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The Eastward Enlargement of the European Union

Michele Ca' Zorzi and Roberto De Santis



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The Eastward Enlargement of the European Monetary Union

MICHELE CA'ZORZI AND ROBERTO A. DE SANTIS

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For further information:

Pierre Werner Chair on European Monetary Union

Robert Schuman Centre for Advance Studies

European University Institute

Via delle Fontanelle, 19

I-50016 San Domenico di Fiesole (FI)

Fax : + 39 055 4685770

Email: laetitia.jespers@iue.it

<http://www.iue.it/RSCAS/Research/Economy/PierreWerner.shtml>

Abstract

The enlargement of the European monetary union to include new EU Member States (NMs) will not lead to higher expected inflation in the enlarged euro area, but only to some redistribution of inflation at the country level, if the policy framework of the monetary authority remains invariant. Shocks to the real exchange rate may affect instead aggregate inflation, if member countries' economic structure differs. The numerical results indicate that the impact on steady state inflation of the current euro area is limited if participating countries are weighted on the basis of nominal GDP and if the upward pressure on the real exchange rate is postulated to be in line with most estimates of the Balassa-Samuelson effect. In the event of real exchange rate or country-specific supply shocks in NMs, the consequences are found to be limited for the current and the enlarged euro area, but sizeable for the NMs themselves.

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All errors are the authors' responsibility.

Michele Ca'Zorzi
European Central Bank
Kaiserstrasse 29
D-60311 Frankfurt am Main
Germany
Email: michele.cazorzi@ecb.int

Roberto A. De Santis
European Central Bank
Kaiserstrasse 29
D-60311 Frankfurt am Main
Germany
Email: roberto.de_santis@ecb.int

1 Introduction

The inclusion of new Member States (NMs) in the European Union (EU), ten in May 2004 and two more expected in 2007, has important policy implications for the euro area. It is one of the aims of the Community explicitly set out in the Treaty 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). At the same time among the goals of the Community, the Treaty identifies the need to promote sustainable and non-inflationary growth, assigning to the Eurosystem the primary objective of preserving price stability (the price stability principle).

This paper should be seen as an attempt to assess these objectives, by studying the impact of EU enlargement on inflation and output in the context of a simple modelling framework, which refers 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), Gros and Hefeker (2002), and Ca' Zorzi and De Santis (2004).¹

To examine the currency union issue, Ca' Zorzi and De Santis (2004) have developed a general specification of the model by allowing differences in the countries' economic structures. The model generalises Lane (2000), Berger (2002) and Gros and Hefeker (2002) by introducing a deterministic and a stochastic component to the real exchange rate. This approach is useful in the context of enlargement, as it is consistent with the empirical and theoretical finding that NMs' currencies tend to appreciate as a result of the catching-

¹As 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.

up process (Grafe and Wyplosz, 1997; De Broeck and Slok, 2001; Frait and Komarek, 2001; Halpern and Wyplosz, 2001; Kovacs 2002, Egert, 2003;).

The model assumes three phases. In the pre-Maastricht phase, steady state inflation depends on the monetary policy framework adopted in each country. With a flexible exchange rate, steady state inflation in NMs 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 deemed 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. At the same time, the process of appreciation of the real exchange rate in NMs exerts an upward pressure on the nominal exchange rate of NMs.

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.

To gauge the magnitude of the effects, this analytical framework is then applied to ten NMs and the euro area. Several alternative scenarios are considered, in order to account for the uncertainty over the pace of the real appreciation process in NMs and over the parameter values of the model.

The main insights of the numerical simulations can be summarised as follows. The impact of enlargement on steady state inflation of the current euro

area is limited, if participating countries are weighted on the basis of their nominal GDP and if the upward pressure on the real exchange rate is postulated to be in line with most estimates of the Balassa-Samuelson effect. However, the deflationary impact on the euro area is more sizeable if NMs are weighted in terms of purchasing power parities and if a stronger real exchange rate appreciation process is assumed.

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 NMs is sensitive to the slope of the Phillips curve. In the event of either country-specific supply shocks in NMs or real exchange rate shocks, the response of inflation and output is found to be small in the enlarged currency area but sizeable in the NMs, irrespective of the slope of the Phillips curve.

The remaining sections of the paper have been structured as follows: Sections 2 and 3 describe the model for NMs and the euro area; Section 4 examines the consequences of the Maastricht phase under the hypothesis that entering in the exchange rate mechanism is fully credible; Section 5 explores the consequences of the enlargement of the euro area from both the point of view of the NMs and the euro area; Section 6 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 7 provides the main conclusions.

2 Independent monetary policy

Consider a static n -country Barro-Gordon (1983) model, defined by a set ($a=1....n-1$) of NMs, 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. Thus, they minimise a quadratic loss function

of the following type:

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

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, \bar{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 $y_i^* = \bar{y}_i$; if on the contrary $\phi_i = 1$, the convergence gap entirely feeds into the monetary policy response, i.e. $y_i^* = \bar{y}_i + \kappa_i$. In the case of the euro area, we assume that $\phi_n = \kappa_n = 0$; thus, $y_n^* = \bar{y}_n$ holds always.

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

$$y_i = \bar{y}_i + \alpha_i (\pi_i - \pi_i^e) + \varepsilon_i \quad (2)$$

where π_i^e denotes expected inflation, α_i the output elasticity to inflation surprises or the inverse of the slope of the Phillips curve and $\varepsilon_i \sim IID(0, \sigma_{\varepsilon_a}^2)$ 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 \bar{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:

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

By imposing rational expectations on (3) yields the inflationary expectation of the private sector:

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

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

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

while the inflation variance is equal to

$$\sigma_{\pi_i}^2 = \left(\frac{\alpha_i}{\alpha_i^2 + \beta_i} \right)^2 \sigma_{\varepsilon_i}^2. \quad (6)$$

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

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

while the output variance is equal to

$$\sigma_{y_i}^2 = \left(\frac{\beta_i}{\alpha_i^2 + \beta_i} \right)^2 \sigma_{\varepsilon_i}^2. \quad (7)$$

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

$$\pi_a - \pi_n = \pi_a^* - \pi_n^* + \frac{\alpha_a}{\beta_a} \phi_a \kappa_a - \frac{\alpha_a}{\alpha_a^2 + \beta_a} \varepsilon_a + \frac{\alpha_n}{\alpha_n^2 + \beta_n} \varepsilon_n. \quad (8)$$

In steady state the inflation differential between NMs and the euro area is wider the larger the difference between π_a^* and π_n^* and if $\phi_a > 0$, the larger the distortion κ_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* NMs' set of currencies is determined by factors exogenous to the model.² Although this restriction is not a necessary feature of the model, both theoretical and empirical considerations suggest that, owing to the catching up process, NMs' currency are bound to appreciate in real terms.³ The nominal depreciation of NMs' currencies *vis-à-vis* the euro, defined as $\hat{e}_a = \pi_a - \pi_n + q_a + \eta_a$, is therefore equal to:

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

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

² 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.

³ 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).

3 Currency board

Estonia, Lithuania and Bulgaria all adopt currency board regimes.⁴ How are inflation and output be affected in this case? Under the assumption of a fully credible regime, the value of the inflation rate does not ensue from an optimisation program.⁵ 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 NMs becomes equal to:

$$\pi_a^{CB} = \pi_n^* - \frac{\alpha_n}{\alpha_n^2 + \beta_n} \varepsilon_n - q_a - \eta_a. \quad (9)$$

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

$$y_a^{CB} = \bar{y}_a + \varepsilon_a - \frac{\alpha_a \alpha_n}{\alpha_n^2 + \beta_n} \varepsilon_n - \alpha_a \eta_a \quad (10)$$

If supply shocks are symmetric and $\alpha_a = \alpha_n$, the impact on inflation and output is the same as for the euro area. By contrast, if supply shocks affect only country a , there is no response in terms of stabilisation by the monetary authority and hence inflation remains unchanged whereas output absorbs entirely 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 NMs and the variance of supply shocks in the euro area, $\sigma_{\varepsilon_n}^2$:

⁴Estonia and Lithuania also joined the Exchange Rate Mechanism II (ERM II) on 28 June 2004, while maintaining the currency board arrangement in place, as a unilateral commitment.

⁵See Alesina and Barro (2002) for a more in depth analysis of currency board regimes.

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

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

$$2 \alpha_a \sigma_{(\varepsilon_a, \eta_a)} + \frac{2 \alpha_a^2 \alpha_n}{\alpha_n^2 + \beta_n} \sigma_{(\varepsilon_n, \eta_a)}.$$

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.⁶ Average inflation under the currency board regime (9) 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.

4 Maastricht phase

Following accession, new member states participate in the EU co-ordination of economic policies and, to the extent to which they have reached a sustainable level of convergence, are expected to join the euro area provided they satisfy the criteria set out in the Maastricht Treaty.⁷ The implications of the Maastricht criteria on inflation and output can be seen in the light of the present modelling framework. We assume that the policy makers decide to proceed with a rapid process of nominal convergence to bring the inflation differential

⁶Cukierman, et al. (2002) found evidence that transition economies with currency boards do not necessarily post lower inflation rates.

⁷This 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.

down to the level required by Maastricht, π_λ . We also assume that this strategy is fully credible, as the pay off is deemed to be sufficiently high. Then, $\pi_a^M = \pi_n + \pi_\lambda$. By using (5) to determine π_n , inflation and output in NMs reduce respectively to:

$$\pi_a^M = \pi_n^* - \frac{\alpha_n}{\alpha_n^2 + \beta_n} \varepsilon_n + \pi_\lambda, \quad (11)$$

$$y_a^M = \bar{y}_a + \varepsilon_a - \frac{\alpha_a \alpha_n}{\alpha_n^2 + \beta_n} \varepsilon_n. \quad (12)$$

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

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

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 (9). In the latter case, it is the inflation criterion that is not satisfied when $-(q_a + \eta_a) > \pi_\lambda$.

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:⁸

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

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

⁸This section does not fully account for the implications of the exchange rate mechanism which only allows some degree of exchange rate flexibility.

5 The enlargement phase

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

$$L_u = \frac{1}{2}E \left[(y_u - y_u^*)^2 + \beta_u (\pi_u - \pi_u^*)^2 \right]. \quad (13)$$

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 NMs: $\pi_u = \sum \varphi_i \pi_i$, $y_u = \sum \varphi_i y_i$ and $\bar{y}_u = \sum \varphi_i \bar{y}_i$, where the weights φ_i are interpreted as the size of country i relative to the enlarged currency area. The inflation differential between any NM and the euro area is equal to the sum of the deterministic and stochastic components of the real exchange rate appreciation: $\pi_a^U - \pi_n^U = -(q_a + \eta_a)$.

Likewise the difference between desired output and the natural rate is defined as $y_u^* - \bar{y}_u = \phi_u \kappa_u$. The timing of events is unchanged and the game is solved as before. Replacing π_u , y_u and y_u^* into (13) and differentiating it with respect to π_n^U determines the reaction function of the central bank 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:

$$\pi_u = \pi_u^* + \frac{\alpha_u \phi_u \kappa_u}{\beta_u} - \frac{\alpha_u}{\alpha_u^2 + \beta_u} \left[\sum_i \varphi_i \varepsilon_i - \sum_a (\alpha_a - \alpha_u) \varphi_a \eta_a \right], \quad (14)$$

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

$$\begin{aligned} \pi_a^U = & \pi_u^* + \frac{\alpha_u \phi_u \kappa_u}{\beta_u} - q_a + \sum_a \varphi_a q_a - \frac{\alpha_u}{\alpha_u^2 + \beta_u} \sum_i \varphi_i \varepsilon_i + \\ & -\eta_a + \frac{1}{\alpha_u^2 + \beta_u} \sum_a (\beta_u + \alpha_a \alpha_u) \varphi_a \eta_a, \end{aligned} \quad (16)$$

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

Provided that the NMs' real convergence objective does not influence monetary policy, i.e. $\forall a, \phi_a \kappa_a = 0$, then $\phi_u \kappa_u = 0$, the monetary policy framework remains invariant (namely, $y_u^* = \bar{y}_u$) 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 NMs' currencies. However, aggregate inflation is affected by real exchange rate shocks if $\alpha_a \neq \alpha_u$. To be more precise, a negative shock to η_a would have a positive (negative) impact on inflation if the slopes of the Phillips curves of NMs are on average steeper (flatter) relative to the euro area. For example, an unanticipated increase in non-tradable prices in NMs by causing a temporary appreciation of the real exchange rate, $\eta_a < 0$, would increase aggregate inflation if the output elasticity to inflation surprises in NMs is on average smaller than that in the euro area, (i.e. $\alpha_a < \alpha_n$). This implies that if the transmission mechanism of monetary policy differs among member states, shocks to relative prices, whether the consequence of a relative productivity shock or a change in world demand for domestic goods, affect aggregate inflation in the currency 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 NMs to converge in real terms. In this case, $y_u^* = \varphi_n \bar{y}_n + \sum \varphi_a y_a^*$. 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 (14)). It also highlights how the inflationary impact of enlargement is neutralised if

ϕ_a is equal to zero.

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 NMs than in the original euro area, following the assumption that NMs are characterised by an appreciating trend $-q_a$. Inflation will be higher in those NMs appreciating the most relative to the average appreciation of the region, $-\sum_a \varphi_a q_a$.

Output in the euro area and NMs is represented by the following set of equations:

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

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

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

The equations derived for inflation and output suggest the following. Following a real exchange rate shock inflation and output co-move in every country. At the union level, however, aggregate output and aggregate inflation move in opposite directions, as monetary authorities tend to offset the inflationary (or deflationary) impact of the shock. 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 NMs are sizeable. 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:

$$\sigma_{\pi_u}^2 = \left(\frac{\alpha_u}{\alpha_u^2 + \beta_u} \right)^2 \left[\sum_i \varphi_i^2 \sigma_{\varepsilon_i}^2 + \sum_a (\alpha_a - \alpha_u)^2 \varphi_a^2 \sigma_{\eta_a}^2 + \Phi \right],$$

$$\sigma_{y_u}^2 = \left(\frac{\beta_u}{\alpha_u^2 + \beta_u} \right)^2 \left[\sum_i \varphi_i^2 \sigma_{\varepsilon_i}^2 + \sum_a (\alpha_a - \alpha_u)^2 \varphi_a^2 \sigma_{\eta_a}^2 + \Phi \right],$$

where $\Phi = 2 \sum_{i \neq j} \varphi_i \varphi_j \sigma_{(\varepsilon_i, \varepsilon_j)} + 2 \sum_{a \neq b} (\alpha_a - \alpha_u) (\alpha_b - \alpha_u) \varphi_a \varphi_b \sigma_{(\eta_a, \eta_b)} - \sum_i \sum_a \varphi_i (\alpha_a - \alpha_u) \varphi_a \sigma_{(\varepsilon_i, \eta_a)}$.

Therefore, the variances of inflation and output depend on the following factors. First, they are a positive function of the variances of supply shocks in each member country. 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.⁹ Second, they are an increasing function of the variance of the real exchange rate, $\sigma_{\eta_a}^2$. 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 the same ($\alpha_n = \alpha_a$), the variance of inflation and output of the currency union is not affected by the stochastic fluctuations of the real exchange rates. Third, they depend positively on the degree of correlation between supply shocks, $\sigma_{(\varepsilon_i, \varepsilon_j)}$. This is quite intuitive as the more closely supply shocks are correlated, the less they are likely to offset each other. Finally, the variance of inflation and output in the currency union depends upon $\sigma_{(\eta_a, \eta_b)}$ and $\sigma_{(\varepsilon_i, \eta_a)}$. Under the hypothesis that $(\alpha_a - \alpha_u) (\alpha_b - \alpha_u) > 0$, it increases if $\sigma_{(\eta_a, \eta_b)} > 0$. This implies, for example, that if NMs are characterised by the same slope of the Phillips curve, then the variance of inflation and output increases if η_a and η_b are positively correlated.

⁹The strength of the impact thus depends on whether $\sum \varphi_a^2 \sigma_{\varepsilon_a}^2$ is high relative to $(1 - \sum \varphi_a)^2 \sigma_{\varepsilon_n}^2$.

6 A numerical exercise

The analytical framework developed in the previous section is applied to the euro area and ten NMs (eight central and eastern European countries, which recently joined the EU, plus Romania and Bulgaria, which are expected to join in 2007). The analysis aims at providing an insight on the size of the impacts of institutional change and of supply and real exchange rate shocks under alternative scenarios.

6.1 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. We compiled quarterly data from 1997 until 2003 from a variety of sources, including Eurostat, the European Central Bank (ECB) and the International Financial Statistics (IFS) of the International Monetary Fund.

In choosing the sample period for this analysis, there is clearly a trade off. The 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 NMs 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 sample averages and applying in some cases a limited degree of judgmental assessment.

We decided to exclude data before 1997, since before then NMs 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

the sample period gives us a first representation of the benchmark.¹⁰ This procedure is clearly rough; and it is also clear that convergence 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.

The first two columns report average inflation and output growth of NMs. As 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. Rapid growth is here defined as the rate necessary for NMs' per-capita GDP to catch up twenty percentage points as a percentage of euro area per capita GDP in the next ten years.¹¹ Finally, in this numerical example, we assume that π^* is equal to 1.5.¹²

In the fourth column we have computed the average real exchange rate appreciation of the euro *vis-a-vis* the currencies of NMs 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

¹⁰In the case of the Czech Republic and Romania, we have restricted the sample for GDP from 2000 onwards in view of the severe downturns at the beginning of the sample period. 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 1999.

¹¹Sensitivity 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 .

¹²We have also carried out an alternative numerical exercise, which assumes that π^* is higher in ACs. 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.

evidence on the monetary transmission mechanism for the euro area, by examining four alternative methodologies, which are: (1) a vector autoregressive 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 NMs, 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: $\tilde{\beta}_a = \alpha_a^0 \phi_a k_a^0 / (\pi_a^0 - 1.5)$, 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 $\phi_a = 0.5$. 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 explic-

itly 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 an 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 (6) and output (7): $\tilde{\beta}_n = \alpha_n^0 (\sigma_y^0 / \sigma_\pi^0)^{1/2} = 1.66$.

6.2 Scenarios

The model developed in the previous sections allows us to examine a number of scenarios assessing the impact of enlargement. In Table 2 we start by reporting the first set of simulations in the pre-Maastricht phase, which can be seen as the benchmark.

The ratios $\hat{\pi}_i / \hat{\varepsilon}_i$ and $\hat{y}_i / \hat{\varepsilon}_i$ measure the responsiveness of inflation and output to a one percent positive 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 NMs, we repeat the same exercise in succession for the three different values of α_a . If the supply structure of NMs is the same as for the euro area, i.e. $\alpha_a = 1.6$, then NMs with flexible exchange rates stabilise supply shocks sizeably more than countries with currency boards.¹³

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

¹³Bulgaria, Estonia and Lithuania's response is identical to the euro area, only when the supply structure is the same.

adopting a currency board, the higher impact is instead reflected in output terms only.

In the Maastricht phase, NMs 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.¹⁴

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 NMs in the enlarged euro area today) or employing GDP in PPP (to capture the weight NMs 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 $\beta_u = \beta_n = 1.66$.

Let us suppose that the desire of NMs to converge faster does not affect the Eurosystem monetary strategy. Then, $\phi_u = 0$ and expected inflation in the enlarged euro area would remain constant. Under the alternative (upper bound) hypothesis that $\phi_u = 1$ the rise in expected inflation in the enlarged euro area would be between 0.15 and 0.39 percentage points depending on the weights and the slopes of the Phillips curves.

As we found in the theoretical section, the distribution of inflation across countries depends on the real appreciation and size of each NMs. To gauge

¹⁴The model makes the simplifying assumption that shocks are sufficiently small to be accommodated within ERM II.

the size of the impact in the first two columns we assume that q_a ranges, in line with most estimates of the BS effect (Halpern and Wyplosz, 2001; Kovacs, 2002; Egert, 2003), between 1.5 and 3%; while in the third column we assume that q_a is equal to the average pace of appreciation between 1997 and 2003 (see Table 3).

The numerical results indicate that the impact on steady state inflation of the current euro area is limited (between 0.1 and 0.2%) if participating countries are weighted on the basis of nominal GDP. The deflationary impact on the euro area is instead more sizeable (between 0.2 and 0.4%), if GDP of NMs are weighted in terms of purchasing power parity. The size of the impact is clearly also an increasing function of the pace of real exchange rate appreciation in NMs. As shown in Table 1, in the period under review the average appreciation of the real exchange rate was stronger than the 3 percent threshold in 6 NMs out of 10. This does not mean necessarily, however, that trend will continue to prevail over the long term, as it may partly be a reflection of the undervaluation phase which characterised the early years of transition. Nevertheless, it underscores how a stronger pace of appreciation than suggested by the BS may prevail over a relatively long period of time. Indeed, 7 years of data are not sufficient to net out the possible impact of cyclical factors. The case of Poland is indicative, as the annual rate of real exchange rate appreciation has dropped from above 6% per annum between 1997 and 2001, to less than 2% between 1997 and 2003. To summarise, this analysis has shown how the impact on the current euro area is limited, if the upward pressure is postulated to be in line with most estimates of the BS effect. The deflationary impact on the euro area might be instead more sizeable if NMs are weighted in terms of purchasing power parities and a stronger real exchange rate appreciation process is assumed.

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 NMs 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 NMs in the aggregate measure of inflation and output. As was the case for currency boards, inflation and output stabilisation in NMs 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 NMs.

To examine the impact of country-specific shocks, suppose that an identical shock takes place in all NMs 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.

Table 4 allows us also to get some insights on the impact of real exchange rate shocks. Here again the impact on the enlarged euro area is in general limited (while the sign is ambiguous as it depends on $\alpha_a - \alpha_u$) and it tends to be rather large for the NMs. For example, an unexpected real exchange appreciation in NMs would result into higher inflation and a temporary boost to NMs' economies;¹⁵ whereas it would have only a small deflationary impact to the current euro area.

In summary, shocks persisting after enlargement may be problematic for the new entrants, and to a smaller extent for the union. Therefore, in assessing

¹⁵The negative effect on competitiveness, which may offset the positive impact on output growth, is outside the scope of this model.

the implications of euro area enlargement the issue of the endogeneity of shocks is a crucial one. The greater the fall in the variance of supply and real exchange rate shocks after enlargement, the stronger the positive impact on welfare for both NMs 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 90s 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.

7 Concluding remarks

In this paper, we have attempted to assess the economic implications of an enlargement of the European monetary union to include new Member States (NMs) of the EU within a simple analytical framework.

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 NMs and the euro area. The results of the numerical simulations critically depend on the relatively small size of NMs. For the euro area the impact on steady-state inflation is limited 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 NMs are weighted in terms of purchasing power parity. The simulations also confirm that the major impact on inflation and output stabilisation are borne by the NMs, 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 NMs critically depends on the slope of the Phillips curve. In particular, if the transmission mechanism of monetary policy differs among member states, real exchange rate shocks affect union wide inflation.

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.

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Appendix 1

Table 1: The Benchmark*

	Inflation (π_t)	Output (y_t)	Convergence gap (k_a)	Real exchange rate (q_a)	Weights		β_i	β_i	β_i
					GPP in Euro	GDP in PPP			
							$\alpha_a = 3.2$	$\alpha_a = 1.6$	$\alpha_a = 0.8$
Bulgaria	5.5	4.1	4.9	-3.7	0.2	0.6	-	-	-
Czech Republic	4.1	2.8	2.6	-3.6	0.8	1.9	1.60	0.80	0.40
Estonia	4.9	5.8	1.2	-3.0	0.1	0.2	-	-	-
Hungary	9.7	4.1	2.0	-4.3	0.7	1.5	0.39	0.20	0.10
Latvia	3.4	6.2	1.9	-2.7	0.1	0.2	1.60	0.80	0.40
Lithuania	2.2	5.3	2.3	-5.9	0.2	0.3	-	-	-
Poland	7.1	3.6	3.4	-1.9	2.3	4.2	0.97	0.49	0.24
Romania	39.9	4.3	3.9	-6.1	0.5	1.8	0.16	0.08	0.04
Slovak Republic	7.5	3.5	2.7	-5.0	0.3	0.7	0.72	0.36	0.18
Slovenia	7.3	3.7	1.5	-1.3	0.3	0.4	0.41	0.21	0.10

* percentage values

Source: Authors' data elaboration based on 1997-2003 data from Eurostat, ECB and IFS.

Table 2: Pre-Maastricht Phase: The Impact of Symmetric Supply Shocks on Inflation and Output*

	$\alpha_a = 3.2$	$\alpha_a = 3.2$	$\alpha_a = 1.6$	$\alpha_a = 1.6$	$\alpha_a = 0.8$	$\alpha_a = 0.8$
	$\hat{\pi}_i / \hat{\varepsilon}_i$	$\hat{y}_i / \hat{\varepsilon}_i$	$\hat{\pi}_i / \hat{\varepsilon}_i$	$\hat{y}_i / \hat{\varepsilon}_i$	$\hat{\pi}_i / \hat{\varepsilon}_i$	$\hat{y}_i / \hat{\varepsilon}_i$
Bulgaria	-0.38	-0.22	-0.38	0.39	-0.38	0.69
Czech Republic	-0.27	0.14	-0.48	0.24	-0.77	0.38
Estonia	-0.38	-0.22	-0.38	0.39	-0.38	0.69
Hungary	-0.30	0.04	-0.58	0.07	-1.08	0.13
Latvia	-0.27	0.14	-0.48	0.24	-0.77	0.38
Lithuania	-0.38	-0.22	-0.38	0.39	-0.38	0.69
Poland	-0.29	0.09	-0.53	0.16	-0.91	0.28
Romania	-0.31	0.02	-0.61	0.03	-1.18	0.06
Slovak Republic	-0.29	0.07	-0.55	0.12	-0.98	0.22
Slovenia	-0.30	0.04	-0.58	0.07	-1.08	0.14
EU12	-0.38	0.39	-0.38	0.39	-0.38	0.39

* percentage points

Table 3: The Enlargement Phase: Deviation of Inflation from Average Inflation in the Currency Union* ($\phi_u = 0$)

	$q_a = -1.5$	$q_a = -3$	q_a (Table 1)
GDP in Euro			
Bulgaria	1.4	2.8	3.5
Czech Republic	1.4	2.8	3.4
Estonia	1.4	2.8	2.8
Hungary	1.4	2.8	4.1
Latvia	1.4	2.8	2.5
Lithuania	1.4	2.8	5.7
Poland	1.4	2.8	1.7
Romania	1.4	2.8	5.9
Slovak Republic	1.4	2.8	4.8
Slovenia	1.4	2.8	1.1
EU12	-0.1	-0.2	-0.2
GDP in PPP			
Bulgaria	1.3	2.6	3.3
Czech Republic	1.3	2.6	3.2
Estonia	1.3	2.6	2.6
Hungary	1.3	2.6	3.9
Latvia	1.3	2.6	2.3
Lithuania	1.3	2.6	5.5
Poland	1.3	2.6	1.5
Romania	1.3	2.6	5.7
Slovak Republic	1.3	2.6	4.6
Slovenia	1.3	2.6	0.9
EU12	-0.2	-0.4	-0.4

* *percentage points*

Table 4: The Enlargement Phase: The Impact of Supply and Real Exchange Rate shocks on Inflation and Output*

	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
GDP in Euro	$\alpha_a = 3.2$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.02	-0.02	$\hat{\pi}_i / \hat{\eta}_a$	-0.92	0.08
	$\alpha_n = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	-0.20	$\hat{y}_i / \hat{\varepsilon}_a$	0.94	-0.03	$\hat{y}_i / \hat{\eta}_a$	-2.93	0.13
	$\alpha_a = 1.6$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.02	-0.02	$\hat{\pi}_i / \hat{\eta}_a$	-0.95	0.05
	$\alpha_n = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	0.39	$\hat{y}_i / \hat{\varepsilon}_a$	0.97	-0.03	$\hat{y}_i / \hat{\eta}_a$	-1.51	0.09
	$\alpha_a = 0.8$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.02	-0.02	$\hat{\pi}_i / \hat{\eta}_a$	-0.96	0.04
	$\alpha_n = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	0.70	$\hat{y}_i / \hat{\varepsilon}_a$	0.98	-0.03	$\hat{y}_i / \hat{\eta}_a$	-0.77	0.06
GDP in PPP	$\alpha_a = 3.2$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.37	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.04	-0.04	$\hat{\pi}_i / \hat{\eta}_a$	-0.82	0.18
	$\alpha_n = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	-0.18	$\hat{y}_i / \hat{\varepsilon}_a$	0.86	-0.07	$\hat{y}_i / \hat{\eta}_a$	-2.63	0.29
	$\alpha_a = 1.6$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.05	-0.05	$\hat{\pi}_i / \hat{\eta}_a$	-0.88	0.12
	$\alpha_n = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	0.39	$\hat{y}_i / \hat{\varepsilon}_a$	0.93	-0.07	$\hat{y}_i / \hat{\eta}_a$	-1.41	0.19
	$\alpha_a = 0.8$	$\hat{\pi}_i / \hat{\varepsilon}_i$	-0.38	$\hat{\pi}_i / \hat{\varepsilon}_a$	-0.05	-0.05	$\hat{\pi}_i / \hat{\eta}_a$	-0.91	0.09
	$\alpha_n = 1.6$	$\hat{y}_i / \hat{\varepsilon}_i$	0.69	$\hat{y}_i / \hat{\varepsilon}_a$	0.96	-0.07	$\hat{y}_i / \hat{\eta}_a$	-0.73	0.14

*percentage points