Quantifying the Effects of Abandoning National Monetary Policy

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February 2004

Abstract

The EU acceding countries are supposed to adopt the Euro as soon as economic convergence is achieved. This paper offers a methodology to quantify the economic consequences of an acceding country's EMU entrance. A small macroeconomic two-country model is specified and combined with two different monetary policy regimes: (i) national monetary policy, (ii) monetary union. The performance of the two regimes is analyzed in terms of inflation and output variability. A model-based optimum currency area index is obtained by computing the relative loss in terms of output gap and inflation rate variability in the two monetary policy regimes.

Keywords: Economic convergence, European monetary union, open economy macroeconomic models, optimal monetary policy, optimum currency area.

JEL classification: E52, F41, F42.

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1 Introduction

In December 2002, the European Union has closed negotiations for EU membership with 10 acceding countries. These countries are Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia. It is planned that these countries join the EU in time for the elections to the European Parliament scheduled for June 2004. Three other countries have applied for membership: Bulgaria, Romania and Turkey. However, negotiations have not yet started with Turkey, or are not yet closed in the case of the two accession countries Bulgaria and Romania. Unlike Denmark and United Kingdom, the ten acceding countries do not have a special status with respect to the European Monetary Union (EMU). They will join EMU with the status "countries with a derogation" and are supposed to adopt the Euro as soon as economic convergence is achieved.

While the Maastricht criteria (inflation rate, long-term interest rate, exchange rate stability, budget deficit and public debt) play a prominent role in the public discussion of the convergence status of acceding countries, this paper describes a model-based methodology to quantify the economic consequences of acceding countries' EMU entrance in terms of the respective country's output and inflation variability. The results provide additional information for the decision on the timing of EMU enlargement. The paper is related to other attempts to operationalize and quantify the optimum currency area theory, e.g. Bayoumi and Eichengreen (1997), de Grauwe (2003b), Fidrmuc and Korhonen (2003) and Kim and Chow (2003). A small two-country model is specified and combined with two different monetary policy regimes: (i) national monetary policy, and (ii) monetary union. The performance of monetary policy is analyzed in terms of inflation rate and output gap standard deviations. These are the usual components of central banks' loss functions in the literature. The relative loss, that is the value of the loss function in case of monetary union divided by the value of the loss function in case of national monetary policy, is interpreted as model-based optimum currency area index. With this approach it can be investigated under which conditions it is advantageous for acceding countries to join the European Monetary Union and what are the costs of joining EMU under non-optimal conditions.

2 A Simple Two-country Model for Monetary Policy Analysis

2.1 Output and Inflation Dynamics

The model describes the development of output gap and inflation rate in two countries. One country ("home") is an accession country, the other country ("foreign") represents the Euro area. The main components are home and foreign IS curve and home and foreign Phillips curve. IS and Phillips curve are specified like in the New IS-LM literature, that is they are forward-looking.[1]

The IS curve of the accession country is:

$$y_t = a_1 y_{t-1} + a_2 E_t y_{t+1} - a_3(R_t - E_t \pi_{t+1}) - a_4 q_t + x_{dt}, \qquad (1)$$

where y_t denotes output gap, R_t is the nominal interest rate, π_t symbolizes the inflation rate, q_t is the real exchange rate (an increase in q reflects a real appreciation), x_d is a demand shock and E_t is the expectation given the information available in period t. It is assumed that $a_i > 0$, that is real appreciation of the domestic currency lowers output because of a loss in competitiveness.

The Euro area IS equation has the same structure, but it is assumed that the real exchange rate between Euro area and an accession country does not affect the Euro area output gap:

$$y_t^f = a_1^f y_{t-1} + a_2^f E_t y_{t+1}^f - a_3^f(R_t^f - E_t \pi_{t+1}^f) + x_{dt}^f, \qquad (2)$$

where the superscript f indicates foreign country's variables or coefficients.

The accession country's Phillips curve is

$$\pi_t = \ln P_t - \ln P_{t-1} = b_1 E_t \pi_{t+1} + b_2 \pi_{t-1} + b_3 y_t + b_4 \Delta q_t + x_{\pi t}, \qquad (3)$$

where x_π is an inflation shock, P is the price level and $b_i > 0$. This Phillips curve includes the first difference of the real exchange rate like the Phillips curve in Batini and Haldane (1999). A real appreciation lowers domestic prices because imports become less expensive. The shock x_π can be interpreted as negative supply shock; this becomes apparent when the Phillips curve is solved for the output gap and is interpreted as aggregate supply relationship.

The Euro area Phillips curve is specified as follows:

$$\pi_t^f = \ln P_t^f - \ln P_{t-1}^f = b_1^f E_t \pi_{t+1} + b_2^f \pi_{t-1}^f + b_3^f y_t^f + x_{\pi t}^f. \qquad (4)$$

[1] The new IS-LM model is reviewed in King (2000), for example.

2.2 Case (i): Two National Monetary Policies

In case of two national monetary policy, an exchange rate equation has to be added. We use uncovered interest rate parity which is a core component of most macroeconomic models for open economies[2] for this purpose. Based on arbitrage considerations uncovered interest rate parity (UIP) states that the interest rate differential between two countries has to equal the expected change in the exchange rate:

$$E_t s_{t+1} - s_t = R_t^f - R_t + x_{st}, \tag{5}$$

where s is the logarithmic nominal exchange rate, x_s denotes an exchange rate shock which can also be interpreted as risk premium if domestic and foreign currency are not considered as complete substitutes.

The real exchange rate is

$$q_t = s_t + p_t - p_t^f, \tag{6}$$

where p_t is the logarithmic domestic price level and p_t^f is the logarithmic Euro area price level.

We restrict ourselves to a very simple national monetary policy rule here, namely the rule proposed by Taylor (1993a) which can be written for our purposes as follows:

$$R_t = c_1 \pi_t + c_2 y_t, \qquad c_1 > 1,\, c_2 > 0. \tag{7}$$

The desired inflation rate and the long-term real interest rate are set to zero. This is not restrictive and does not influence the following simulation results as long as they can be assumed to be constant. The analysis can easily be extended in the way it is done for example in Taylor (1999), that is interest-rate smoothing or forward-looking behavior can be implemented. $c_1 > 1$ guarantees that monetary policy has actually a stabilizing effect on the inflation rate ("Taylor principle").

Monetary policy in the Euro area is assumed to be conducted in the same way:

$$R_t^f = c_1^f \pi_t^f + c_2^f y_t^f, \qquad c_1^f > 1,\, c_2^f > 0. \tag{8}$$

In summary, the model contains five endogenous variables after substituting the the respective monetary policy rules for the interest rates in the IS curves. The vector of endogenous variables is

$$z_t = (y_t, p_t, s_t, y_t^f, p_t^f)'$$

[2]Taylor (1993b), for example, uses interest rate parity as one equation in his multicountry model for the analysis of macroeconomic policy questions. Merlevede et al. (2003) analyze various aspects of integration of EU acceding countries with the Euro area in a model in which interest rate parity is part of the nominal exchange rate equation. The model applied by Batini and Haldane (1999) for the discussion of monetary policy rules contains interest rate parity as one of its equations. Interest rate parity is also part of the so-called new open economy macroeconomics models based on the Redux model of Obstfeld and Rogoff (1995), for a recent exposition see Mark (2001).

and there are seven exogenous shocks:

$$x_t = (x_{dt}, x_{pt}, x_{st}, x_{Rt}, x^f_{dt}, x^f_{pt}, x^f_{Rt})'.$$

2.3 Case (ii): Monetary Union

The accession countries are relatively small compared to the Euro area as a whole. The sum of real GDP of all ten acceding countries is about 7% of Euro area real GDP, see European Central Bank (2002). Poland, which is the largest acceding country, exhibits a share of about 3% in Euro area real GDP. Therefore, it is assumed here that the single monetary policy in the Euro area follows the Taylor rule (8). In this case, the interest rate in the accession country is

$$R_t = R^f_t + x_{st} \tag{9}$$

which follows from uncovered interest rate parity when the expected change in the exchange rate is zero. The shock x_{st} is not set to zero because it is possible that national medium- and long-term interest rates differ in the currency union's member states due to differing economic outlooks.

In this case, the model contains four endogenous variables:

$$z_t = (y_t, p_t, y^f_t, p^f_t)'$$

and six exogenous shocks:

$$x_t = (x_{dt}, x_{pt}, x_{st}, x^f_{dt}, x^f_{pt}, x^f_{Rt})'.$$

3 Performance of Monetary Policy

The performance of monetary policy is measured in terms of output and inflation volatility. This is the standard measure in the related literature, see for example Taylor (1999).[3] The two-country model can be written in the following way:

$$Bz_t = CE_t z_{t+1} + Hh_t + Jj_t + Dx_t, \tag{10}$$

where

$$h_t = z_{t-1}, \quad j_t = h_{t-1}.$$

B, C, H, J and D are coefficient matrices. The model is solved numerically using the algorithm provided by Blanchard and Kahn (1980). First, however, the coefficients in IS

[3] Using a fully specified optimizing model would allow to assess performance in terms of the utility function of the representative household. This approach is proposed by Woodford (2003), for example.

curve, Phillips curve and monetary policy rule (a_i, b_i, c_i) have to be specified. Here we set the coefficients in a more or less arbitrary but nevertheless economically meaningful way. The same or similar coefficients have been used or estimated in previous studies. The numerical values are given in table 1.

The effects and performance of monetary policy do not only depend on the choice of the monetary policy regime but also on the correlation of the different shocks in the model economy. We put the focus on the correlation of domestic and area wide demand and supply shocks here; however, the analysis can easily be extended to study the influence of other shocks. Optimum currency area theory[4] predicts that the loss in national stabilization ability is low when shocks are symmetric while the costs of joining the currency area in terms of less stability are high in case of asymmetric shocks. The correlation of domestic and Euro area shocks is given by the correlation matrix of innovations in x_t:

$$\text{case (i):} \quad \Sigma_x^{(i)} = \begin{pmatrix} 1 & 0 & 0 & 0 & \sigma_{dd} & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & \sigma_{pp} & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ \sigma_{dd} & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & \sigma_{pp} & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix} \tag{11}$$

and

$$\text{case (ii):} \quad \Sigma_x^{(ii)} = \begin{pmatrix} 1 & 0 & 0 & \sigma_{dd} & 0 & 0 \\ 0 & 1 & 0 & 0 & \sigma_{pp} & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ \sigma_{dd} & 0 & 0 & 1 & 0 & 0 \\ 0 & \sigma_{pp} & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{pmatrix}. \tag{12}$$

Now we can simulate the model and calculate simulated time series for all variables, especially for output gap and inflation rate. The simulation has been run with a time series length of 100 observations and 500 replications. The shock processes are generated as AR(1)-processes with a first-order autocorrelation of 0.75 and innovations drawn from a multivariate normal distribution with covariance matrix implying the correlations given by $\Sigma_x^{(i)}$ and $\Sigma_x^{(ii)}$, respectively. Finally, the mean standard deviations of output gap and inflation rate over all replications are calculated. The correlations σ_{dd} and σ_{pp} lie between -1 and 1. The results are depicted in figures 1-3. Figures 1 and 2 show that the standard

[4]See de Grauwe (2003a) for an overview of optimum currency area theory, for example.

deviation of output is lower when demand and supply shocks are positively correlated. That symmetric shocks decrease the costs of currency areas is known from optimum currency area theory. However, figure 1 shows that two national monetary policy does also perform better in case of correlated shocks than in case of asymmetric shocks. Therefore, the costs following from the renunciation of national monetary policy have to be measured by the relative standard deviations of inflation rate and output gap. The relative standard deviations are shown in figure 3: the graphs show standard deviations of inflation rate and output observed in case of monetary union divided by the respective standard deviations in case of two national monetary policies. A new result obtained here is that positively correlated demand and supply shocks decrease the costs of a currency areas in terms of output gap variability but that the variability of the inflation rate is not minimized by positive correlation of productivity shocks. Furthermore, it can be seen that the variability of the inflation rate in a monetary union is lower than with two monetary policies when demand shocks are positively correlated. The variability of the output gap, however, is always higher in a monetary union – irrespective of the correlation of shocks. Joining a monetary union is therefore advantageous for a country if it puts a high weight on the reduction of the inflation rate's variability.

The results for inflation rate and output gap can be combined by specifying a loss function for monetary policy. We suppose here that the loss is defined as the sum of inflation variance and output gap variance:

$$L^{(i)} = \sigma_y^{(i)^2} + \sigma_\pi^{(i)^2} \qquad L^{(ii)} = \sigma_y^{(ii)^2} + \sigma_\pi^{(ii)^2} \tag{13}$$

Of course, a weighted sum can be calculated by a country in its decision making progress in order to consider its own preferences. The relative loss $L^{(ii)}/L^{(i)}$ is a model-based optimum currency area index. The larger it is, the larger are the costs of the currency area in terms of less national stability. It is advantageous to join the currency area, if the index is smaller than one. The index depends inter alia on the correlations of national supply and demand shocks with the corresponding shocks in the Euro area, see figure 4. In case of equal weights on output and inflation variance, the loss is always higher in a monetary union. However, this picture alters when the weight on the inflation rate in the loss function is increased. Then it is possible that the relative loss is smaller than one which indicates that it is advantageous to join the monetary union.

Country-specific information is provided in table 2 which shows the results of the analysis for individual accession countries. These results are very preliminary because they are based on the relatively arbitrarily specified coefficients in IS and Phillips curve. The correlations of accession countries' supply and demand shocks with the corresponding

Euro area shocks are taken from Fidrmuc and Korhonen (2003) who follow Blanchard and Quah (1989) and impose the restriction that demand shocks do not affect real output in the long-run in order to identify supply and demand shocks in a two dimensional vector autoregressive model for output growth and inflation rate. Additionally, the standard deviation of shocks on the country-specific risks premiums implied by uncovered interest rate parity (x_{st}) is allowed to vary between countries. These standard deviations have been calculated in Holtemöller (2003). While Bulgaria, Estonia and Slovenia would profit from joining the monetary union in terms of lower inflation variability, none of the accession countries currently exhibits a relative loss smaller than one. Accordingly, it is advantageous for each country two follow a national monetary policy and not to fix its exchange rate against the Euro yet. This may change in the future if the correlation of national demand shocks with Euro area demand shocks increases and if the variance of country-specific shocks x_{st} decreases.

4 Conclusions

In this paper, a methodology for the construction of a model-based optimum currency area index is developed: A small macroeconomic two-country model is specified and combined with two different monetary policy regimes, namely national monetary policy and monetary union. In the latter case, the nominal interest rate of a potential EMU accession country is simply set to the Euro area interest rate and Euro area monetary policy follows a simple Taylor rule. The main ingredients of the model are forward-looking IS and Phillips curves for the two countries. The model is solved numerically and output gap and inflation rate are simulated for the two monetary policy regimes and for different correlations of domestic and Euro area demand and supply shocks. Based on the current numerical specification, the abandonment of national monetary policy may lead to a lower inflation variability but to a higher output variability. Depending on national preferences, a loss function for monetary policy can be constructed. The relative loss, that is the value of the loss function in the monetary union divided by the value of the loss function in case of national monetary policy, can be interpreted as a model-based optimum currency area index: it is advantageous for an accession country to join European Monetary Union if the relative loss is smaller than one, that is if the weighted sum of inflation rate and output gap standard deviations is smaller in case of monetary union than in case of two national monetary policies. These results may help to choose the appropriate monetary policy regime that fits a country's preferences. The next steps in the analysis will be an empirically guided specification of the coefficients in the equations of the model – either by calibration or by estimation – and a more systematic analysis of the impact of different shock constellations on the stabilizing effects of monetary policy. The decision about the timing of EMU entrance may also be supported by the described methodology by introducing time dependent coefficients into the model. The coefficients of the real exchange rate in IS and Phillips curve and the correlation of supply and demand shocks, for example, possibly change over time.

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Figure 1: Performance of National Monetary Policies

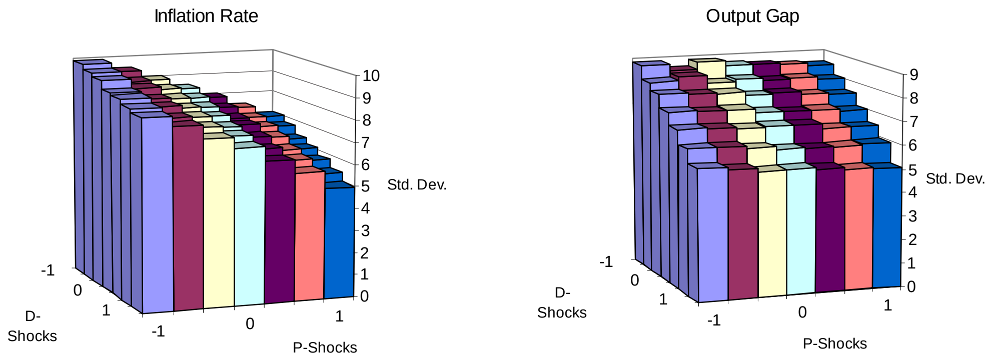

Figure 2: Performance of Monetary Union

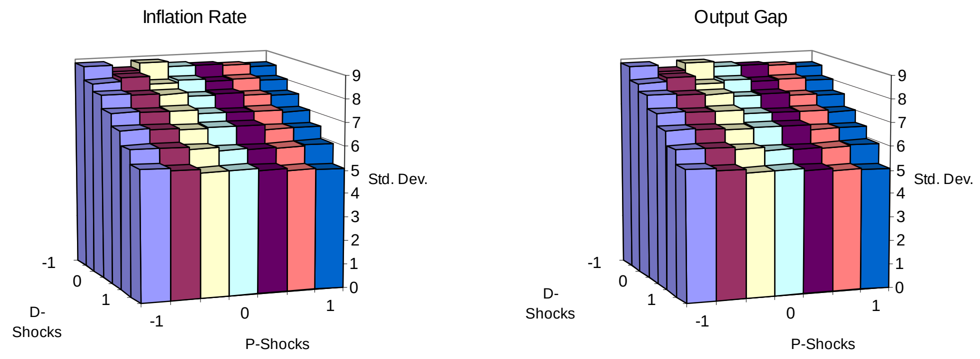

Figure 3: Relative Performance

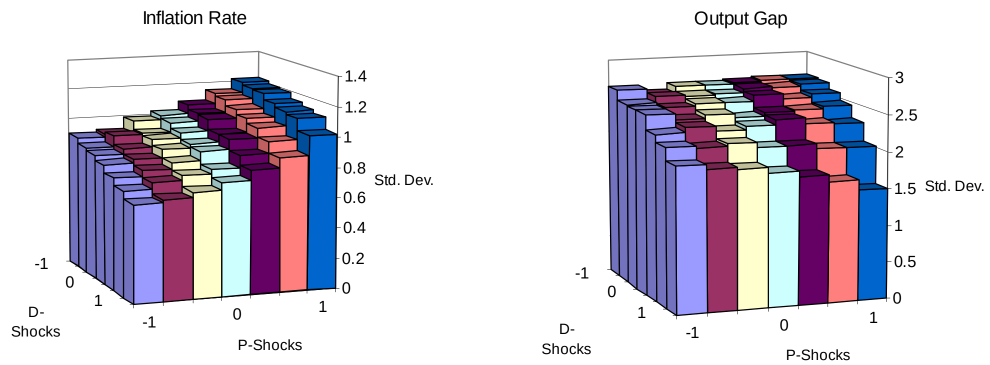

Figure 4: Relative Performance in Case of a Loss Function with Equal Weights on Inflation and Output Variance

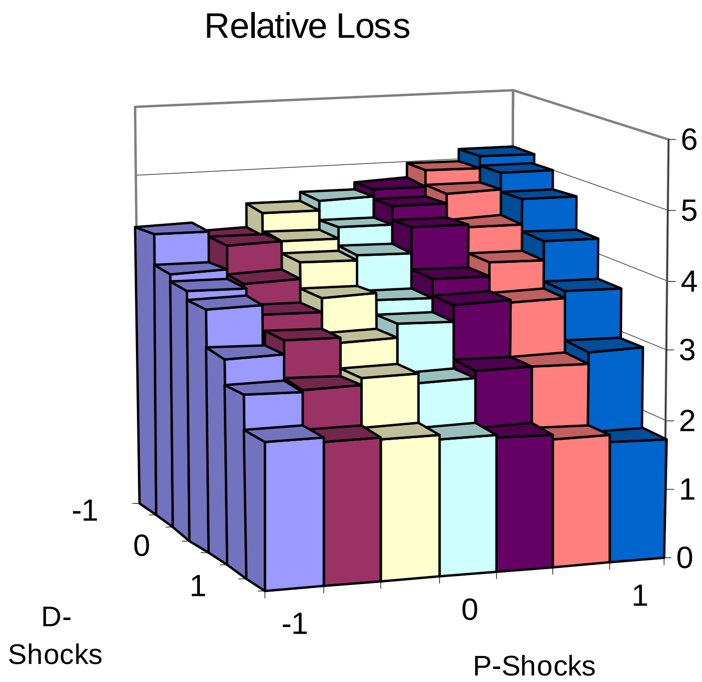

Table 1: Numerical Specification of Coefficients

Coefficient	Value
$a_1 = a_1^f$	0.5
$a_2 = a_2^f$	0.5
$a_3 = a_3^f$	0.5
a_4	0.002
$b_1 = b_1^f$	0.85
$b_2 = b_2^f$	0.15
$b_3 = b_3^f$	0.1
b_4	0.2
$c_1 = c_1^f$	1.5
$c_2 = c_2^f$	0.5

Table 2: Performance of Monetary Policies in Accession Countries

Country	σ_{pp}	σ_{dd}	σ_s	$\sigma_y^{(i)}$	$\sigma_\pi^{(i)}$	$\sigma_y^{(ii)}$	$\sigma_\pi^{(ii)}$	$\sigma_y^{(ii)}/\sigma_y^{(i)}$	$\sigma_\pi^{(ii)}/\sigma_p i^{(i)}$	$L^{(ii)}/L^{(i)}$
Bulgaria	-0.03	0.03	0.93	8.73	7.75	21.16	7.10	2.42	0.92	3.66
Czech Rep.	0.04	-0.15	5.96	9.81	9.14	43.60	13.39	4.44	1.46	11.57
Estonia	0.25	0.12	0.09	8.43	7.27	18.89	6.66	2.24	0.92	3.24
Hungary	0.46	0.25	8.97	9.78	9.75	60.56	18.49	6.19	1.90	21.02
Latvia	0.30	-0.49	6.17	9.92	8.98	45.72	14.11	4.61	1.57	12.79
Lithuania	-0.11	-0.49	5.53	10.24	9.34	42.66	14.11	4.17	1.51	10.51
Poland	0.08	0.28	2.77	8.45	7.72	25.37	8.34	3.00	1.08	5.44
Romania	0.02	0.03	10.01	10.81	10.97	67.90	20.54	6.28	1.87	21.22
Slovakia	0.05	-0.05	5.48	9.57	8.80	41.01	12.70	4.29	1.44	10.90
Slovenia	0.15	-0.18	0.87	8.90	7.72	21.77	7.35	2.45	0.95	3.80

Notes: The table shows standard deviations of output gap (σ_y) and inflation rate (σ_π) in accession countries. Case (i) refers to two national monetary policies, case (ii) to monetary union. The correlations of demand (σ_{dd}) and supply (σ_{pp}) shocks with the respective Euro area shocks are taken from Fidrmuc and Korhonen (2003) and the standard deviations of UIP shocks (σ_s) from Holtemöller (2003). The loss function is $L = \sigma_y^2 + \sigma_\pi^2$.