood of asymmetric shocks and unsyncronised business cycles. While this line of reasoning has been refined and critically discussed over the years (e.g. Corden, 1972; Mundell 1973), it has remained, until recently at least, the mainstream view. This consensus, however, has been challenged by the influential empirical analysis of Rose (2001, 2002, 2004), which finds strong evidence of a positive impact of currency unions on trade. This, as well as the experience with currency unions, has led some analysts to assess more positively the possibility of a country joining a currency union even before full economic integration is achieved.

The aim of this paper is to review some of these argumentations on the basis of a stylised theoretical approach, which explicitly incorporates (i) the real exchange rate appreciation process which typically characterises catching up countries (by reviewing the Balassa-Samuelson effect) and (ii) the positive impact of currency unions on potential output, as identified by the work originated by Rose. Our motivation is partly theoretical and partly to adapt the standard analysis to the case of catching up countries, which has generally been ignored in this context.

We examine first the welfare implications for the currency union as a whole. We show that the expected loss of common currency union does not depend on the deterministic factors affecting the real exchange rate (such

as the Balassa-Samuelson effect), but only on the variances and covariances of supply shocks. We also show that, if the transmission mechanisms of monetary policy differ among member states, the expected loss of the common currency area depends on the variance of real exchange rate shocks (i.e. intersectoral productivity, aggregate demand and purchasing power parity shocks).

The presence of members undergoing structural change could have therefore negative welfare implications for the common currency union to the extent that this is reflected in high variances of aggregate supply and real exchange rate shocks. There is, however, an important qualification to be made. These variances are weighted by the square of the size of each participant to the union. Thus, a relatively high variance of shocks in one country has a limited impact on the union insofar as this country is not too large. We also find that the smaller the covariance of aggregate supply shocks between the two countries, the smaller the aggregate loss. The intuition for this is that the less supply shocks are correlated, the more they tend to offset each other at the union level.

At the country level, joining a currency union necessarily implies an inefficient response to domestic and foreign shocks as well as a loss of control over average inflation. This notwithstanding, it may be beneficial to join a currency union as long as the gain in potential output is sufficiently large. Under the simplifying assumption that the transmission mechanisms of monetary policy is the same between countries, the gain in potential output must be the larger, the smaller the country, the larger the difference between the standard deviation of supply shocks in the two participating countries, the smaller the correlation of supply shocks and the larger the variance of real exchange rate shocks. Therefore a country characterised by sizeable asymmetric shocks may still benefit from joining a currency union, if the potential output gain is sufficiently large.

1 Introduction.

The birth of a single currency in Europe and the prospects for future expansions of the euro area shed a new light over the debate on the optimal composition of currency unions.

The traditional view, inspired by the early optimal currency area literature (see Mundell, 1961; McKinnon, 1963; Kenen 1969), stresses the importance that countries belonging to a common currency area are highly integrated among each other. The motivation for this is that a high degree of integration, for example in terms of trade, might help reduce the likelihood of asymmetric shocks and unsyncronised business cycles. While this line of reasoning has been refined and critically discussed over the years (e.g. Corden, 1972; Mundell 1973), it has remained, until recently at least, the mainstream view.[1]

This consensus, however, has been challenged by the influential empirical analysis of Rose (2001, 2002, 2004), which finds strong evidence of a positive impact of currency unions on trade. The positive impact on potential output via trade and financial integration,[2] as well as the experience with currency unions, has led some analysts to assess more positively the possibility of a country joining a currency union even before full economic integration is achieved.

The key questions underlying this debate can be summarised as follows: What are the consequences of renouncing to an independent monetary policy for inflation and output in a small open economy? How is this choice affected by the catching up process and by the role of external shocks? And what are the welfare implications of joining a currency union, and more specifically,

[1] For recent reviews of optimal currency areas literature see Mongelli (2002), Horvath (2003) and Artis (2004).

[2] Bagella, et al. (2004) investigate the direct output impact of EMU. They find that: (i) reduced exchange rate volatility (ii) higher and less heterogenous quality of institutional rules and (iii) more stable macroeconomic policies have had a significant impact on the level and growth rates of per capita GDP in euro area countries.

of the Balassa-Samuelson (BS) effect and of other factors affecting the real exchange rate, such as aggregate demand and PPP shocks?[3]

A satisfactory answer to all these questions requires addressing at least five crucial issues. First, one needs a macroeconomic framework defining the relationship between nominal and real variables, which in turn critically depends on the shape of the aggregate supply.

Second, one needs to make an overall assessment on what determines potential output and its endogeneity with respect to the exchange rate regime. According to the growth literature, catching up is 'conditional' on a number of factors among which institutional factors,[4] and the exchange rate regime may play a role. Moreover, following the influential analysis of Rose (2000, 2001, 2004),[5] the elimination of exchange rate risks and the formation of a currency union are often viewed as having a positive impact on long term growth prospects,[6] due to deeper integration of trade and financial markets.[7]

Third, one should consider the possible link between real exchange rate and intersectoral productivity growth. The disaggregation of potential output across sectors is important, because it provides useful insights on inflation. Starting point is the appealing stylised fact that whenever countries successfully catch up, productivity growth tends to be higher in the trad-

[3] There is a considerable ongoing debate, applied especially to the case of Central and Eastern European countries, as to what extent the BS model explains the causes of real appreciation processes in fast-growing small open economies as opposed to other factors, such as demand factors, the liberalisation of prices and undervalued exchange rates at the beginning of the transition process (see Egert et. al, 2003; MacDonald and Wojcik, 2004; Mihaljek and Klau, 2004).

[4] Durlauf and Quah (1999) provide an exaustive survey on recent empirical evidence on what factors, both economic and institutional, affect economic growth.

[5] The size of the currency union effect on international trade is controversial in the literature, but it is generally accepted to be positive. For a meta-analysis see Rose (2004).

[6] An opposite theoretical effect may be in action if a currency union encourages a wage equalisation process across countries that is not supported by corresponding improvements in productivity. In a similar vein, Cukierman and Lippi (2001) discuss the possibility that currency unions increase labour-unions wage demands for any given level of productivity.

[7] Edwards and Magendzo (2003), have recently qualified these results by stressing the need to distinguish between countries which "dollarise" from those participating to a fully fledged currency union, concluding that only in the latter case one can find evidence of a positive impact on growth.

able than in the non-tradable sector. Under a standard set of assumptions, this implies that successfully catching up countries face a real exchange rate appreciation vis-à-vis trading partners (Balassa, 1964; Samuelson, 1964),[8] hence a higher inflation if the exchange rate is fixed.[9]

Fourth, one should take into account that countries forming a monetary union lose direct control of domestic inflation.

Fifth, in judging the impact of the exchange rate framework, one needs to assess the macroeconomic impact of economic shocks. Besides the traditional debate on the importance of shocks on the velocity of money versus real shocks in determining the optimal exchange rate regime,[10] the literature frequently focuses upon the role played by asymmetric supply shocks but generally ignores the role played by real exchange rate shocks.[11]

In this paper, by taking into account these five issues, we develop a stylised two-sector, two-country general equilibrium model, in which we assume that the large developed country conducts an independent monetary policy and the relatively low-income, small-open economy has the option of forming a monetary union. The framework extends the set up in Ca' Zorzi and De Santis (2004, 2005) by modelling explicitly the variables affecting the real exchange rate deterministically (e.g. the BS effect) and by pos-

[8] High productivity growth in the tradable sector relative to the non-tradable sector leads to higher real wages in the tradable sector of fast-growing countries. Assuming labour mobility across sectors and for a given world price for tradables, the relative price of non-tradables must necessarily increase to keep the marginal product of labour equal to the real wage in the non-tradable sector. Thus, countries growing more rapidly are generally expected to face a more sizeable real exchange rate appreciation. This effect is known in the literature as the BS effect.

[9] The implications of the BS effect has recently been assessed by a number of authors, including Sinn and Reutter (2001) for the euro area, De Broeck and Slok (2001) and Halpern and Wyplosz (2001) for transition countries and Devereux (1999) and Ito, Isard and Symansky (1999) for Asia.

[10] For example the traditional Poole's analysis emphasises the importance of the relative variance of money demand and output demand shocks in deciding whether to adopt a fixed or a flexible exchange rate regime. Fixed exchange rates help stabilising money demand shocks, while flexible exchange rates help stabilising output shocks (Poole, 1970).

[11] For a theoretical perspective within a common currency area see for example Cooper and Kempf (2000); Lane (2000); Siber and Sutherland (2000); Ca' Zorzi and De Santis (2004).

tulating, in line with the empirical evidence, a positive impact of currency unions on potential output. In addition, the modelling framework considers two country-specific shocks: aggregate supply shocks and, what is generally ignored, real exchange rate shocks.[12]

The remaining sections of the paper have been organised as follows: Section 2 describes the two-sector, two-country general equilibrium model and derives a Lucas-type supply curve; Section 3 introduces the loss function for the central banker and examines the implications for output and inflation of a flexible exchange rates versus a currency union regime; Section 4 investigates the welfare implications of renouncing to a national currency. Section 5 provides some concluding remarks.

2 A simple framework.

In this section we present a stylised two-sector, two-country general equilibrium model that incorporates factors determining the real exchange rate and, at the same time, yields a Lucas supply function. Monetary non-neutrality is introduced by having the nominal wage set prior to the realisation of shocks.

The structure of the model for both countries is consistent with a 'synthetic view' of the world, admitting in other words the existence of a trade off between inflation and output, while denying any relationship over the long term. The implicit assumption is therefore that the loss of monetary policy control may be harmful in the short run, but bears no consequences on output over a long run horizon. We also assume that the small open economy fulfils the necessary conditions for catching up relative to the large country and, as in the BS literature, that growth is biased toward the tradable sector.

[12] As shown later, in this framework real exchange rate shocks encompass: (i) unanticipated changes in relative productivity between the traded and non-traded sectors (ii) aggregate demand shocks (iii) shocks to PPP in the tradable sector.

2.1 The demand side

Let us define the fast growing small open economy as country h and the large economy as country f, both producing traded goods (T) and non-traded goods (N). These are indexed, respectively, with $r = h, f$ and $i = T, N$. The model is in logs and all variables are interpreted as growth rates unless stated otherwise. Consumers allocate their expenditure between traded and non-traded goods as follows:

$$y_r = \gamma_r y_r^T + (1 - \gamma_r) y_r^N, \tag{1}$$

where γ_r denotes the share of the traded goods in the consumer basket.

With this specification the CPI inflation rate is given by a weighed average of the price of traded goods, p_r^T, and the price of non-traded goods, p_r^N:

$$p_r = \gamma_r p_r^T + (1 - \gamma_r) p_r^N, \tag{2}$$

while the sectoral demand for goods, y_r^i, depends only on relative prices:

$$y_r^i - y_r = -\left(p_r^i - p_r\right). \tag{3}$$

2.2 The supply side

Sectoral output is produced using a standard Cobb-Douglas technology:

$$y_r^i = a_r^i + \left(1 - b_r^i\right) l_r^i, \tag{4}$$

where a_r^i is sector-i productivity and l_r^i is sector-i employment while $0 < b_r^i < 1$. Aggregating over sectors gives:

$$y_r = a_r + \gamma_r \left(1 - b_r^T\right) l_r^T + (1 - \gamma_r) \left(1 - b_r^N\right) l_r^N, \tag{5}$$

where $a_r = \gamma_r a_r^T + (1 - \gamma_r) a_r^N$ is aggregate productivity in country r.

The sectoral demands for labour are derived by equating the marginal product of labour to the producer real wage:

$$l_r^i = p_r^i + y_r^i - w_r, \tag{6}$$

where w_r is the nominal wage rate, which is equalised across sectors. The latter expression can be re-arranged as follows:

$$p_r^N - p_r^T = \left(y_r^T - l_r^T\right) - \left(y_r^N - l_r^N\right). \tag{7}$$

Since from (3) $p_r^N - p_r^T = y_r^T - y_r^N$, (7) implies $l_r^T = l_r^N = l_r$. In other words, relative prices adjust so as to prevent a change in the sectoral allocation of employment.[13] Hence, by using (4) and (7)

$$p_r^N - p_r^T = a_r^T - a_r^N + \left(b_r^N - b_r^T\right) l_r. \tag{8}$$

If productivity growth in the traded sector is greater than in the non-traded sector, the relative price for non-traded goods increases. This result is the first main proposition of the BS model. Positive aggregate demand shocks also temporary raise the relative price for non-traded goods if $b_r^N > b_r^T$.[14]

[13] Combining these two expressions amounts to finding the tangency point between the production possibility frontier and the consumer's indifferent curves under the assumption that the traded sector always clears, namely that the current account balance is always zero (or, alternatively, a constant proportion of output).

[14] De Gregorio, et al. (1994) show that in several european countries (i) demand shifts towards the nontradable sector, (ii) real wage pressures and (iii) productivity growth in the traded good sector were the key variables explaining the increase in the relative price of nontradable goods. Similarly, MacDonald and Wojcik (2004) argue that the price ratio between non-tradable and tradable goods not only depends on relative productivity across sectors but also on demand factors. Additionaly, they argue that the assumption of purchasing power parity is too restrictive for catching up countries. The impact of similar aggregate demand shocks in a new open economy macroeconomics (NOEM) context is shown in Cova (2004).

2.3 Real exchange rate determination

In the standard version of the BS model, it is assumed that PPP holds for the tradable sector. Here we extend the analysis slightly by allowing deviations from PPP in the tradable sector for the small country, i.e. $q_h^T = p_f^T + e - p_h^T$ where p_f^T is traded goods inflation determined within the large country and e is the change in the nominal exchange rate. By construction we assume instead that $q_f^T = 0$. Taking into account also (8) we can now rewrite (2) as follows:

$$p_h = p_f^T + e + \theta_h \tag{9}$$

$$p_f = p_f^T + \theta_f, \tag{10}$$

where $\theta_r = (1 - \gamma_r)\left[\left(a_r^T - a_r^N\right) + \left(b_r^N - b_r^T\right) l_r\right] - q_r^T$.

Therefore, inflation in the small open economy can be decomposed into three components: *imported* inflation, p_f^T, *exchange-rate-induced* inflation, e, and *structural* inflation, θ_h. By structural inflation we mean the component of inflation determined by consumer preferences, by differences in productivity across the traded and non-traded sectors, by aggregate demand effects and PPP deviations. Let us also define $\tau_r \equiv \theta_r - E(\theta_r)$ as the country-specific shock to structural inflation, where $E(\theta_r)$ denotes the deterministic component of structural inflation in country r, being $E(...)$ the expectations operator.

By using (9) and (10), and by defining the change in the real exchange rate as $s = p_f + e - p_h$, we derive:

$$s = -(\theta_h - \theta_f). \tag{11}$$

If structural inflation is higher in the home country (i.e. $\theta_h > \theta_f$), the real exchange rate of the home country appreciates.

2.4 Monetary non-neutrality

We introduce a nominal rigidity in wage setting in a standard way. Following e.g. Rogoff (1985), Blanchard and Fisher (1989), or Cooley and Hansen (1995), we assume the existence in each country of a union setting the economy-wide nominal wage so as to minimise the expected deviation of aggregate employment l_r from its long run flexible-wage level $\bar{l}_r$:

$$w_r = \arg\min E\left(l_r - \bar{l}_r\right)^2. \tag{12}$$

The nominal wage is set prior to the realisation of shocks and it is assumed that workers are prepared to meet any demand for labour required by firms after the realisation of shocks. This feature, which is standard in the literature originates from distortions in the labour market (e.g. monopolistic power, etc.). These distortions cause a wedge between the wage rate and the marginal cost of providing additional labour. An expected rise in labour demand by firms will be met by workers as long as this wedge remains positive.

Consistently with the assumption made in Section 2.2, the long run supply is inelastic so that $\bar{l}_r = 0$, and hence employment growth is simply given by the aggregation of (6):

$$l_r = p_r + y_r - w_r. \tag{13}$$

The optimal wage rate is, therefore, the one which clears the labour market in expectation. Abstracting from demographic factors, labour supply is assumed to be perfectly inelastic in the long run, so that $E(l_r) = 0$ and, hence, $E(y_r) = E(a_r)$.

The optimising growth rate of nominal wage consistent with (12) is equal

to the expected growth rate of nominal income:

$$w_r = E\left(p_r + y_r\right). \tag{14}$$

One of the features of this two country, two sector model is that we can derive the Lucas aggregate supply curve. In fact, given (5), (13) and (14), one can derive output growth:[15]

$$y_r = \bar{y}_r + \alpha_r\left(p_r - Ep_r\right) + \varepsilon_r, \tag{15}$$

where $\bar{y}_r \equiv E\left(y_r\right) = E\left(a_r\right)$ is the natural growth rate of the economy, $\alpha_r \equiv \phi_r/(1-\phi_r)$ is the slope of the Lucas AS curve, $\varepsilon_r \equiv \left(a_r - Ea_r\right)/(1-\phi_r)$ is an aggregate supply shock to productivity and $\phi_r \equiv \gamma_r\left(1-b_r^T\right) + (1-\gamma_r)\left(1-b_r^N\right)$.

2.5 Decomposing the real exchange rate

In order to isolate the BS effect, we decompose the change in the real exchange rate (11) between its non-deterministic $\tau_s = -\left(\tau_h - \tau_f\right)$, and deterministic component:

$$E\left(s\right) = -E\left[\left(1-\gamma_h\right)\left(a_h^T - a_h^N\right) - \left(1-\gamma_f\right)\left(a_f^T - a_f^N\right)\right] + E\left(q_h^T\right). \tag{16}$$

In the standard BS model, it is generally assumed that $\gamma_r^N = \gamma_r^T$ and $q_r^T = 0$. Under these hypotheses, if the small open economy experiences larger intersectoral productivity growth in favour of the tradable sector relative to the large country, then the home economy experiences trend appreciation of its real exchange rate $E\left(s\right) < 0$. This result is the second standard proposition of the BS model. In the more general case, this impact on $E\left(s\right)$ is reinforced (or offset), depending on whether the tradable

[15] This generalisation of the Lucas supply curve to two sectors establishes the link between the BS and time inconsistency frameworks.

sector in the home economy is smaller (or larger) relative to the foreign economy, i.e. $\gamma_h < \gamma_f$ (or $\gamma_h > \gamma_f$). This in turn depends on the respective consumer preferences in the two countries. The BS effect is also reinforced if the catching up economy experiences price convergence in the tradable sector relative to the large economy, i.e. $E\left(q_h^T\right) < 0$. In light of the empirical evidence and for ease of exposition we henceforth assume that catching up economies experience a real appreciation process, i.e. $E\left(s\right) < 0$.

Turning to the non-deterministic component of the real exchange rate, it is straightforward to see that τ_s is determined either by shocks to inter-sectoral productivity, aggregate demand or PPP.[16] In particular, under the plausible assumption that $b_r^N > b_r^T$, a positive aggregate demand shock in the catching up economy temporarily strengthens its real exchange rate.[17]

The model is at this point complete and can be solved in the context of a general equilibrium analysis, as (1), (2), (3), (4), (6) and (14) determines the following variables: y_r, p_r, p_r^i, y_r^i, l_r^i, w_r; while $e = q_h^T + p_h^T - p_f^T$ gives the nominal exchange rate.

[16] Comparative statics will be carried out under the hypothesis that the other shock is invariant. For example, if a productivity shock hits both the traded and non-traded sectors with the same magnitude, then $\tau_r = 0$ and $\epsilon_r \neq 0$. Conversely, if a positive productivity shock in the traded sector is offset by a negative productivity shock in the non-traded sector, then $\tau_r \neq 0$ and $\epsilon_r = 0$. Obviously, if shocks to demand and/or PPP occurs, then $\tau_r \neq 0$ and $\epsilon_r = 0$.

[17] One could - but this is beyond the scope of this analysis - attempt to include more formally the notion of market segmentation and terms of trade effects. For example, Benigno and Thornissen (2003) show by means of numerical simulations that an increase in total factor productivity in the traded sector would have a depreciating impact on the real exchange rate through the market segmentation channel, which captures the effects of local currency pricing. Opposing to this, the internal real exchange rate shows an appreciating trend in accordance with the BS effect. These effects tend to offset each other in the long run. NOEM models can also be reconciled with the BS effect if pricing to market is postulated (see Bergin, 2001; Vilagi, 2004).

3 Inflation, output and welfare under different regimes.

Assume that the policy makers minimise the following quadratic loss functions:

$$L_r = \frac{1}{2}(y_r - \bar{y}_r)^2 + \frac{\beta}{2}(p_r - p_r^*)^2 \tag{17}$$

$$\bar{y}_r = \left\{ \begin{array}{c} \widehat{y}_r, \text{ in the flexible exchange rate regime} \\ \widehat{y}_r + \lambda_r, \text{ in the currency union regime} \end{array} \right\} \tag{18}$$

where p_r^* is defined as the level of admissible inflation in country r. We also assume that $\lambda_r > 0$, hence capturing the hypothesis of a positive impact of currency unions on the natural rate of output, as suggested among others by Rose (2000, 2001, 2004), Edwards and Magendzo (2003) and Bagella et al. (2004).

Since the level of potential output is endogenous to the formation of the currency union, the Lucas AS curve can be re-written as

$$y_r = \bar{y}_r + \alpha_r (p_r - Ep_r) + \varepsilon_r. \tag{19}$$

The policy makers in minimising their loss functions take as given (19), expected inflation by the private sector and the realised shocks. Events unfold as follows: the private sector forms expectations on prices, conditionally on the information available at that time. The output shock is realized and, finally, monetary policy is set. The game is solved by backward induction.

In what follows we consider two cases:

1. the small open economy h retains monetary sovereignty and full discretionality by adopting flexible exchange rates;

2. the small open economy h and the large economy f form a monetary union.

For both cases we compute the equilibrium solutions and we study the impact on welfare.

3.1 Flexible exchange rates

We assume that the central bank controls inflation directly. Minimisation of (17) given (9), (10) and (19) with respect to p_r yields the typical Nash-equilibrium solutions of the time-inconsistency literature: $Ep_r = p_r^*$, $p_r = p_r^* - \alpha_r \left(\alpha_r^2 + \beta\right)^{-1} \varepsilon_r$, $y_r = \bar{y}_r + \beta \left(\alpha_r^2 + \beta\right)^{-1} \varepsilon_r$, $E\left(L_r\right) = \beta \left[2\left(\alpha_r^2 + \beta\right)\right]^{-1} \sigma_{\varepsilon_r}^2$, where $\sigma_{\varepsilon_r}^2 = E\left(\varepsilon_r\right)^2$. Moreover, the reduced form of traded goods inflation and exchange rate dynamics can be computed as follows:

$$p_f^T = p_f^* - E\theta_f - \tau_f - \frac{\alpha_f}{\alpha_f^2 + \beta}\varepsilon_f,$$

$$e = p_h^* - p_f^* - E\left(\theta_h - \theta_f\right) + \tau_s - \left(\frac{\alpha_h}{\alpha_h^2 + \beta}\varepsilon_h - \frac{\alpha_f}{\alpha_f^2 + \beta}\varepsilon_f\right).$$

This means that the deterministic change to structural inflation (e.g. the BS effect) does not have an impact on realised inflation, unless it is implicitly incorporated when evaluating the level of admissible inflation. Moreover, inflation and output performance do not depend on real exchange rate shocks. The latter only affect tradable inflation and developments in the nominal exchange rate.

3.2 Monetary union

Let us assume now that the small open economy h and the large economy f form a monetary union. The new established monetary authority takes policy decisions focusing the economic analysis on union-wide inflation and output aggregates. Therefore, the policy maker minimises the following loss function:

$$L^u = \frac{1}{2}\left(y^u - \bar{y}^u\right)^2 + \frac{\beta}{2}(p^u - p^{u^*})^2, \tag{20}$$

where u denotes the monetary union regime, $y^u \equiv my_h + (1-m)\, y_f$ the aggregate union-wide output, $p^u \equiv mp_h + (1-m)\, p_f$ the aggregate union-wide inflation, p^{u^*} the level of admissible inflation and $\bar{y}^u \equiv m\,(\widehat{y}_h + \lambda_h) + (1-m)\,(\widehat{y}_f + \lambda_f)$ the potential output rate, with m indicating the weight of the small open economy h.[18]

Differentiating (20) with respect to the common tradable inflation rate p_f^T, determines the reaction function of the monetary authority as a function of inflationary expectations. By imposing rational expectations one can derive expected inflation. Finally, the equilibrium outcome is achieved by replacing expected inflation in the reaction function, which yields:

$$
\begin{aligned}
p^u &= p^{u^*} - \frac{\alpha^u}{\alpha^{u^2} + \beta}\left[\varepsilon^u - m(1-m)\,(\alpha_h - \alpha_f)\,\tau_s\right], \\
p_h^u &= p_h^* + \Omega_h - \frac{\alpha^u}{\alpha^{u^2} + \beta}\varepsilon^u - \frac{\alpha_f \alpha^u + \beta}{\alpha^{u^2} + \beta}\,(1-m)\,\tau_s, \\
p_f^u &= p_f^* + \Omega_f - \frac{\alpha^u}{\alpha^{u^2} + \beta}\varepsilon^u + \frac{\alpha_h \alpha^u + \beta}{\alpha^{u^2} + \beta} m\tau_s.
\end{aligned}
$$

where $\alpha^u = m\alpha_h + (1-m)\,\alpha_f$, $\varepsilon^u = m\varepsilon_h + (1-m)\varepsilon_f, \Omega_h = p^{u^*} - p_h^* + (1-m)\,E\,(\theta_h - \theta_f)$ and $\Omega_f = p^{u^*} - p_f^* - mE\,(\theta_h - \theta_f)$

It is noticeable that expected inflation in the enlarged currency area is not affected by deterministic changes in the real exchange rate. However, aggregate inflation is affected by real exchange rate shocks if $\alpha_h \neq \alpha_f$. To be more precise a shock appreciating the real exchange rate in the catching up economy, $\tau_s < 0$, would have a positive (negative) impact on aggregate inflation if $\alpha_h < \alpha_f$ $(\alpha_h > \alpha_f)$. This implies that if the transmission mechanism of monetary policy differs among member states, shocks to the real exchange rate, whether the consequence of a relative productivity, aggregate

[18] Benigno (2004) shows - in a NOEM context with tradable goods only - that, if the two regions share the same degree of nominal rigidity, the terms of trade are completely insulated from monetary policy and the optimal outcome is obtained by targeting a weighted average of the regional inflation rates. These weights coincide with the economic sizes of the region. Benigno's framework also delivers a simple welfare criterion based on the utility of the consumers that has the usual trade-off between stabilizing inflation and output.

demand or PPP shocks, affect aggregate inflation in the new currency area. Moreover, $\tau_s < 0$ leads to higher inflation in country h and lower in country f.

The impact of the formation of the currency union on expected inflation in country r is captured by the parameter Ω_r. For any given level of p^{u^*}, deterministic changes in the real exchange rate (e.g. BS effect or increased consumer preferences in favour of nontradables) bring about a relatively small downward impact on inflation in the large country and a relatively large upward impact on the small country.

Suppose that p^{u^*} is determined endogenously by minimising $\widetilde{L}^u = mL_h + (1-m)L_f$, where L_h and L_f represent the respective loss functions of h and f. Then p^{u^*} is equal to $mp_h^* + (1-m)p_f^*$.[19] Let us consider two special cases. If we postulate that admissible inflation is the same in the two countries, i.e. $p_h^* = p_f^*$, the small economy h experiences a rise in inflation equal to $\Omega_h = (1-m)E(\theta_h - \theta_f)$ while the large economy f experiences a decline in inflation amounting to $\Omega_f = -mE(\theta_h - \theta_f)$.[20] In this case, the costs of higher inflation due to the deterministic factors affecting the real exchange rate are internalised and, consequently, the optimal redistribution of inflation calls for lower inflation in the large country f.

If we postulate instead that the difference in admissible inflation between the small and the large country is equal to the corresponding difference in structural inflation, i.e. $p_h^* - p_f^* = E(\theta_h - \theta_f)$, then joining a monetary union has no impact on expected inflation in the two countries as $\Omega_h = \Omega_f = 0$.

Finally, this analysis allows us to study also the properties of output

[19] More generally, if central banks' preferences between country h and country f are different, then $p_u^* = mp_h^* + (1-m)p_f^* + \frac{m(1-m)(\beta_h - \beta_f)}{m\beta_h + (1-m)\beta_f} E(\theta_h - \theta_f)$

[20] For example, if the deterministic appreciation of the real exchange rate is equal to 1% and the joining country weighs 10% in terms of GDP, the inflationary impact for the small open economy is equal to 0.9%,while the deflationary impact for the large economy will be equal to 0.1%.

stabilisation policy of a monetary union:

$$
\begin{aligned}
y^u &= \overline{y}^u + \frac{\beta}{\alpha^{u^2} + \beta} \left[\varepsilon^u - m(1-m) \left(\alpha_h - \alpha_f \right) \tau_s \right], \\
y_h^u &= \widehat{y}_r + \lambda_h + \varepsilon_h - \frac{\alpha_h \alpha^u}{\alpha^{u^2} + \beta} \varepsilon^u - \frac{\alpha_h \left(\alpha_f \alpha^u + \beta \right)}{\alpha^{u^2} + \beta} (1-m) \tau_s, \\
y_f^u &= \widehat{y}_r + \lambda_f + \varepsilon_f - \frac{\alpha_f \alpha^u}{\alpha^{u^2} + \beta} \varepsilon^u + \frac{\alpha_f \left(\alpha_h \alpha^u + \beta \right)}{\alpha^{u^2} + \beta} m \tau_s.
\end{aligned}
$$

One can see how, differently from the case of flexible exchange rates, real exchange rate shocks have real effects in the case of currency unions.

With regard to aggregate welfare, using the reduced form for inflation and output, under the hypothesis that ε_r are orthogonal to τ_s, the expected loss for the union as a whole, $E\left(L_u\right)$, takes the following form:

$$
E\left(L^u\right) = \frac{\beta}{2\left(\alpha^{u^2} + \beta\right)} \sigma_{\varepsilon^u}^2 + \frac{\beta \left(\alpha_h - \alpha_f \right)^2}{2\left(\alpha^{u^2} + \beta\right)} m^2 \left(1-m\right)^2 \sigma_\tau^2,
$$

where $\sigma_{\varepsilon^u}^2 = m^2 \sigma_{\varepsilon_h}^2 + \left(1-m\right)^2 \sigma_{\varepsilon_f}^2 + 2m\left(1-m\right) \sigma_{\varepsilon_h \varepsilon_f}$ and σ_τ^2 is the variance of the real exchange rate shock.

The above expression reveals that the expected loss of the currency union is not a function of the deterministic factors affecting the real exchange rate, but rather of the variances and covariances of shocks. The presence of a member undergoing structural change could have therefore negative welfare implications for the currency union as a whole, to the extent that this is reflected in high variances of aggregate supply shocks, $\sigma_{\varepsilon_h}^2$. This is subject, however, to an important qualification. These variances are weighted by the square of the size of each participant to the union. Thus, a relatively high variance of shocks in one country has a limited impact on the union insofar as this country is not too large. It is also interesting to note that the smaller the covariance between supply shocks, the smaller the aggregate loss. The intuition behind this result is that the less supply shocks are correlated among each other, the more they tend to offset at the union level. Finally, a

high variance of real exchange rate shocks σ_τ^2 determines a negative welfare impact on the currency union. The size of this impact will be the greater the more the participants to the common currency area differ in supply structure (i.e. different transmission mechanisms of monetary policy), as measured by the wedge $\alpha_h - \alpha_f$, and the more the two countries are similar in size.

4 Welfare implications at country level

If a currency union is formed, under the hypothesis that aggregate and real exchange rate shocks are orthogonal to each other, the respective expected loss functions for country h and f can be computed as follows:

$$E\left(L_h^u\right) = \frac{1}{2\left(\alpha^{u^2}+\beta\right)^2}\left\{g\sigma_{\epsilon_h}^2 + h\sigma_{\epsilon_f}^2 + l\sigma_\tau^2 - r\sigma_{\varepsilon_h\varepsilon_f}\right\} + \frac{\beta}{2}\Omega_h^2,$$
$$E\left(L_f^u\right) = \frac{1}{2\left(\alpha^{u^2}+\beta\right)^2}\left\{d\sigma_{\epsilon_h}^2 + e\sigma_{\epsilon_f}^2 + f\sigma_\tau^2 - v\sigma_{\varepsilon_h\varepsilon_f}\right\} + \frac{\beta}{2}\Omega_f^2,$$

where:

$d = m^2\alpha^{u^2}\left(\alpha_f^2+\beta\right) > 0,$
$e = (1-m)^2\alpha^{u^2}\beta + \left(\beta + m\alpha_h\alpha^u\right)^2 > 0,$
$f = m^2\left(\alpha_h\alpha^u+\beta\right)^2\left(\alpha_f^2+\beta\right) > 0,$
$g = m^2\alpha^{u^2}\beta + \left[\beta + (1-m)\,\alpha_f\alpha^u\right]^2 > 0,$
$h = (1-m)^2\alpha^{u^2}\left(\alpha_h^2+\beta\right) > 0,$
$l = (1-m)^2\left(\alpha_f\alpha^u+\beta\right)^2\left(\alpha_h^2+\beta\right) > 0,$
$r = 2(1-m)^2\alpha^u\left\{\beta\left[\alpha_h + m\left(\alpha_h-\alpha_f\right)\right] + \alpha_h\alpha_f\alpha^u\right\} > 0$ if $\alpha_h > \alpha_f,$
$v = 2m^2\alpha^u\left\{\beta\left[\alpha_f + (1-m)\left(\alpha_f-\alpha_h\right)\right] + \alpha_h\alpha_f\alpha^u\right\} > 0$ if $\alpha_h < \alpha_f.$

The above equations show that the expected losses in the two countries are a positive function of the variances $\sigma_{\epsilon_h}^2, \sigma_{\epsilon_f}^2, \sigma_\tau^2$. They are instead a negative function of the covariance of supply shocks, $\sigma_{\varepsilon_h\varepsilon_f}$ if the monetary transmission mechanism is the same across countries ($\alpha_h = \alpha_f$). If instead $\alpha_h < \alpha_f$ $(\alpha_h > \alpha_f)$, the welfare impact of a change in the covariance of

supply shocks is indeterminate. This means that the monetary transmission mechanism affects the impact of asymmetric supply shocks on the countries participating to a currency union. Finally, the variance of foreign supply as well as real exchange rate shocks have a greater impact on the domestic economy the smaller it is, as d and f are scaled by a factor of m^2 while h and l by a factor of $(1-m)^2$.

The expected losses of countries h and f are also an increasing function of Ω_h and Ω_f. Therefore, under the assumption that $p_h^* = p_f^*$, the expected loss is an increasing function of the deterministic change in the real exchange rate, weighted by the size of the partner country in the currency union. Under the alternative assumption that $p_h^* - p_f^* = E(\theta_h - \theta_f)$, this deterministic component has instead no impact on the two countries' welfare, as $\Omega_h = \Omega_f = 0$.

To compare the welfare of a country between the flexible and currency union regime, we take into account the positive impact that currency unions may have on potential output.[21] To this aim, we consider the social loss function $\widehat{L}_r = \frac{1}{2}(y_r - y_r^*)^2 + \frac{\beta}{2}(p_u - p_u^*)^2$, where the desired output rate y_r^* is equal to the natural rate of output in the currency union regime, $\widehat{y}_r + \lambda_r$. Then, the expected social loss is equal to $E\left(\widehat{L}_r\right) = E(L_r) + \lambda_r^2/2$ in the case of flexible exchange rates and $E\left(\widehat{L}_r^u\right) = E(L_r^u)$ in the case of a currency union. Therefore, it is welfare enhancing for a country to join, i.e. $E\left(\widehat{L}_r^u\right) < E\left(\widehat{L}_r\right)$, if the gain in potential output λ_r dominates the costs (i) of an inefficient response to domestic and foreign shocks and (ii) the inability of setting inflation at the level prevailing before monetary union (if $\Omega_r \neq 0$).

To get further insights on the role of shocks, consider the simplifying assumption that $\Omega_h = \Omega_f = 0$ and $\alpha_h = \alpha_f = \alpha$. In this case, it is optimal

[21] In this analysis for simplicity we abstract from the possibility that increased trade integration might have some effects on the cross-country correlation of shocks (see Frankel and Rose, 1998).

to form a monetary union for country h and country f, if respectively:

$$\overline{\lambda}_h > (1-m)\left[\frac{\alpha^2}{(\alpha^2+\beta)}\left(\sigma^2_{\epsilon_h}+\sigma^2_{\epsilon_f}-2\sigma_{\varepsilon_h\varepsilon_f}\right)+\left(\alpha^2+\beta\right)\sigma^2_{\tau}\right]^{1/2}>0, \quad (21)$$

$$\overline{\lambda}_f > m\left[\frac{\alpha^2}{(\alpha^2+\beta)}\left(\sigma^2_{\epsilon_h}+\sigma^2_{\epsilon_f}-2\sigma_{\varepsilon_h\varepsilon_f}\right)+\left(\alpha^2+\beta\right)\sigma^2_{\tau}\right]^{1/2}>0. \quad (22)$$

It is also useful to decompose $\sigma^2_{\epsilon_h}+\sigma^2_{\epsilon_f}-2\sigma_{\varepsilon_h\varepsilon_f}$ as the sum of $\left(\sigma_{\epsilon_h}-\sigma_{\epsilon_f}\right)^2$ and $2\left(1-\rho_{\varepsilon_h\varepsilon_f}\right)\sigma_{\varepsilon_h}\sigma_{\varepsilon_f}$, where $\rho_{\varepsilon_h\varepsilon_f}$ is defined as the correlation coefficient of supply shocks. This decomposition shows that the costs of currency unions are an increasing function of the difference in the standard deviations of supply shocks, $\sigma_{\varepsilon_h}-\sigma_{\varepsilon_h}$ and a decreasing function of the correlation coefficient, $\rho_{\varepsilon_h\varepsilon_f}$. The optimality conditions (21) and (22) hold as long as the gain in potential output, $\overline{\lambda}_r$, is sufficiently large. More specifically, $\overline{\lambda}_r$ must be the larger:

(i) the smaller the country;

(ii) the larger the difference between the standard deviations of supply shocks, $\sigma_{\varepsilon_h}-\sigma_{\varepsilon_h}$;

(iii) the smaller the correlation of supply shocks, $\rho_{\varepsilon_h\varepsilon_f}$

(iv) the larger the variance of real exchange rate shocks σ^2_{τ};

In the limit case when $\sigma^2_{\epsilon_h}=\sigma^2_{\epsilon_f}$, $\rho_{\varepsilon_h\varepsilon_f}=1$ and $\sigma^2_{\tau}=0$, the optimality condition is reduced simply to $\overline{\lambda}_r>0$.

On the other hand, countries characterised by sizeable asymmetric shocks (for example $\rho_{\varepsilon_h\varepsilon_f}=0$ and $\sigma^2_{\tau}>0$) may still benefit from joining a currency union if the potential output gain is sufficiently large.

5 Concluding remarks

This paper has assessed the role that the exchange rate regime plays in a small open economy on the basis of a two-sector, two-countries general equilibrium model incorporating explicitly the deterministic changes in the

real exchange rate, the potential output gain of joining a currency union and the role played by aggregate as well as real exchange rate shocks.

The paper has found that, if flexible exchange rates are retained, expected inflation in the small open economy does not depend on the trend appreciation of the real exchange rate, unless this is implicitly incorporated in the level of admissible inflation. At the same time, the nominal exchange rate is expected to appreciate, as a result of the intersectoral productivity growth differential, possibly reinforced by the process of convergence in tradable inflation.

The paper has also shown that if a currency union is formed, the expected loss of the common currency area does not depend on the deterministic factors affecting the real exchange rate (such as the Balassa-Samuelson effect or relative changes in consumer preferences) but only on the variance-covariance matrix of supply shocks. Moreover, if the transmission mechanisms differ among member states, the expected loss of the common currency area depends on the variance of real exchange rate shocks (i.e. intersectoral productivity, aggregate demand and purchasing power parity shocks).

Therefore, the presence of members undergoing structural change may have negative welfare implications for the common currency union to the extent this is reflected in high variances of aggregate supply and real exchange rate shocks. There is, however, an important qualification to be made. These variances are weighted by the square of the size of each participant to the union. Thus, a relatively high variance of shocks in one country has a limited impact on the union insofar as this country is not too large. The paper has also found that the smaller the covariance of aggregate supply shocks between the two countries, the smaller the aggregate loss. The intuition for this is that the less supply shocks are correlated, the more they tend to offset each other at the union level.

At the country level, the welfare implications of renouncing to an inde-

pendent monetary policy are indeterminate, as the suboptimal response to domestic and foreign shocks and the inability of setting inflation at the desired level may be more than compensated by higher potential output. This notwithstanding, it may be beneficial to join a currency union as long as the gain in potential output is sufficiently large. Under the simplifying assumption that the transmission mechanisms of monetary policy is the same between the two countries, the gain in potential output must be the larger, the smaller the country, the larger the difference between the standard deviation of supply shocks in the two participating countries, the smaller the correlation of supply shocks and the larger the variance of real exchange rate shocks. Therefore a country characterised by sizeable asymmetric shocks may still benefit from joining a currency union, if the potential output gain is sufficiently large.

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