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THE ADMISSION OF ACCESSION COUNTRIES TO AN ENLARGED MONETARY UNION: A TENTATIVE ASSESSMENT

BY MICHELE CA' ZORZI AND ROBERTO A. DE SANTIS

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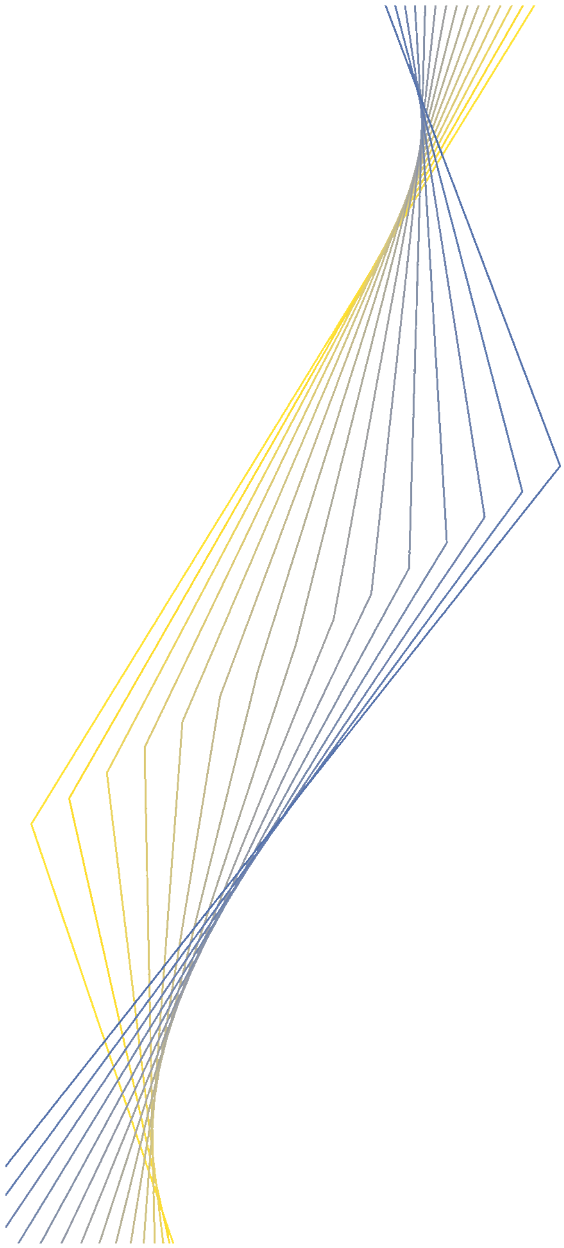

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BY MICHELE CA' ZORZI[2]
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Abstract

The enlargement of the European monetary union to include the accession countries (ACs) will not lead to higher average inflation in the enlarged euro area, but only to inflation redistribution across countries if continuity of the monetary policy framework is preserved. In the short term, unanticipated shocks to the real exchange rate may instead affect aggregate inflation if member countries' economic structure differs. When comparing welfare, inflation and output stabilisation, we find that the size, differences in economic structure and the variance-covariance matrix of supply and real exchange rate shocks play a key role. The numerical results indicate that the implications for the euro area are significant only if we assume a strong real exchange rate appreciation and if ACs are weighted in terms of purchasing power parity standards. In the event of real exchange rate or country-specific supply shocks in ACs, the consequences would be limited for both the current and the enlarged euro area, but sizeable for ACs themselves.

Keywords: Accession Countries, Balassa-Samuelson Effect, European Monetary Union, Exchange Rate Regimes, Monetary Policy.

JEL Classification Codes: E52, E58, F33, F40

Non-technical summary

This paper studies the impact of the enlargement of the European monetary union to include the accession countries (ACs) in the context of a simple modelling framework characterised by the pre-Maastricht, the Maastricht and the enlarged monetary union phases.

As one would expect, prior to adopting the Maastricht criteria steady state inflation depends on the monetary policy framework adopted. With a flexible exchange rate, steady state inflation in ACs will be higher, the less credible the monetary policy framework and the flatter the Phillips curve. In the case of a currency board regime instead, inflation is partly imported from the anchor country and partly determined by the real exchange rate appreciation process. The model is also consistent with the view that the currency board regime may be suited to countries that need to enhance the credibility of their monetary policy framework; whereas it poses a number of risks if country-specific supply shocks are thought to be likely.

In the Maastricht phase, the model assumes that the inflation requirement of the Treaty determines a radical change to the way inflationary expectations are formed, consistent with the rapid achievement of the nominal convergence objective. As a consequence of this, the process of appreciation of the real exchange rate in ACs may exert an upward pressure on the nominal exchange rate of ACs.

In the enlarged monetary union phase, the model suggests that average inflation in the enlarged euro area is not affected via the credibility channel or via the real exchange rate appreciation process, provided that the monetary policy framework is unchanged. Enlargement in this case simply results in a different distribution of inflation across countries, with a deflationary impact on the euro area.

This analytical framework is then applied to ten ACs and the euro area with the aim of simulating the impact of institutional changes and of supply and real exchange rate shocks. Several alternative scenarios are considered, in order to account for the uncertainty over the real appreciation trend in ACs and the parameter values of the model.

In the enlarged monetary union case, the main insights of the numerical simulations can be summarised as follows. The deflationary impact on the euro area is negligible, if participating countries are weighted on the basis of their nominal GDP and if the upward pressure on the equilibrium exchange rate is in line with most estimates of the Balassa Samuelson effect

(between 1.5 and 3% per annum). However, the deflationary impact is more sizeable if ACs are weighted in terms of purchasing power parity and if a stronger real exchange rate appreciation process, more in line with recent trends in ACs, is postulated.

With regard to shocks, the results depend on whether they are symmetric or country-specific. If supply shocks are symmetric, the response of inflation and output in the enlarged currency area is very similar to that of the euro area before enlargement, while the response in ACs is sensitive to the slope of the Phillips curve. In the event of country-specific shocks (i.e. supply shocks and real exchange rate shocks) in ACs, the response of inflation and output is small in the enlarged currency area but sizeable in the ACs themselves, irrespective of the slope of the Phillips curve. The welfare impact on the euro area and the ACs is nevertheless unclear. It is positive, if the variance of supply and real exchange rate shocks in ACs falls sufficiently after euro area enlargement.

1 Introduction

The timing of the enlargement of the euro area to include accession countries (ACs) has increasingly become a core policy issue. The guiding principles explicitly set out in the Treaty establishing the European Community are twofold. On the one hand, the aim is to strengthen economic cohesion through the ultimate adoption of a single currency, excluding any form of positive or negative discrimination between EU Member States (the equality of treatment principle). On the other hand, among the goals of the Community, the Treaty identifies the need to promote sustainable and non-inflationary growth, assigning the Eurosystem the primary objective of preserving price stability (the price stability principle).

Against this background, this paper should be seen as an attempt to study the impact of accession on inflation and output within a simple modelling framework referring to the standard time inconsistency literature initiated by Kydland and Prescott (1977), Barro and Gordon (1983), and Rogoff (1985), and recently applied to the case of currency unions by Lane (2000), Alesina and Barro (2002), Berger (2002) and Gros and Hefeker (2002).[1] This burgeoning literature provides a simple structure to encompass the Eurosystem and the ACs in one unique modelling framework.[2]

For the Eurosystem, one could alternatively refer to another set of papers which interpret the mandate of the central banker as a quantitative contract, linking performance with incentives (Walsh, 1995; Svenson, 1997).[3] However, this latter assumption seems somewhat tenuous, as it would require the Euro-

[1] As in the papers by Lane (2000), Alesina and Barro (2002), Berger (2002) and Gross and Hefeker (2002) we have adopted a static approach. It should be noted, however, that Clarida, Gali and Gertler (1999) have shown how to extend the single-country discretionary case with rational expectation to a dynamic framework maintaining the typical results of the Barro-Gordon setting. The model becomes more complex due the persistence parameter of the AR(1) process, which characterises the supply shocks.

[2] In particular, Berger (2002) investigates the euro area enlargement issue in a political economy setting and discusses institutional reforms scenarios.

[3] For a detailed survey of the literature see Persson and Tabellini (1999).

pean Central Bank (ECB) to be the agent and the governments, parliaments and institutions of the European Union to be the principal (Bean, 1998).[4]

For the ACs, recent econometric studies also seem to provide some support for using a time inconsistency approach to analyse economic developments. For example, it has been shown that a positive relationship exists between transition countries' inflation and distortions (Maliszewski, 2000). Other studies have placed greater emphasis on the role of the central banks' preferences, showing that a negative relationship between inflation and central bank independence holds not only for industrialised countries (Grilli et al., 1991; Cukierman, 1992; Alesina and Summers, 1993), but also for transition economies (Loungani and Sheets, 1997; Cottarelli et al, 1998; Maliszewski, 2000; Neyapti, 2001; Cukierman, et al., 2002).

To examine the enlargement issue, we have chosen a rather general specification to allow for differences in the countries' economic structures. It generalises Lane (2000), Alesina and Barro (2002) and Berger (2002), by allowing both the cost of inflation relative to that of output and the slope of the Phillips curves to differ between member countries. Moreover, it introduces a deterministic and a stochastic component to the real exchange rate of ACs *vis-à-vis* the euro area in order to be consistent with the empirical and theoretical finding that ACs' currencies are likely to appreciate as a result of the catching-up process (Grafe and Wyplosz, 1997; De Broeck and Slok, 2001; Frait and Komarek, 2001).

In this paper, we consider the euro area and $n-1$ ACs, and three distinct phases: the pre-Maastricht phase, the Maastricht phase and the enlarged mon-

[4] Although the ECB is not goal independent, because its primary objective is mandated by the Treaty, the quantitative definition of price stability was decided by the Governing Council of the ECB in October 1998 (Issing, 2001). Furthermore, Blinder (2000), by using a questionnaire-study answered by 84 central bank economists and 53 academics, found that incentive-compatible contracts are rated as least important by both central banks and economists to build credibility. Rather, they rate a track record for honesty and inflation aversion, together with central bank independence, to be the most important methods for enhancing credibility and fighting inflation.

etary union phase.

In the pre-Maastricht phase, steady state inflation in ACs depends on the monetary policy framework. With a flexible exchange rate, steady state inflation will be higher, the less credible the monetary policy framework and the flatter the Phillips curve. With a currency board regime, inflation is partly imported from the anchor country and partly determined by the process of real exchange rate appreciation. A priori it is not possible therefore to say whether inflation is higher with a flexible exchange rate or under a currency board regime.

In the Maastricht phase, the inflation requirement of the Treaty determines a radical change to the way inflationary expectations are formed, consistent with the rapid achievement of the nominal convergence objective. The real exchange rate appreciation process may, however, exert upward pressure on the nominal exchange rate.

Finally, in the enlarged monetary union phase, steady-state inflation is not affected by the real convergence process for the following two reasons. First, the real convergence process does not have an inflationary impact via the credibility channel, provided that continuity of the monetary policy framework is preserved. Second, the real exchange rate appreciation of ACs' currencies has no impact on aggregate inflation, and instead simply determines a redistribution of inflation across the participating countries. In the short term, unanticipated shocks to the real exchange rate may instead affect aggregate inflation if member countries' economic structures differ.

We also examine the different impacts on inflation and output of each exchange rate regime in response to supply and real exchange rates shocks and compute the loss for each country. When comparing welfare, inflation and output stabilisation between the currency union and the other exchange rate regimes, we find that the size, supply structure and variance-covariance matrix of supply and real exchange rate shocks play a crucial role. This comparison, however, is not straightforward as changing the exchange rate regime not only modifies the monetary policy framework, but it may affect the parameter values and the variance of shocks. The issue of endogeneity is partly captured by the model, as the various phases, pre-Maastricht, Maastricht and monetary union, are characterised by the different behaviour of inflation and output.

To carry out a quantitative assessment, we apply the model to ten central and eastern European ACs and the euro area. The results seem to indicate that the impact on euro area steady-state inflation is negligible if participating countries are weighted on the basis of their GDP in national currency and if the upward pressure on the equilibrium real exchange rate is limited. However, the deflationary impact on the euro area is more sizeable if we assume a strong real exchange rate appreciation and if ACs are weighted in terms of purchasing power parity (PPP).

With regard to shocks, the results depend on whether they are symmetric or country-specific. If supply shocks are symmetric, the response of inflation and output in the enlarged currency area is very similar to that of the euro area before enlargement, while the response in ACs is sensitive to the slope of the Phillips curve. If shocks are country-specific (i.e. supply shocks and real exchange rate shocks) in ACs, the response of inflation and output is small in the enlarged currency area but sizeable in the ACs themselves, irrespective of the slope of the Phillips curve. The welfare impact on the euro area and the ACs is nevertheless unclear. It is positive, if the variance of supply and real exchange rate shocks in ACs falls sufficiently after euro area enlargement.

The remaining sections of the paper have been structured as follows: Sections 2, 3 and 4 describe the model for ACs and the euro area; Section 5 examines the consequences of the Maastricht phase; Section 6 explores the consequences of the enlargement of the euro area from both the point of view of the ACs and the euro area; Section 7 investigates the implications for welfare and the variance of both inflation and output. Section 8 presents the benchmark of the model, and simulates the impact of institutional changes as well as of supply and real exchange rate shocks; finally, Section 9 provides the main conclusions and discusses the scope for future research.

2 Inflation and output with independent monetary policies

Consider a static n-country Barro-Gordon (1983) model, defined by a set (a=1....n-1) of ACs, and the euro area n. The objective function of the central bank in each country (i=1....n) is based upon the assumption that monetary authorities dislike departures of actual output and inflation from their respective optimal values.[5] Thus, they minimise a quadratic loss function of the following type:

$$L_i = \frac{1}{2} E\left[(y_i - y_i^*)^2 + \beta_i (\pi_i - \pi_i^*)^2 \right], \tag{1}$$

where y_i denotes actual output, y_i^* desired output, π_i actual inflation, π_i^* the bliss point and β_i weights the cost of inflation relative to that of output.

Define $\kappa_i \geq 0$ as the degree of distortions, market imperfections or technological gap that prevents countries from achieving their maximum potential convergence *vis-à-vis* the euro area (Beetsma and Jensen, 1999; and Berger, 2002). This parameter in the present framework will be referred to as the 'convergence gap'. We assume that the difference between desired output, y_i^*, and the natural rate, $\overline{y}_i$, is a fraction ϕ_i of the convergence gap, κ_i, where the coefficient $0 \leq \phi_i \leq 1$ measures to what extent monetary authorities wish to converge faster than the natural rate would allow for. In the extreme cases, if $\phi_i = 0$, the convergence gap does not have any influence on the monetary policy decision making process, so that $y_i^* = \overline{y}_i$; if on the contrary $\phi_i = 1$, the conver-

[5] This loss function, which is taken from standard monetary economics literature, is only a modelling approximation to the euro area framework and is not meant to be an accurate characterisation for the objective function of the Governing Council of the ECB, which focuses on price stability over the medium term.

gence gap entirely feeds into the monetary policy response, i.e. $y_i^* = \overline{y}_i + \kappa_i$. In the case of the euro area, we assume that $\phi_n = \kappa_n = 0$; thus, $y_n^* = \overline{y}_n$ holds always.

On the supply side, the deviation of output from its natural level, $\overline{y}_i$, is positively related to unanticipated inflation:

$$y_i = \overline{y}_i + \alpha_i \left(\pi_i - \pi_i^e\right) + \varepsilon_i \tag{2}$$

where α_i denotes the output elasticity to inflation surprises or the inverse of the slope of the Phillips curve and $\varepsilon_i \sim IID\left(0, \sigma_{\varepsilon_a}^2\right)$ is a white noise.

Events unfold as follows: the private sector forms expectations on prices, conditionally on the information available at that time. The output shock is realised and, finally, monetary policy is set. Monetary authorities, therefore, dispose of an informational advantage with respect to private agents. The game is solved by backward induction. Since y_a^* is higher than the natural rate $\overline{y}_a$, the standard time-inconsistency problem of monetary policy arises.

Monetary authorities minimise the objective function (1) subject to (2). Replacing (2) and y_i^* in (1) and differentiating with respect to π_i determines the reaction function of the central bank as a function of inflationary expectations:

$$\pi_i = \pi_i^* + \frac{\alpha_i^2}{\alpha_i^2 + \beta_i}\pi_i^e + \frac{\alpha_i}{\alpha_i^2 + \beta_i}\phi_i\kappa_i - \frac{\alpha_i}{\alpha_i^2 + \beta_i}\varepsilon_i. \tag{3}$$

By imposing rational expectations ($\pi_i = \pi_i^e$) on (3) yields the inflationary expectation of the private sector:

$$\pi_i^e = \pi_i^* + \frac{\alpha_i}{\beta_i}\phi_i\kappa_i, \tag{4}$$

which in turn replaced in (3) yields realised inflation:

$$\pi_i = \pi_i^* + \frac{\alpha_i}{\beta_i}\phi_i\kappa_i - \frac{\alpha_i}{\alpha_i^2 + \beta_i}\varepsilon_i, \tag{5}$$

while the inflation variance is equal to $\sigma^2_{\pi_i} = \left(\frac{\alpha_i}{\alpha_i^2+\beta_i}\right)^2 \sigma^2_{\varepsilon_i}$.

The standard equilibrium outcome (5) states that under discretion, the private sector correctly anticipates the deterministic level of inflation. If $\phi_a > 0$, average inflation in ACs will be an increasing function of both the flatness of the Phillips curve and the convergence gap parameter, and a decreasing function of the cost of inflation relative to that of output. Conversely, if $\phi_a = 0$, average inflation will be equal to π_i^* irrespective of the value of β_i. In other words, the establishment of a credible monetary policy, not aiming at output objectives above the natural rate, breaks the link between expected inflation and the variance of inflation.

To derive *ex post* output, replace (4) and (5) in (2). Then,

$$y_i = \overline{y}_i + \frac{\beta_i}{\alpha_i^2 + \beta_i}\varepsilon_i,$$

while the output variance is equal to: $\sigma^2_{y_i} = \left(\frac{\beta_i}{\alpha_i^2+\beta_i}\right)^2 \sigma^2_{\varepsilon_i}$.

Substituting inflation and output into equation (1) we find the following standard expression:

$$L_i = \frac{\left(\alpha_i^2 + \beta_i\right)}{2\beta_i}\phi_i^2 k_i^2 + \frac{\beta_i}{2\left(\alpha_i^2 + \beta_i\right)}\sigma^2_{\varepsilon_i}. \tag{6}$$

3 Inflation differentials

Given (5), the inflation differential between ACs and the euro area is:

$$\pi_a - \pi_n = \pi_a^* - \pi_n^* + \frac{\alpha_a}{\beta_a}\phi_a\kappa_a - \frac{\alpha_a}{\alpha_a^2 + \beta_a}\varepsilon_a + \frac{\alpha_n}{\alpha_n^2 + \beta_n}\varepsilon_n. \tag{7}$$

In steady state the inflation differential between ACs and the euro area is wider the larger the difference between π_a^* and π_n^* and the more the convergence gap translates into higher inflation $\alpha_a\phi_a\kappa_a/\beta_a$.

The analysis also allows us to get an insight on what are the determinants of the nominal exchange rate. Let us assume that the real exchange rate of the euro *vis-à-vis* ACs' set of currencies is determined by factors exogenous to the model.[6] Although this restriction is not a necessary feature of the model, both theoretical and empirical considerations suggest that, owing to the catching up process, ACs' currency are bound to appreciate in real terms (Grafe and Wyplosz, 1997; De Broeck and Slok, 2001; Frait and Komarek, 2001; Halpern and Wyploz, 2001; Kovacs, 2002).[7] The nominal depreciation of ACs' currencies *vis-à-vis* the euro, defined as $\widehat{e}_a = \pi_a - \pi_n + q_a + \eta_a$, is therefore equal to

$$\widehat{e}_a = \pi_a^* - \pi_n^* + \frac{\alpha_a}{\beta_a}\phi_a\kappa_a + q_a - \frac{\alpha_a}{\alpha_a^2 + \beta_a}\varepsilon_a + \frac{\alpha_n}{\alpha_n^2 + \beta_n}\varepsilon_n + \eta_a,$$

where $q_a < 0$ is the deterministic component of the real exchange rate appreciation of ACs and η_a is a shock to the real exchange rate with zero mean and constant variance. In other words, ACs' currencies are expected to depreciate, whenever the steady-state inflation differential is larger than the real exchange rate appreciation, which is due to the catching-up process.

How can ACs reduce the inflation differential in the pre-Maastricht phase? As suggested by (7), one way to reduce the inflation differential is through structural adjustments, by progressively reducing the convergence gap *vis-à-vis* the euro area. This process, although ongoing, would likely require a considerable number of years to fully play out particularly in the light of the remaining technological gap and the greater distortions in the product and factor markets. These factors would, however, not be an absolute impediment to nominal convergence. In fact, an increase in β_a would allow the monetary

[6] Alesina and Barro (2002) generalise the one good model to allow countries to produce different market baskets of final goods by introducing a random error term, which was taken to be serially independent with zero mean and constant variance and to be distributed independently of countries' supply shocks.

[7] Whenever countries successfully catch up, productivity growth tends to be higher in the tradable 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-a-vis trading partners (Balassa, 1964; Samuelson, 1964).

authorities to reduce average inflation, although at some costs in terms of output stabilisation. To mitigate these costs, the best way forward is to continue improving the monetary policy framework, as is taking place in several ACs, by reducing ϕ_a. As we will see in Section 7, the reduction of ϕ_a has also positive implications in the enlargement phase for the euro area as a whole.

4 Pure currency boards in ACs

Bulgaria, Estonia and Lithuania have all adopted currency board regimes. How will the dynamics of inflation and output be affected in this case? By fixing the exchange rate, $\pi_a^{CB} = \pi_n - q_a - \eta_a$, and by using (5) to determine π_n, the inflation rate in AC's becomes equal to:

$$\pi_a^{CB} = \pi_n^* - \frac{\alpha_n}{\alpha_n^2 + \beta_n}\varepsilon_n - q_a - \eta_a. \tag{8}$$

Under a currency board, inflation in ACs depends on both the impact of shocks affecting the euro area and on real exchange rate movements determined by the catching-up process. Note that inflation no longer depends on shocks affecting ACs, because a pure currency board implicitly prevents the monetary authorities from stabilising them. The output equation becomes in fact the following:

$$y_a^{CB} = \bar{y}_a + \varepsilon_a - \frac{\alpha_a \alpha_n}{\alpha_n^2 + \beta_n}\varepsilon_n - \alpha_a \eta_a \tag{9}$$

If supply shocks are symmetric and $\alpha_a = \alpha_n$, the impact on inflation and output is the same as for the euro area. If supply shocks are country-specific to ACs, inflation would remain unchanged and the impact on output would be equal to the size of the shock, ε_a.

Foreign shocks may also have sizeable effects on the domestic economy. This can be seen for example by the positive relationship between the variances of inflation and output in the ACs and the variance of supply shocks in the euro area, $\sigma^2_{\varepsilon_n}$:

$$\sigma^2_{\pi_a^{CB}} = \left(\frac{\alpha_n}{\alpha_n^2+\beta_n}\right)^2 \sigma^2_{\varepsilon_n} + \sigma^2_{\eta_a} + 2\frac{\alpha_n}{\alpha_n^2+\beta_n}\sigma_{(\varepsilon_n,\eta_a)},$$

$$\begin{aligned} \sigma^2_{y_a^{CB}} &= \sigma^2_{\varepsilon_a} + \left(\frac{\alpha_a\alpha_n}{\alpha_n^2+\beta_n}\right)^2 \sigma^2_{\varepsilon_n} + \alpha_a^2\sigma^2_{\eta_a} - \frac{2\alpha_a\alpha_n}{\alpha_n^2+\beta_n}\sigma_{(\varepsilon_a,\varepsilon_n)} - \\ &\quad 2\alpha_a\sigma_{(\varepsilon_a,\eta_a)} + \frac{2\alpha_a^2\alpha_n}{\alpha_n^2+\beta_n}\sigma_{(\varepsilon_n,\eta_a)}. \end{aligned}$$

Another interesting aspect is that, a priori at least, it is not possible to say whether inflation is lower under a currency board regime or under flexible exchange rates.[8] Average inflation under the currency board regime (8) is lower than that under the flexible exchange rate regime (5) if the real exchange rate pressure is sufficiently contained, in other words if $-q_a < \pi_a^* - \pi_n^* + \alpha_a\phi_a\kappa_a/\beta_a$. This regime therefore appears particularly suited to countries that need to enhance the credibility of their monetary policy framework; whereas it poses a number of risks if country-specific supply or real exchange rate shocks are thought to be likely.

Substituting inflation and output, as determined by (8) and (9), we find that the loss under the currency board regime is equal to:

$$\begin{aligned} L_a^{CB} &= \frac{\phi_a^2 k_a^2}{2} + \frac{\beta_a}{2}\left(\pi_a^* - \pi_n^* + q_a\right)^2 + \frac{1}{2}\sigma^2_{\varepsilon_a} + \frac{\alpha_n^2\left(\alpha_a^2+\beta_a\right)}{2\left(\alpha_n^2+\beta_n\right)^2}\sigma^2_{\varepsilon_n} + \frac{\left(\alpha_a^2+\beta_a\right)}{2}\sigma^2_{\eta_a} - \\ &\quad -\frac{\alpha_a\alpha_n}{\alpha_n^2+\beta_n}\sigma_{(\varepsilon_a,\varepsilon_n)} - \alpha_a\sigma_{(\varepsilon_a,\eta_a)} + \frac{\alpha_n\left(\alpha_a^2+\beta_a\right)}{\left(\alpha_n^2+\beta_n\right)^2}\sigma_{(\varepsilon_n,\eta_a)}, \end{aligned}$$

which corresponds to the expression in Alesina and Barro (2002) if $\alpha_a = \alpha_n$, $\beta_a = \beta_n$ and $q_a = \phi_a = 0$.[9]

[8] Cukierman, et al. (2002) found evidence that transition economies with currency boards do not necessarely post lower inflation rates.

[9] Note that in Alesina and Barro (2002) the loss is also a function of seignorage revenues. This latter aspect is outside the scope of this paper.

5 The Maastricht phase

Following EU accession, the new member states will participate in the EU coordination of economic policies and, to the extent to which they have reached a sustainable level of convergence, will join the euro area provided they satisfy the criteria set out in the Maastricht Treaty.[10] The implications of the Maastricht criteria on inflation and output can be seen in the light of the present modelling framework. It assumes that the policy makers decide to proceed with a rapid process of nominal convergence to bring the inflation differential down to the level required by Maastricht, π_λ. Likewise the present modelling framework assumes that this pre-announcement is fully credible, as the pay off is judged by the authorities to be sufficiently high. Then, $\pi_a^M = \pi_n + \pi_\lambda$. By using (5) to determine π_n, inflation and output in ACs reduce respectively to:

$$\pi_a^M = \pi_n^* - \frac{\alpha_n}{\alpha_n^2 + \beta_n}\varepsilon_n + \pi_\lambda, \tag{10}$$

$$y_a^M = \bar{y}_a + \varepsilon_a - \frac{\alpha_a \alpha_n}{\alpha_n^2 + \beta_n}\varepsilon_n. \tag{11}$$

Examining finally what determines the nominal exchange rate appreciation, we find that:

$$\widehat{e}_a^M = q_a + \pi_\lambda + \eta_a.$$

While the inflation criterion is by assumption satisfied, there would be some upward pressure on the nominal exchange rate if $-(q_a + \eta_a) > \pi_\lambda$, which would have to be dealt with in the context of the exchange rate mechanism. It is useful contrasting this result to the currency board solution (8). In the latter case, it is the inflation criterion that is not satisfied when $-(q_a + \eta_a) > \pi_\lambda$.

[10] This institutional framework was re-iterated on a number of occasions by the President and Governing Council Board Members of the ECB. See for example: Central Banking (2001), *Interview: Otmar Issing*, vol. 11, pp. 28-29.

It can easily be shown that in the case of Maastricht supply shocks are stabilised in the same way as for currency boards. However, the variances of inflation and output differ, as in the case of Maastricht the nominal exchange rate absorbs real exchange rate shocks:[11]

$$\sigma^2_{\pi_a^M} = \left(\frac{\alpha_n}{\alpha_n^2 + \beta_n}\right)^2 \sigma^2_{\varepsilon_n}$$

$$\sigma^2_{y_a^M} = \sigma^2_{\varepsilon_a} + \left(\frac{\alpha_a \alpha_n}{\alpha_n^2 + \beta_n}\right)^2 \sigma^2_{\varepsilon_n} - \frac{2\alpha_a \alpha_n}{\alpha_n^2 + \beta_n} \sigma_{(\varepsilon_a, \varepsilon_n)}$$

With inflation and output determined by (10) and (11), the loss under Maastricht can be written as:

$$L_a^M = \frac{\phi_a^2 k_a^2}{2} + \frac{\beta_a}{2} \left(\pi_a^* - \pi_n^* - \pi_\lambda\right)^2 + \frac{1}{2}\sigma^2_{\varepsilon_a} + \frac{\alpha_n^2 \left(\alpha_a^2 + \beta_a\right)}{2\left(\alpha_n^2 + \beta_n\right)^2} \sigma^2_{\varepsilon_n} - \frac{\alpha_a \alpha_n}{\alpha_n^2 + \beta_n} \sigma_{(\varepsilon_a, \varepsilon_n)}.$$

6 The enlargement phase

We now turn to consider the case where ACs join monetary union, with the objective of monetary policy being represented by:

$$L_u = \frac{1}{2} E\left[\left(y_u - y_u^*\right)^2 + \beta_u \left(\pi_u - \pi_u^*\right)^2\right]. \tag{12}$$

Inflation, actual output and the natural output in the enlarged currency union with n countries are expressed as a weighted average between the amounts of respective inflation and output rates in the euro area and in the ACs: $\pi_u = \sum \varphi_i \pi_i$, $y_u = \sum \varphi_i y_i$ and $\overline{y}_u = \sum \varphi_i \overline{y}_i$, where the weights φ_i are interpreted as the size of country i relative to the enlarged currency area. The inflation differential between any AC and the euro area is equal to the sum of the deterministic and stochastic components of the real exchange rate appre-

[11] This section does not fully account for the implications of the exchange rate mechanism which only allows some degree of exchange rate flexibility.

ciation: $\pi_a^U - \pi_n^U = -\left(q_a + \eta_a\right)$.

Likewise the difference between desired output and the natural rate is defined as $y_u^* - \overline{y}_u = \phi_u \kappa_u$. The timing of events is unchanged and the game is solved as before. Replacing π_u, y_u and y_u^* into (12) and differentiating it with respect to a common inflation rate π_n^U determines the reaction function of the central bank as 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:

$$\pi_u = \pi_u^* + \frac{\alpha_u \phi_u \kappa_u}{\beta_u} - \frac{\alpha_u}{\alpha_u^2 + \beta_u}\left[\sum_i \varphi_i \varepsilon_i + \sum_a \left(\alpha_a - \alpha_u\right)\varphi_a \eta_a\right], \qquad (13)$$

$$\begin{aligned} \pi_n^U &= \pi_u^* + \frac{\alpha_u \phi_u \kappa_u}{\beta_u} + \sum_a \varphi_a q_a - \frac{\alpha_u}{\alpha_u^2 + \beta_u}\sum_i \varphi_i \varepsilon_i + \qquad (14) \\ &\quad + \frac{1}{\alpha_u^2 + \beta_u}\sum_a \left(\beta_u + \alpha_a \alpha_u\right)\varphi_a \eta_a, \end{aligned}$$

$$\begin{aligned} \pi_a^U &= \pi_u^* + \frac{\alpha_u \phi_u \kappa_u}{\beta_u} - q_a + \sum_a \varphi_a q_a - \frac{\alpha_u}{\alpha_u^2 + \beta_u}\sum_i \varphi_i \varepsilon_i + \qquad (15) \\ &\quad - \eta_a + \frac{1}{\alpha_u^2 + \beta_u}\sum_a \left(\beta_u + \alpha_a \alpha_u\right)\varphi_a \eta_a, \end{aligned}$$

where $\alpha_u = \sum \varphi_i \alpha_i$.

Provided that the ACs' real convergence objective does not influence monetary policy, i.e. $\phi_a \kappa_a = \phi_u \kappa_u = 0$, the monetary policy framework remains invariant (namely, $y_u^* = \overline{y}_u$) and expected inflation at the steady state is $\pi_u^e = \pi_u^*$. It is also noticeable that expected inflation in the enlarged currency area is not affected by anticipated developments in the real exchange rates of ACs' currencies. However, inflation is affected by real exchange rate shocks if $\alpha_a \neq \alpha_u$. To be more precise, a positive shock to η_a would have a positive (negative) impact on inflation if the slopes of the Phillips curves of ACs are on average flatter (steeper) relative to the euro area.

To highlight any potential effect of a departure from the current monetary policy framework in the euro area, we also examine an additional case, whereby monetary policy in the enlarged euro area would account for the desire of ACs to converge in real terms. In this case, $y_u^* = \varphi_n \overline{y}_n + \sum \varphi_a y_a^*$. As a corollary, it can easily be shown that $\phi_u \kappa_u = \sum \phi_a \kappa_a$, which would imply a positive inflation bias, potentially threatening the price stability mandate (see (13)). It also highlights how ACs, by improving the monetary policy framework and bringing ϕ_a to zero would neutralise the potential inflationary impact on the enlarged euro area.

In addition to the impact on average inflation, this framework also allows us to get an insight on the distribution of inflation. Average inflation will be higher in ACs than in the original euro area, following the assumption that ACs are characterised by an appreciating trend $-q_a$. Inflation will be obviously higher in those ACs appreciating the most relative to the average appreciation of the region, $-\sum_a \varphi_a q_a$.

Ex post output in the euro area and ACs is represented by the following set of equations:

$$y_u = \overline{y}_u + \frac{\beta_u}{\alpha_u^2 + \beta_u} \sum_i \varphi_i \varepsilon_i - \frac{\beta_u}{\alpha_u^2 + \beta_u} \sum_a (\alpha_a - \alpha_u) \varphi_a \eta_a,$$

$$y_n^U = \overline{y}_n + \varepsilon_n - \alpha_n \frac{\alpha_u}{\alpha_u^2 + \beta_u} \sum_i \varphi_i \varepsilon_i + \frac{\alpha_n}{\alpha_u^2 + \beta_u} \sum_a (\beta_u + \alpha_a \alpha_u) \varphi_a \eta_a,$$

$$y_a^U = \overline{y}_a + \varepsilon_a - \alpha_a \frac{\alpha_u}{\alpha_u^2 + \beta_u} \sum_i \varphi_i \varepsilon_i - \alpha_a \eta_a + \frac{\alpha_a}{\alpha_u^2 + \beta_u} \sum_a (\beta_u + \alpha_a \alpha_u) \varphi_a \eta_a.$$

The equations derived for inflation and output suggest the following. Say φ_a is a small number. Then the impact of a country-specific shocks, ε_a, is almost entirely reflected in terms of changes in the output of country a. A real exchange rate shock, η_a, has sizeable effects in country a, with inflation and output moving in the same direction. It is interesting to note, how, both types of shocks have a limited impact on the euro area. Conversely if a shock takes place in the euro area, ε_n, the effects on ACs are sizeable.

7 Variance of inflation and output, and welfare in an enlarged monetary union

Given the closed form solutions calculated in the previous section, it is relatively straightforward to derive the variances of inflation and output in the enlarged euro area:

$$\sigma^2_{\pi_u} = \left(\frac{\alpha_u}{\alpha_u^2 + \beta_u}\right)^2 (\Omega + \Phi),$$

$$\sigma^2_{y_u} = \left(\frac{\beta_u}{\alpha_u^2 + \beta_u}\right)^2 (\Omega + \Phi),$$

where $\Omega = \sum_i \varphi_i^2 \sigma^2_{\varepsilon_i} + \sum_a \left[(\alpha_a - \alpha_u)\varphi_a\right]^2 \sigma^2_{\eta_a}$ and $\Phi = 2\sum_{i \neq j} \varphi_i \varphi_j \sigma_{(\varepsilon_i, \varepsilon_j)} + 2\sum_{a \neq b} (\alpha_a - \alpha_u)(\alpha_b - \alpha_u) \varphi_a \varphi_b \sigma_{(\eta_a, \eta_b)} + \sum_i \sum_a \varphi_i (\alpha_a - \alpha_u) \varphi_a \sigma_{(\varepsilon_i, \eta_a)}$.

Moreover, assuming that $\phi_u = 0$, the loss for the enlarged euro area takes a similar form:

$$L_u|_{\phi_u = 0} = \frac{\beta_u}{2(\alpha_u^2 + \beta_u)} (\Omega + \Phi). \tag{17}$$

Therefore, the loss and the variance of inflation and output depend on the following factors. First, they are a positive function of the variances of supply shocks in each member countries. These variances, however, are weighted by the 'square' of the share of the size of each participant to the union. A relatively high variance of shocks in one country may therefore have a limited impact on the union insofar as this country is not too large.[12] Second, the loss and the variance of inflation and output depend positively on the degree

[12] The strength of the impact thus depends on whether $\sum \varphi_a^2 \sigma^2_{\varepsilon_a}$ is high relative to $(1 - \sum \varphi_a)^2 \sigma^2_{\varepsilon_n}$.

of correlation between supply shocks, $\sigma_{(\varepsilon_a,\varepsilon_n)}$. This is quite intuitive as the more closely supply shocks are correlated, the less they are likely to offset each other. Third, they are an increasing function of the variance of the real exchange rate of ACs *vis-à-vis* the euro area, $\sigma^2_{\eta_a}$. The impact will be greater the more the participants to the common currency area differ in supply structure, as measured by the wedge $\alpha_a - \alpha_u$. In the specific case where the slope of the aggregate supply is identical across all the members participating in the monetary union $\alpha_n = \alpha_a$, the loss and the variance of inflation and output are not affected in any way by the stochastic fluctuations of the real exchange rates. Fourth, they depend on $\sigma_{(\eta_a,\eta_b)}$ and $\sigma_{(\varepsilon_i,\eta_a)}$.

It is also possible to calculate the loss functions at a country level, though these expressions turn out to be rather cumbersome. To get some insights nonetheless, we simplify the model by assuming that ACs are part of a homogenous region s, and that the covariance between supply and real exchange rate shocks is zero.[13] In this case,

$$L^s_n|_{\Phi=0} = \frac{\beta_n}{2}\left[\pi^*_n - \pi^*_u\right]^2 + \frac{\varphi^2_a\beta_n}{2}q^2_a + \frac{1}{2\left(\alpha^2_u + \beta_u\right)^2}\left\{d\sigma^2_{\epsilon_a} + e\sigma^2_{\epsilon_n} + f\sigma^2_{\eta_a}\right\},$$

$$L^s_a|_{\Phi=0} = \frac{\beta_a}{2}\left[\pi^*_a - \pi^*_u\right]^2 + \frac{\left(1-\varphi_a\right)^2\beta_a}{2}q^2_a + \frac{1}{2\left(\alpha^2_u + \beta_u\right)^2}\left\{g\sigma^2_{\epsilon_a} + h\sigma^2_{\epsilon_n} + l\sigma^2_{\eta_a}\right\},$$

where $d = \varphi^2_a\alpha^2_u\left(\alpha^2_n + \beta_n\right)$, $e = \left(1-\varphi_a\right)^2\alpha^2_u\beta_n + \left(\beta_u + \varphi_a\alpha_a\alpha_u\right)^2$,
$f = \varphi^2_a\left(\alpha_a\alpha_u + \beta_u\right)^2\left(\beta_n + \alpha^2_n\right)$, $g = \varphi^2_a\alpha^2_u\beta_a + \left[\beta_u + \left(1-\varphi_a\right)\alpha_n\alpha_u\right]^2$,
$h = \left(1-\varphi_a\right)^2\alpha^2_u\left(\alpha^2_a + \beta_a\right)$, $l = \left(1-\varphi_a\right)^2\left(\alpha_n\alpha_u + \beta_u\right)^2\left(\beta_a + \alpha^2_a\right)$.

These two expressions show that foreign supply shocks and real exchange rate shocks have a greater impact the smaller the region, as d and f are scaled by a factor of φ^2_a, while h and l are scaled by a factor of $\left(1-\varphi_a\right)^2$.

[13] Being part of an homogeneous region is equivalent to assuming that shocks in each AC have the same variance and are perfectly correlated with the corresponding shock in the remaining countries in the region.

This suggests that, in the event of supply and real exchange rate shocks, the ACs bear most of the effects. It is worthwhile to emphasise, however, that it is not straightforward to compare the regional losses before and after monetary union. There is an endogeneity issue, given that when a country joins a monetary union, the variances of the real exchange rate and of supply shocks are likely to fall.

8 A numerical exercise

The analytical framework developed in the previous section is applied to ten ACs and the euro area with the aim of simulating the impact of institutional changes and of supply and real exchange rate shocks. The analysis aims at providing an insight on the size of the impacts of various alternative scenarios.

8.1 The benchmark

Table 1 shows the benchmark dataset, which constitutes a baseline from which we depart to account for the uncertainty over the parameter values.[14] We compiled quarterly data from 1997 (or when available) until 2001. For GDP we have used quarterly data from a variety of sources, including national, Eurostat and OECD. In the case of Romania, the quarterly series were too short and therefore we opted for annual data. As for prices, we have used Eurostat HICP series that have come recently available, while for the nominal exchange rate series we have employed ECB sources.

[Insert Table 1, here]

Our aim was to get the best possible snapshot of the present situation, while attempting to exclude cyclical factors. There is clearly a trade off. The

[14] Amongst ACs we excluded Cyprus and Malta owing to a lack of recent data; however the results of the simulation analysis would be affected only marginally, as the size of both economies is indeed very small.

longer the time span considered, the more one underestimates the impact that in the last decade structural reforms and recent changes in the monetary policy framework of ACs have had. The shorter the time span, the more one runs into potential distortions of the results due to changes in cyclical conditions. We have therefore opted for a compromise solution, by computing averages that exclude data before 1997 and applying in some cases a limited degree of judgmental assessment.

We decided to exclude data before 1997, since before then ACs experienced a sizeable fall in output while inflation stood at relatively high levels. Both these aspects do not seem very representative of the current situation, as the initial phase of restructuring is over, while the monetary policy framework of many countries has changed remarkably since then.

Taking averages over those 5 years gives a first representation of where we stand today. This sample period was on the whole rather balanced as it was characterised by relatively low growth at the beginning, by very strong growth between 1999 and 2000 and lower growth in 2001.[15] However, the 5 years of quarterly observations would provide a distorted picture due to prolonged downturns in the Czech Republic and Romania. In those cases and in the case of Bulgaria, we have restricted the sample period to make the benchmark more representative.[16] This procedure is clearly rough; and it is also clear that the accession is a dynamic process whereby the parameters of the model may continue to change. Therefore the benchmark is only a starting point and various alternative scenarios must be considered to get an insight of the magnitude of the effects.

[15] For selected countries, there have been attempts to estimate trend growth on the basis of standard econometric methodologies, although the short-time series and structural change objections still apply.

[16] In the case of the Czech Republic and Romania, we have restricted the sample for GDP to 2000 and 2001. Before that date, Romania experienced a strong recession, while the Czech Republic experienced a banking crisis and a prolonged slowdown. In the case of Bulgaria, although the currency board was introduced in July 1997, very high inflation persisted for almost one year longer. To get a representative trend for the dynamics of output and inflation in this country, we have considered data starting from the third quarter of 1998.

The first two columns report average inflation and output growth of ACs over the above discussed sample period. For the reasons explained above we interpret these numbers as expected inflation and the natural rate of output respectively, which are needed to compute β_a and κ_a. In the third column we report κ_a. This measure is proxied by taking the difference between the growth rate which would allow a rapid convergence and the natural rate of output. One can think of various alternatives to quantify the degree of convergence in the absence of distortions. In this example, rapid growth is here defined as the rate necessary for ACs' per-capita GDP to catch up twenty percentage points as a percentage of euro area per capita GDP in the next ten years. Therefore, the implicit assumption in this case is that if all ACs simultaneously eliminated market distortions and technological gaps, poorer countries would potentially catch up faster.[17] In this numerical exercise, we assume that π^* is equal to 1.5 not only for the euro area but also for ACs.[18]

In the fourth column we have computed the average real exchange rate appreciation of the euro *vis-a-vis* the currencies of ACs over the same sample period (HICP based). In the fifth and sixth column, we report computed GDP weights both in nominal terms and PPP.

With reference to the slopes of the Phillips curve, we have set $\alpha_n = 1.6$, hence making the implicit assumption that output is more responsive than prices in the euro area. Some recent evidence supports this hypothesis. For example, a recent empirical study by van Els, et al. (2002) presents some evidence on the monetary transmission mechanism for the euro area, by examining four alternative methodologies, which are: (1) a vector autoregressive

[17] Sensitivity analysis on the convergence gap parameter has been carried out. The overall results suggest that the scenarios are robust for any plausible values of κ_a.

[18] We have also carried out an alternative numerical exercise, which assumes that π^* is higher in ACs than in the euro area because ACs might have different inflationary objectives. Under this hypothesis, the credibility channel would play a smaller role in explaining the inflation differential with respect to the euro area. Therefore, the inflation and output responses to shocks would be numerically different in the flexible exchange rate regime. The other numerical results of the paper – in particular the case of enlargement - would remain unchanged.

model, (2) a structural model for the euro area, (3) an aggregate of euro area national central banks structural models, (4) and a macro model estimated by the National Institute of Economic and Social Research. All four empirical approaches suggest that if the time horizon spans over two years, the output response to changes in monetary policy is between 1.8 and 6 times larger than the price response. Less clear-cut is the result if the horizon spans over three years, as the output response is, depending on the model, in the range between 0.4 and 1.9 times the price response. Therefore, the value we have chosen for the slope of the Phillips curve implicitly collocates our time horizon in the range between 2 and 3 years after the shock.

As for the slopes of the Phillips curve in ACs, we are not aware of any major attempt in the literature to estimate the Phillips curves for all countries on a comparable basis. In light of this uncertainty, we have thus decided to conduct a sensitivity analysis by considering three alternative values for α_a, making the assumption that the responsiveness of output relative to prices is twice as great as in the euro area, ($\alpha_a = 3.2$), the same, ($\alpha_a = 1.6$) or half ($\alpha_a = 0.8$).

β_a is then computed, so that the observed value of endogenous variables constitutes the equilibrium of the numerical model: $\widetilde{\beta}_a = \alpha_a^0 \phi_a k_a^0 / \left(\pi_a^0 - 1.5\right)$, where the tilde represents the computed parameter, while the nil denotes the initial value of the associated variable. The results are reported in the last three columns of the table, under the assumption that $\phi_a = 0.5$. The steeper the Phillips curve, the less conservative the central banker needs to be, as there is a smaller incentive to generate inflationary surprises. Conversely, the larger the convergence gap and/or the higher the desire to converge faster, the more conservative the central banker needs to be to attain a certain inflation rate. A relatively high parameter β_a suggests that the inflation rate has been kept at a relatively low level in those countries relative to the level of the structural parameter κ_a. It is higher in the case of Latvia, because this country has been pegging its exchange rate to the IMF Special Drawing Rights since 1994, a strategy which has been consistent with low average inflation. This case is not explicitly modelled in the current setup, but it is indirectly captured via a high β for this country. Bulgaria, Estonia and Lithuania have adopted a currency board regime. Therefore, β cannot be computed in their case, as they are "importing" the credibility of the euro area monetary framework. As far as the euro area is concerned, the lack of inflation bias breaks the link between β and π^e. Therefore, the cost of inflation relative to that of output of the euro area can only be computed by taking the relative variance between inflation and output: $\widetilde{\beta}_n = \alpha_n^0 \left(\sigma_y^0/\sigma_\pi^0\right)^{1/2} = 1.67$.

8.2 Scenarios

The model developed in the previous sections allows us to examine a number of scenarios assessing the impact of enlargement. First, we examine how steady-state inflation is affected by enlargement. Second, we investigate the implications for inflation and output stabilisation in response to supply and real exchange rate shocks. Finally we explore some welfare related issues, suggesting the importance of the size of ACs both for the union and the countries themselves.

In Table 2 we start by reporting the first set of simulations in the pre-Maastricht phase, which can be seen as the benchmark.

[Insert Table 2, here]

The ratios $\widehat{\pi}_i/\widehat{\varepsilon}_i$ and $\widehat{y}_i/\widehat{\varepsilon}_i$ measure the responsiveness of inflation and output to a one percent supply shock. For example, in the case of the euro area we find that inflation falls by 0.38 while output increases by 0.39 percentage points. To get some insights on ACs, we repeat the same exercise in succession for the three different values of α_a. If the supply structure of ACs is the same as for the euro area, i.e. $\alpha_a = 1.6$, then ACs with flexible exchange rates stabilise output sizeably more than countries with currency boards.[19]

Carrying out a sensitivity analysis across the three different values of α_a, we find that the steeper the Phillips curve in ACs (hence the smaller α_a) the higher the impact of supply shocks is in terms of ACs' output and, when $\alpha_a > \sqrt{\beta_a}$ as in this case (see Table 1), in terms of inflation. For countries adopting a currency board, the higher impact is instead reflected in output terms only.

In the Maastricht phase, ACs experience a process of nominal disinflation. As we discussed earlier, in response to supply shocks, the impact on inflation and output becomes basically the same as for the three countries that have a currency board. Conversely, real exchange rate shocks cannot be stabilised under the currency board, while they are fully absorbed by changes in the nominal exchange rate under Maastricht.[20]

Turning to the case of enlargement, the loss function of the euro area is modified to account for the new countries participating to the currency union. As monetary policy takes account of the state of the economy in the enlarged monetary union as a whole, the weight of each country depends on its GDP share. As it can be seen from Table 3, we aggregate countries either using nominal GDP in euro (to capture the weight of ACs in the enlarged euro area today) or employing GDP in PPP (to capture the weight AC's will progressively get closer to as the catching up process continues). Both scenarios assume that the common monetary policy is characterised by the same preferences as before enlargement, namely $\beta_u = \beta_n = 1.67$.

[Insert Table 3, here]

Suppose that the Eurosystem does not change its monetary strategy, and therefore the desire of ACs to converge faster does not play a role. Then,

[19] Bulgaria, Estonia and Lithuania's response is identical to the euro area, only when the supply structure is the same.

[20] The model makes the simplifing assumption that shocks are sufficiently small to be accomodated within ERM II.

$\phi_u = 0$ and expected inflation in the enlarged euro area would remain constant at 1.5%. Under the alternative (upper bound) hypothesis that $\phi_u = 1$ expected inflation would rise in the enlarged euro area to 1.6% or 1.8% depending on the weights.

As we found in the theoretical section, the distribution of inflation across countries depends on the real appreciation and size of each ACs. If the medium term real exchange appreciation of ACs is in line with most estimates of the Balassa-Samuelson effect, with q_a ranging between 1.5% and 3% over the medium term (Halpern and Wyploz, 2001; Kovacs, 2002) and assuming $\phi_u = 0$, the deflationary impact in the euro area and the inflationary impact on ACs is limited, irrespective of the weights. If the real appreciation remains instead comparable to the levels achieved in the recent past, the deflationary impact in the euro area becomes potentially more significant, as can be seen in Table 3. Thus the crucial question is whether the recent sizeable appreciation that has characterised ACs is only a temporary phenomenon, that can be explained for example by the unwinding of the undervaluation phase of the early years of transition; or whether the values predicted by the Balassa-Samuelson literature for q_a should be considered as lower estimates of the pace of appreciation to be expected for some years to come.

How would the new currency area be affected by symmetric supply shocks? For the enlarged euro area as a whole the results are robust irrespective of the values of α_a (see Table 4). Indeed, the impact on inflation and output in the enlarged currency area in response to symmetric shocks is similar to those of the euro area before enlargement. The effects for ACs are much more similar to the case where they would adopt a currency board regime than that of flexible exchange rates. This is not surprising, considering the relatively low weight of ACs in the aggregate measure of inflation and output. As was the case for currency boards, inflation and output stabilisation in ACs is thus sensitive to α_a. In particular, when $\alpha_a = 3.2$, a positive symmetric supply shock on the enlarged euro area would have a considerable impact on output in ACs.

To examine the impact of country-specific shocks, suppose that an identical shock takes place in all ACs contemporaneously and that no shock occurs in the euro area. The impact of a scenario such as this on the enlarged currency area would be quite limited (see Table 4). But on the countries subject to the shock the impact would be very large, irrespective of α_a, as the degree of output stabilisation turns out to be extremely small.

[Insert Table 4, here]

Table 4 allows us also to get some insight on the impact of real exchange rate shocks. Here again the impact on the enlarged euro area would be in general limited (while the sign is ambiguous as it depends on $\alpha_a - \alpha_u$). Once again, however, the impact tends to be rather large for the ACs. For example, an unexpected real exchange appreciation in ACs would result into higher inflation and a temporary boost to ACs' economies;[21] whereas it would have only a small deflationary impact to the current euro area.

To explore some welfare related issues of enlargement, we make a number of simplifying assumptions. Assume in the first place that $\phi_a = 0$, and that the ACs are an homogenous region. Assuming also that $\alpha_a = \alpha_n$ and $\beta_u = \beta_n$, then the ratio between (17) and (6) is equal to

$$\Pi = \frac{\Omega + \Phi}{\sigma^2_{\varepsilon_n}} = \frac{1}{\sigma^2_{\varepsilon_n}} \left[\varphi_a^2 \sigma^2_{\varepsilon_a} + (1 - \varphi_a)^2 \sigma^2_{\varepsilon_n} + 2\varphi_a (1 - \varphi_a) \sigma_{(\varepsilon_a, \varepsilon_n)} \right].$$

Under this set of restrictions, Π can be interpreted as a scalar, measuring how many times the variances of inflation and output and the loss would rise in the new enlarged euro area *vis-à-vis* the former euro area. Various hypotheses can be made. For example, in the special case when the variances of shocks is the

[21] The negative effect on competitiveness, which may offset the positive impact on output growth, is outside the scope of this model.

same across the two regions and the degree of correlation is one, we obviously find that $\Pi = 1$, suggesting that there is no impact. In a scenario where instead the variance of supply shocks in ACs is say four times the variance of supply shocks in the euro area and the degree of correlation of shocks is as high as one, Π is equal to 1.11 when φ is measured in nominal GDP and 1.25 when φ is measured in PPP terms. Notwithstanding that, according to this hypothesis, almost half of the members have a fourfold higher variance of supply shocks, the impact on the union is relatively contained. The qualitative conclusion is that the impact on the union would not be 'too' large as long as the variances of supply shocks in ACs do not remain 'too' high relative to the euro area.

It is also important to emphasise the role that the correlation coefficient plays. If the degree of correlation is smaller than one, the loss could remain unchanged even if the variance of supply shocks stays higher in ACs. As an illustration, in Table 5 we have calculated the variance of supply shocks in ACs relative to the euro area that would keep the loss in the enlarged euro area equal to the loss in the euro area before enlargement. If for example, the correlation coefficient is 0.5, there would be no impact on welfare under the hypothesis that the variance of supply shocks would be 3 (or 3.5 depending on the weight) times larger in ACs.

[Insert Table 5, here]

To conclude, the main insight of this section is that a high variance of shocks persisting after enlargement may be problematic, for the new entrants in particular, and to a smaller extent for the union. Therefore, in assessing the implications of euro area enlargement the issue of the endogeneity of supply shocks is a crucial one. According to Boone and Maurel (1999), the business cycles of several ACs appear already strongly correlated with the German cycle. Similarly, Frenkel and Nickel (2002) find that the more advanced ACs exhibit shocks and shock adjustment processes that are very similar to some euro area countries. Instead, Fidrmuc and Korhonen (2001) find that only a small number of ACs is characterised by high correlation of supply shocks with the euro area. However, they also find that countries like Italy, which were thought to be initially "peripheral", are becoming increasingly integrated with the rest of the euro area in terms of trade and financial links. To put it differently $\sigma^2_{\varepsilon_a}$ and $\sigma^2_{\eta_a}$ could diminish substantially after enlargement. The greater the fall in the variance of supply and real exchange rate shocks, the stronger the positive impact on welfare for both ACs and the union. Indeed, it is striking how many countries currently participating in the euro area monetary union, including those with a relatively low GDP per capita, have observed in the course of the 90's a sizeable fall in the variance of inflation and output. Monetary union and the associated process of convergence may well have been important factors behind these developments.

9 Concluding remarks

In this paper, we have attempted to assess the economic implications of an enlargement of the European monetary union to include the accession countries (ACs) in various scenarios, where expected inflation in the ACs is linked to the cost of inflation relative to that of output, the short-term Phillips curve, the stage of convergence and the desire to converge.

In the Maastricht phase, the inflation requirement of the Treaty determines a radical change in the way inflationary expectations are formed, consistent with the rapid achievement of the nominal convergence objective. In other words, if the reward for joining monetary union is considered to be sufficiently high, the convergence gap does not feed into the inflationary expectations' mechanism.

After enlargement we find that there is no impact on average inflation in the enlarged euro area via the credibility channel, provided that its monetary policy is unchanged, and via the anticipated real exchange rate appreciation. Enlargement in this case simply results in a different distribution of inflation across countries. We also find that unanticipated shocks to the real exchange rate will affect aggregate inflation if the aggregate supply structure differs from one participating country to the next. In general, the cost of an enlarged monetary union for each member would depend upon the slopes of the Phillips curves of all members, the size of its economy, and the variance of country-specific supply and real exchange rate shocks.

The model is applied to ten central and eastern European ACs and the euro area. The results of the numerical simulations critically depend on the relatively small size of ACs. For the euro area the impact on steady-state inflation is very small if participating countries are weighted on the basis of their GDP in national currency and if the upward pressure on the equilibrium real exchange rate is limited. However, the deflationary impact on the euro area is more sizeable if we assume a strong appreciation of the real exchange rate and if ACs are weighted in terms of purchasing power parity. The simulations also confirm that the major impact on welfare, inflation and output stabilisation are borne by the ACs, and only to a much smaller extent by the euro area and the enlarged currency union. Sensitivity analysis also indicates that the impact of symmetric shocks on inflation and output in the ACs critically depends on the slope of the Phillips curve.

It should be emphasised that an enlarged monetary union would, in itself, have several positive effects: it would strengthen economic cohesion, reduce risk premia, facilitate foreign direct investment and encourage technological progress. Clearly, the simplified set-up employed in the present study entirely omits these important aspects. Finally, this modelling framework may also be extended to include fiscal issues, as the delegation of monetary policy could not entirely solve the time inconsistency problem on the fiscal front.

References

[1] Alesina, A. and Barro, R. J. (2002), 'Currency Unions', *Quarterly Journal of Economics*, Vol. 117, pp. 409-436.

[2] Alesina, A. and Summers, L. (1993), 'Central Bank Independence and Macroeconomic Performance: Some Comparative Evidence', *Journal of Money, Credit and Banking,* Vol. 25, pp. 151-162.

[3] Balassa, B. (1964), 'The Purchasing Power Parity Doctrine: A Reappraisel', *Journal of Political Economy*, Vol. 72, pp. 584-596.

[4] Barro, R. and Gordon, D. (1983), 'A Positive Theory of Monetary Policy in a Natural Rate Model', *Journal of Political Economy*, Vol. 91, pp. 589-610.

[5] Bean, C. S. (1998), 'The New UK Monetary Arrangements: A View from the Literature', *Economic Journal*, Vol. 108, pp. 1795-1809.

[6] Beetsma, R.M.W.J. and Jensen, H. (1999), 'Structural Convergence under Reversible and Irreversible Monetary Unification', *CEPR Discussion Paper Series*, No. 2116.

[7] Berger, H. (2002), 'The ECB and Euro-Area Enlargement', *IMF Working Paper*, No. 175.

[8] Blinder, A. S. (2000), 'Central-Bank Credibility: Why Do We Care? How Do We Build it?', *American Economic Review*, Vol. 90, pp. 1421-1431.

[9] Boone, L. and Maurel, M. (1999), 'An Optimal Currency Area Perspective of the EU Enlargment to the CEECs', *CEPR Discussion Paper Series*, No. 2119.

[10] Clarida, R., Gali, J. and Gertler, M. (1999), 'The science of Monetary Policy: A New Keynesian Perspective', *Journal of Economic Literature*, Vol. 37, pp. 1661-1707.

[11] Cottarelli, C., Griffiths, M. and Moghadam, M., R. (1998), 'The Non-Monetary Determinants of Inflation: A Panel Data Study', *IMF Working Papers*, No. 98/23.

[12] Cukierman, A. (1992), *Central Bank Strategy, Credibility, and Independence. Theory and Evidence*, Cambridge, MIT Press.

[13] Cukierman, A., Miller, G. P. and Neyapti, B.(2002), 'Central Bank Reform, Liberalization and Inflation in Transition Economies - An International Perspective', *Journal of Monetary Economics*, Vol. 49, pp. 237-264.

[14] De Broeck, M. and Slok, T (2001), 'Interpreting Real Exchange Rate Movements in Transition Countries', Bank of Finland, *BOFIT Discussion Papers*, No. 7.

[15] Fidrmuc, J. and Korhonen, L. (2001), 'Similarity of Supply and Demand Shocks between the Euro Area and the CEECs', Bank of Finland, *Bofit Discussion Papers*, No. 14.

[16] Frait, J. and Komarek, L. (2001), 'Real Exchange Rate Trends in Transition Countries', *Warwick Economic Research Papers*, No. 696.

[17] Frenkel, M. and Nickel, C. (2002), 'How Symmetric are Shocks and the Shock Adjustment Dynamics Between the Euro Area and Central and Eastern European Countries?', *IMF Working Papers*, No. 02/222.

[18] Grafe, C. and Wyplosz, C. (1997), 'The Real Exchange Rate in Transition Economies', *CEPR Discussion Paper Series*, No. 1773.

[19] Grilli, V., Masciandaro, D. and Tabellini, G. (1991), 'Political and Monetary Institutions and Public Financial Policies in the Industrial Countries', *Economic Policy*, Vol. 13, pp. 341-392.

[20] Gros, D. and Hefeker, C. (2002), 'One Size Must Fit All: National Divergences in a Monetary Union', *German Economic Review*, Vol. 3, pp. 247-262.

[21] Halpern, L and Wyplosz, C. (2001), 'Economic Transformation and Real Exchange Rates in the 2000s: The Balassa-Samuelson Connection', *Economic Survey of Europe*, No. 1, pp. 227-239.

[22] Issing, O. (2001), 'The Euro Area and the Single Monetary Policy', *International Journal of Finance and Economics*, Vol. 6, pp. 277-288.

[23] Kovacs, M. A. (2002), 'On the Estimated Size of the Balassa-Samuelson Effect in Five Central and Eastern European Countries', *National Bank of Hungary Working Paper*, No. 5..

[24] Kydland F. and Prescott, E. (1977), 'Rules Rather Than Discretion: the Inconsistency of Optimal Plans', *Journal of Political Economy*, Vol. 85, pp. 473-490.

[25] Lane, P. (2000), 'Asymmetric Schocks and Monetary Policy in a Currency Union', *Scandinavian Journal of Economics*, Vol. 102, pp. 585-604.

[26] Loungani, P. and Sheets, N. (1997), 'Central Bank Independence, Inflation and Growth in Transition Economies', *Journal of Money Credit and Banking*, Vol. 29, pp. 381-399.

[27] Maliszewski, W., S. (2000), 'Central Bank Independence in Transition Economies', *Economics of Transition*, Vol. 8, pp. 749-789.

[28] Neyapti, B. (2001), 'Central Bank Independence and Economic performance in Eastern Europe', *Economic Systems*, Vol. 25, pp. 381-399.

[29] Persson, T. and Tabellini, G. (1999), 'Political Economics and Macroeconomic Policy', in Taylor J.B. and Woodford, M., *Handbook of Macroeconomics*, Amsterdam, North-Holland, Vol. 1c, pp. 1397-1482.

[30] Rogoff, K. (1985), 'The Optimal Degree of Commitment to an Intermediate Monetary Target', *Quarterly Journal of Economics*, Vol. 100, pp. 1169-90.

[31] Samuelson, P.A. (1964), 'Theoretical notes on trade problems', *Review of Economics and Statistics*, Vol. 46, pp. 145-154.

[32] Svensson, L. E. O. (1997), 'Optimal Inflation Targets, 'Conservative' Central Banks and Linear Inflation Contracts', *American Economic Review*, Vol. 87, pp. 98-114.

[33] van Els, P., A. Locarno, B. Mojon and J. Morgan (2002), 'New Macroeconomic Evidence on Monetary Policy Transmission in the Euro Area', European Central Bank, mimeo, presented in Venice at the 2002 Congress of the European Economic Association.

[34] Walsh, C. (1995), 'Optimal Contracts for Independent Central Bankers', *American Economic Review*, Vol. 85, pp 150-67.

Table 1: The Benchmark
(percentage values)

	Inflation (π_i)	Output (y_i)	Convergence gap (k_a)	Real exchange rate (q_a)	Weights GPP in Euro	Weights GDP in PPP	β_i $\alpha_a = 3.2$	β_i $\alpha_a = 1.6$	β_i $\alpha_a = 0.8$
Bulgaria	5.7	3.4	5.6	-4.2	0.2	0.6	-	-	-
Czech Republic	5.4	3.2	2.2	-4.1	0.8	1.9	0.9	0.5	0.2
Estonia	5.9	5.2	1.8	-4.4	0.1	0.2	-	-	-
Hungary	11.6	4.5	1.6	-4.5	0.7	1.5	0.3	0.1	0.1
Latvia	3.8	5.3	2.9	-6.7	0.1	0.2	2.0	1.0	0.5
Lithuania	3.3	3.3	4.3	-8.8	0.2	0.3	-	-	-
Poland	9.4	4.3	2.8	-6.5	2.3	4.2	0.6	0.3	0.1
Romania	49.1	2.9	5.3	-9.7	0.5	1.8	0.2	0.1	0.0
Slovak Republic	8.2	3.5	2.7	-4.6	0.3	0.7	0.6	0.3	0.2
Slovenia	7.7	4.2	0.9	-1.4	0.3	0.4	0.2	0.1	0.1

Source: Authors' data elaboration based on 1997-2001 data from official national sources, ECB, Eurostat and OECD. See also footnote (16).

Table 2: Pre-Maastricht Phase: The Impact of Symmetric Supply Shocks on Inflation and Output (percentage points)

	$\alpha_a = 3.2$	$\alpha_a = 3.2$	$\alpha_a = 1.6$	$\alpha_a = 1.6$	$\alpha_a = 0.8$	$\alpha_a = 0.8$
	$\hat{\pi}_i / \hat{\varepsilon}_i$	$\hat{y}_i / \hat{\varepsilon}_i$	$\hat{\pi}_i / \hat{\varepsilon}_i$	$\hat{y}_i / \hat{\varepsilon}_i$	$\hat{\pi}_i / \hat{\varepsilon}_i$	$\hat{y}_i / \hat{\varepsilon}_i$
Bulgaria	-0.38	-0.22	-0.38	0.39	-0.38	0.69
Czech Republic	-0.29	0.08	-0.53	0.15	-0.92	0.26
Estonia	-0.38	-0.22	-0.38	0.39	-0.38	0.69
Hungary	-0.31	0.02	-0.60	0.05	-1.14	0.09
Latvia	-0.26	0.17	-0.45	0.28	-0.70	0.44
Lithuania	-0.38	-0.22	-0.38	0.39	-0.38	0.69
Poland	-0.30	0.05	-0.56	0.10	-1.02	0.18
Romania	-0.31	0.02	-0.60	0.03	-1.17	0.07
Slovak Republic	-0.29	0.06	-0.56	0.11	-1.00	0.20
Slovenia	-0.31	0.02	-0.60	0.04	-1.15	0.08
EU12	-0.38	0.39	-0.38	0.39	-0.38	0.39

Table 3: The Enlargement Phase: Dispersion of Inflation Among the Member States ($\phi_u = 0$, percentage points)

	$q_a = -1.5$	$q_a = -3$	q_a (Table 1)
		GDP in Euro	
Bulgaria	2.9	4.3	5.4
Czech Republic	2.9	4.3	5.3
Estonia	2.9	4.3	5.6
Hungary	2.9	4.3	5.7
Latvia	2.9	4.3	7.9
Lithuania	2.9	4.3	10.0
Poland	2.9	4.3	7.7
Romania	2.9	4.3	10.9
Slovak Republic	2.9	4.3	5.8
Slovenia	2.9	4.3	2.6
EU12	1.4	1.3	1.2
Enlarged area	1.5	1.5	1.5
		GDP in PPP	
Bulgaria	2.8	4.1	5.0
Czech Republic	2.8	4.1	4.9
Estonia	2.8	4.1	5.2
Hungary	2.8	4.1	5.3
Latvia	2.8	4.1	7.5
Lithuania	2.8	4.1	9.6
Poland	2.8	4.1	7.3
Romania	2.8	4.1	10.5
Slovak Republic	2.8	4.1	5.4
Slovenia	2.8	4.1	2.2
EU12	1.3	1.1	0.8
Enlarged area	1.5	1.5	1.5

Table 4: The Enlargement Phase: The Impact of Supply and Real Exchange Rate shocks on Inflation and Output
(percentage points)

			Symmetric supply shock				Country specific supply shock				Real exchange rate shock		
			ACs	EU12	Enlarged euro area		ACs	EU12	Enlarged euro area		ACs	EU12	Enlarged euro area
	$\alpha_a = 3.2$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	-0.38	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.02	-0.02	-0.02	$\hat{\pi}_i / \hat{\eta}_a$	-0.92	0.08	-0.03
	$\alpha_a = 3.2$	$\hat{y}_i / \hat{\varepsilon}_i$	-0.20	0.40	0.37	$\hat{y}_i / \hat{\varepsilon}_a$	0.94	-0.03	0.02	$\hat{y}_i / \hat{\eta}_a$	-2.93	0.14	-0.03
GDP	$\alpha_a = 1.6$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	-0.38	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.02	-0.02	-0.02	$\hat{\pi}_i / \hat{\eta}_a$	-0.95	0.05	0.00
In Euro	$\alpha_a = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	0.39	0.39	0.39	$\hat{y}_i / \hat{\varepsilon}_a$	0.97	-0.03	0.02	$\hat{y}_i / \hat{\eta}_a$	-1.51	0.09	0.00
	$\alpha_a = 0.8$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	-0.38	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.02	-0.02	-0.02	$\hat{\pi}_i / \hat{\eta}_a$	-0.96	0.04	0.02
	$\alpha_a = 0.8$	$\hat{y}_i / \hat{\varepsilon}_i$	0.70	0.39	0.41	$\hat{y}_i / \hat{\varepsilon}_a$	0.98	-0.03	0.02	$\hat{y}_i / \hat{\eta}_a$	-0.77	0.06	0.02
	$\alpha_a = 3.2$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.37	-0.37	-0.37	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.04	-0.04	-0.04	$\hat{\pi}_i / \hat{\eta}_a$	-0.82	0.18	-0.06
	$\alpha_a = 3.2$	$\hat{y}_i / \hat{\varepsilon}_i$	-0.18	0.41	0.34	$\hat{y}_i / \hat{\varepsilon}_a$	0.86	-0.07	0.04	$\hat{y}_i / \hat{\eta}_a$	-2.63	0.29	-0.06
GDP	$\alpha_a = 1.6$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	-0.38	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.05	-0.05	-0.05	$\hat{\pi}_i / \hat{\eta}_a$	-0.88	0.12	0.00
In PPP	$\alpha_a = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	0.39	0.39	0.39	$\hat{y}_i / \hat{\varepsilon}_a$	0.93	-0.07	0.05	$\hat{y}_i / \hat{\eta}_a$	-1.41	0.19	0.00
	$\alpha_a = 0.8$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	-0.38	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.05	-0.05	-0.05	$\hat{\pi}_i / \hat{\eta}_a$	-0.91	0.09	0.03
	$\alpha_a = 0.8$	$\hat{y}_i / \hat{\varepsilon}_i$	0.69	0.39	0.42	$\hat{y}_i / \hat{\varepsilon}_a$	0.96	-0.07	0.05	$\hat{y}_i / \hat{\eta}_a$	-0.73	0.14	0.04

Table 5: Iso-welfare and the relative variance of supply shocks
(percentage points)

Correlation among supply shocks	σ_a^2/σ_n^2
GDP in Euro	
0.0	36.2
0.2	11.9
0.5	3.5
0.8	1.5
1.0	1.0
GDP in PPP	
0.0	16.0
0.2	7.7
0.5	3.0
0.8	1.5
1.0	1.0

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