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Uncovered interest rate parity and analysis of monetary convergence of potential EMU accession countries

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Abstract. This paper analyzes deviations from uncovered interest rate parity which are interpreted as indicator of the substitutability of currencies. Backward recursive statistical tests and error correction models are applied to study the co-movement of interest rates, and rolling regressions are used to study size and volatility of country specific risk premiums. In accordance to their degree of monetary integration with the Euro area, new EU members and accession countries are divided into three groups. Estonia and Lithuania seem to exhibit the highest degree of monetary integration with the Euro area.

Key words: Cointegration, economic convergence, European monetary union, monetary integration, interest rate parity, risk premium

JEL Classification: C22, C32, F36, F41

1 Introduction

In May 2004, ten new members – Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia – have joined the European Union (EU). 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 new members do not have a special status with respect to the European Monetary Union (EMU). They have joined EMU

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with the status "countries with a derogation" and are supposed to adopt the Euro as soon as economic convergence is achieved (European Central Bank, 2002a). However, it is a difficult task to measure economic convergence. Sweden also holds the status of a country with derogation and is committed by the Treaty establishing the European Community to adopt the Euro. Because Sweden has not joined the European Exchange Rate Mechanism (ERM II) yet, it cannot fulfill one of the Maastricht criteria, namely membership in the ERM II for at least two years without devaluation, see European Central Bank (2002b, p. 3).

The purpose of this paper is to analyze convergence of interest rates and stability of exchange rates in potential EMU accession countries, that is in new member states and accession countries. The EU members Denmark, Sweden and United Kingdom are also included in the analysis. The results are compared to evidence for Greece which has entered the Euro area in January 2001. Cyprus and Malta are excluded form the analysis because of their minor economic importance (about 1.2% of new member states' population and about 3% of their GDP, see European Central Bank (2002a)) and the lack of reliable data. Following uncovered interest rate parity theory, the difference between domestic and foreign interest rates should correspond to the expected exchange rate change plus a risk premium. When reaching economic integration, this risk premium should disappear such that the development of the risk premium can be interpreted as measure of monetary integration. This is only one aspect of economic convergence; fiscal policy indicators, inflation rate and legal system, inter alia, are other important factors which are not considered here. An overview of the overall convergence processes in EU acceding and accession countries is given for example by Piazolo (2000).

The econometric procedure applied in this paper and the country-specific empirical results provide useful information for the assessment of the monetary convergence process in terms of the development of country-specific risk premiums. This information is important for at least two reasons: (1) It reveals how participants in financial markets assess the convergence status of the acceding countries. Costs and benefits of EMU enlargement will depend inter alia on financial markets' confidence in the proper selection of new EMU members[1], and public confidence is reflected in convergence of interest rates and exchange rate stability. (2) Structural theoretical models describing monetary convergence and integration are needed to analyze welfare effects of monetary policy strategies in general and of the European integration process in special. As uncovered interest rate parity is an important component of theoretical international monetary economic models, the empirical evidence reported in this paper may serve as stylized facts which may be useful for the specification, parameterization and also for the evaluation of theoretical models.

[1] See de Grauwe (2003a) for a general discussion of costs and benefits of European Monetary Union; Bayoumi and Eichengreen (1997) provide an optimal currency area (OCA) index for European countries; Kim and Chow (2003) analyze whether western European countries form an OCA; de Grauwe (2003b) and Fidrmuc and Korhonen (2003) discuss OCA aspects of EMU enlargement.

The paper is organized as follows: In section 2, methodological issues are addressed, section 3 presents the empirical results and section 4 provides conclusions. The main result of this study is that some countries show stationary interest rate spreads against the Euro area interest rate, low or decreasing risk premiums and low or decreasing volatility of risk premiums while others face high or even increasing risks signaling problems with the convergence and integration process. According to the presented results, Estonia is the country with the highest degree of monetary integration; on the other hand, Hungary exhibits still a non-stationary interest rate spread (about 10.2 percentage points in March 2004) and increasing risk premium volatility.

2 Methodological issues

2.1 Uncovered interest rate parity and substitutability of currencies

Interest rate parity is a core component of most macroeconomic models for open economies. Taylor (1993), 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 does contain 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).

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.[2] Denote the domestic nominal interest rate per annum in period t by i_t, the corresponding interest rate of the reference country by i_t^*, and the exchange rate in terms of reference currency per domestic currency by S_t, then UIP for monthly data can be written as:

$$\frac{12}{k}\Delta_k s^e_{t+k} = i^*_t - i_t, \tag{2.1}$$

where $s_t = \ln S_t$, $\Delta_k s^e_{t+k} = s^e_{t+k} - s_t$, k is the maturity in months related to the interest rates, and superscript e indicates expected values. Domestic and foreign interest rate have to be identical with respect to maturity, uncertainty, default probability etc. of the corresponding asset. The factor $(12/k)$ annualizes the expected exchange rate change in order to have the same horizon as the interest rates. According to UIP, a higher domestic interest rate indicates an expected devaluation of the domestic currency while a lower domestic rate than the reference interest rate indicates an expected appreciation of the domestic currency.

[2]For a textbook treatment of interest rate parity see for example Krugman and Obstfeld (2003) or the more advanced book by Mark (2001) and the references given there, recent discussions about UIP and capital market efficiency can be found in Levich (1989), McCallum (1994), Engel (1996), Chinn and Meredith (1998), and Cheung et al. (2002), for example.

However, this strict form of UIP can only be expected to hold, if foreign and domestic currencies are perfect substitutes. This is seldom the case, so the relation has to be augmented by a country-specific and possibly time varying risk premium ϕ_t:

$$\frac{12}{k}\Delta_k s^e_{t+k} = i^*_t - (i_t - \phi_t) \tag{2.2}$$

or

$$\phi_t = \left(i_t - i^*_t\right) + \frac{12}{k}\Delta_k s^e_{t+k}. \tag{2.3}$$

The risk premium is positive if the domestic interest rate is higher than UIP predicts. The time path of ϕ_t can ex-post be interpreted as an indicator for the substitutability of domestic and reference currency by replacing the expected exchange rate change with the ex-post observed exchange rate change. If a systematically positive or negative risk premium exists, the two currencies are not yet close substitutes, which indicates that monetary integration has not been achieved yet. On the other hand, if the risk premium fluctuates with low or diminishing variance around zero, domestic and reference currency are accepted as close substitutes which may be interpreted as evidence in favor of economic integration. Imposing on average correct exchange rate change expectations by replacing Δs^e_{t+k} by Δs_{t+k} is not very restrictive here: Large and frequent forecast errors should only occur if monetary integration is low such that the interpretation of the observed UIP deviation is not distorted by the assumption of correct exchange rate change expectations. Moreover, since expectations are assumed to be rational, expectation errors average out over time.

Deviations from UIP are also used as a measure of financial integration for a group of industrial countries by Lothian (2002). The development of country-specific risk premiums in the three acceding countries Czech Republic, Hungary and Poland has been analyzed by Orlowski (2003) who distinguishes between inflation rate premium and exchange rate premium and interprets a simultaneous decline in both premiums as indicator for monetary convergence.

2.2 Data and empirical methodology

Monthly data on interest rates and exchange rates of potential new EMU members are taken from International Financial Statistics and the internet home pages of central banks.[3] The respective sample periods depend on data availability. The beginnings of the samples vary between 1994:1 and 2002:3 and the sample ends between 2002:6 and 2004:10. The interest rates are 3-month money market rates where available and 1-month money market rates for Slovenia and Bulgaria. The Euro area interest rate is chosen such that it corresponds to the maturity of the respective interest rate selected for the

[3]See data appendix for further details.

individual countries. The difference order k for the nominal exchange rate is chosen accordingly.

The following empirical methodology is applied. The risk premium is considered in terms of a stochastic process ϕ_t. According to Wold's decomposition theorem, every covariance-stationary stochastic process can be decomposed into a deterministic process μ_t and a moving-average (MA) process u_t, see for example Hamilton (1994). The stochastic term u_t can be approximated by an autoregressive moving-average process of suitable order, ARMA(p, q):

$$\phi_t = \mu_t + u_t = \mu_t + \sum_{i=0}^{\infty} \psi_i \varepsilon_{t-i} \approx \mu_t + \sum_{i=1}^{p} \rho_i u_{t-i} + \sum_{i=0}^{q} \theta_i \varepsilon_{t-i}, \tag{2.4}$$

where ε_t is a serially uncorrelated innovation process with mean zero and constant variance. In case of monetary integration, μ_t should be small or even zero and ϕ_t should be stationary or integrated of order zero because otherwise shocks on the risk premium were persistent and the risk premium exhibited no tendency to return to its unconditional mean. Before monetary integration is achieved, a significant or even non-stationary country-specific risk premium may be observed.

Given the common empirical finding that exchange rates are best described by random walks, exchange rate changes are integrated of order zero, I(0). Since interest rates can be supposed to be integrated of order one, the interest rate spread can only be integrated of order zero if domestic and reference interest rates are cointegrated with cointegrating vector (1, −1). This implies that the risk premium can only be integrated of order zero if the spread between the domestic and reference interest rates is stationary, see again equation (2.3). Therefore, the first step of the econometric procedure is to test if domestic and reference interest rates are cointegrated. Backwards recursive Johansen trace tests and likelihood ratio (LR) tests for restrictions on the cointegration vector are applied for this purpose. The LR trace test for the cointegration rank would also reveal the case in which both interest rates were integrated of order zero, such that univariate unit root tests for the interest rates need not to be reported here.[4] The LR trace test is a test for the rank r of the matrix Π in the vector error correction representation of a n-dimensional vector autoregressive (VAR) model for domestic and foreign interest rate ($n = 2$), see for example Johansen (1995) or Lütkepohl (2001):

$$\Delta x_t = (\Pi : v)\begin{pmatrix} x_{t-1} \\ 1 \end{pmatrix} + \sum_{i=0}^{p-1} \Gamma_i \Delta x_{t-i} + e_t, \tag{2.5}$$

where $x_t = \left(i_t, i_t^*\right)'$, Γ_i are 2×2 coefficient matrices, p is the lag length of the level representation of the VAR model and e_t is a 2-dimensional serially uncorrelated error term. v reflects a constant restricted to the cointegration space. This deterministic specification implies that interest

[4] An analysis of the integration properties and cointegration relations of Euro area and U.S. interest rates with different maturities is provided by Wolters (2002). He shows that Euro area interest rates with different maturities are integrated of order one which is compatible with the present case.

rates do not follow a linear trend and that the long-term equilibrium relation between the interest rates may include a constant term which reflects the sum of average expected exchange rate change and risk premium. The matrix Π can be decomposed into two $(2 \times r)$-matrices α and β such that $\Pi = \alpha\beta'$, where β denotes the cointegrating vector(s) and $\alpha = (\alpha_1, \alpha_2)'$ contains the adjustment parameters. α_1, that is the adjustment coefficient of the domestic interest rate, is reported in the empirical analysis. It characterizes the adjustment of the respective accession country's interest rate in direction of the long-run equilibrium between domestic and Euro area interest rate. The null hypotheses of the LR trace tests are that the cointegration rank, that is the number of linearly independent stationary relations between the variables, is at most zero (LR(0)), and that the cointegration rank is at most one (LR(1)), respectively. The null hypothesis is rejected if the LR trace statistic is larger than the corresponding critical value. If $r = 0$ then there is no stationary relation. The existence of a stationary relationship between the interest rates $(\beta' x_t)$ is indicated by a cointegration rank of $r = 1$. If $r = 2$ both variables are integrated of order zero. When a single stationary relation between domestic and foreign interest rate is present, it is tested if the restriction $\beta = (1, -1)$ is rejected using the LR test for restrictions on the cointegration vector, see Johansen (1995). If this restriction is not rejected, it can be concluded that the spread $\beta' x_t = i_t - i_t^*$ is integrated of order zero.

The minimum number of observations for the backward recursive LR trace tests is 24. The LR trace test for the cointegration rank is distorted for small samples in the sense that a correct null hypothesis is rejected with a probability that may differ substantially from the nominal significance level of the test. Johansen (2002b) proposes a data and model dependent correction factor which corrects the size of the test. This correction factor is calculated for each sample and is taken into account in the decision on the cointegration rank. In the graphical representations of the backward recursive tests, however, only the constant asymptotic critical values are depicted. The corrected critical values vary with each recursive step and would make the graphs much less readable.[5] A similar correction is possible for testing restrictions on the cointegration vector, see Johansen (2000, 2002a). Since the null hypothesis is usually rejected too often, the correction may only change the test result when the restriction is rejected. Since the lowest p-value in the empirical application (0.02 for Slovak Republic) does not reject the null hypothesis at a significance level of 1%, this correction has not been implemented here. In all other relevant cases, the p-value is larger than 0.05.

In the second step, rolling regressions with a window of 24 observations of the type:

$$\phi_t = \phi_0 + u_t, \quad u_t = \varepsilon_t + \theta_\ell \varepsilon_{t-\ell} + \rho_1 u_{t-1}, \tag{2.6}$$

allowing for a non-zero, locally constant risk premium ϕ_0, are conducted. The window size is set to 24 months because this is also the length of the

[5] The corrected critical values can be obtained from the author upon request.

reference period for the Maastricht criteria.[6] The MA term is included to take into account that an MA error is possibly introduced by taking k^{th} differences of the exchange rate. The empirical calculations have shown that one AR and one MA term are sufficient to eliminate autocorrelation in the residuals. The inverted root of the AR polynomial is checked, and if the AR polynomial is actually stationary, it is tested within every window whether the constant ϕ_0 is significant at the 5%-level. Additionally, the standard error of the regression, σ_ε, is analyzed. Because there might be heteroscedasticity even in the 24 months windows, the Newey-West heteroscedasticity and autocorrelation consistent (HAC) estimator for the covariance matrix is used, see Hamilton (1994 p. 282 f).

The information about the cointegration properties of the interest rates, the recursively calculated time paths of the risk premium ϕ_0 and the corresponding standard error of the residuals, which is a measure of the volatility of the risk premium, are used to assess the integration status of the potential EMU candidates. Three groups of countries are identified:

1. Low degree of monetary integration (group one):
   - There is no co-movement of Euro area and domestic interest rate.
   - The risk premium is still large and/or highly unstable.
2. Medium degree of monetary integration (group two):
   - Euro area and domestic interest rates are cointegrated with cointegration vector $(1, -1)$ and the domestic interest rate adjusts towards the Euro area interest rate (α_1 is negative and significantly different from zero).
   - The risk premium is still large and/or unstable.
3. High degree of monetary integration (group three):
   - Euro area and domestic interest rates are cointegrated with cointegration vector $(1, -1)$ and the domestic interest rate adjusts towards the Euro area interest rate (α_1 is negative and significantly different from zero).
   - The risk premium is small and its variability is decreasing.

In the following section, the empirical results are presented and each country is classified as belonging to one of these groups.

3 Empirical results

3.1 The benchmark case: Greece

Greece has joined EMU in January 2001 and is the only country that has entered the Euro area after the beginning of stage three of EMU in 1999 so

[6]The economic development of EMU accession countries which are already members of the EU is discussed in terms of the Maastricht criteria in the Convergence Report that is published every two years in May by the ECB. Robustness checks with window sizes of 12, 18, 30 and 36 months have shown that the volatility of the risk premium is higher when a smaller window is considered. On the other hand, broader windows increase the persistence of the risk premiums. However, the qualitative results tend to be insensitive against the window size specification.

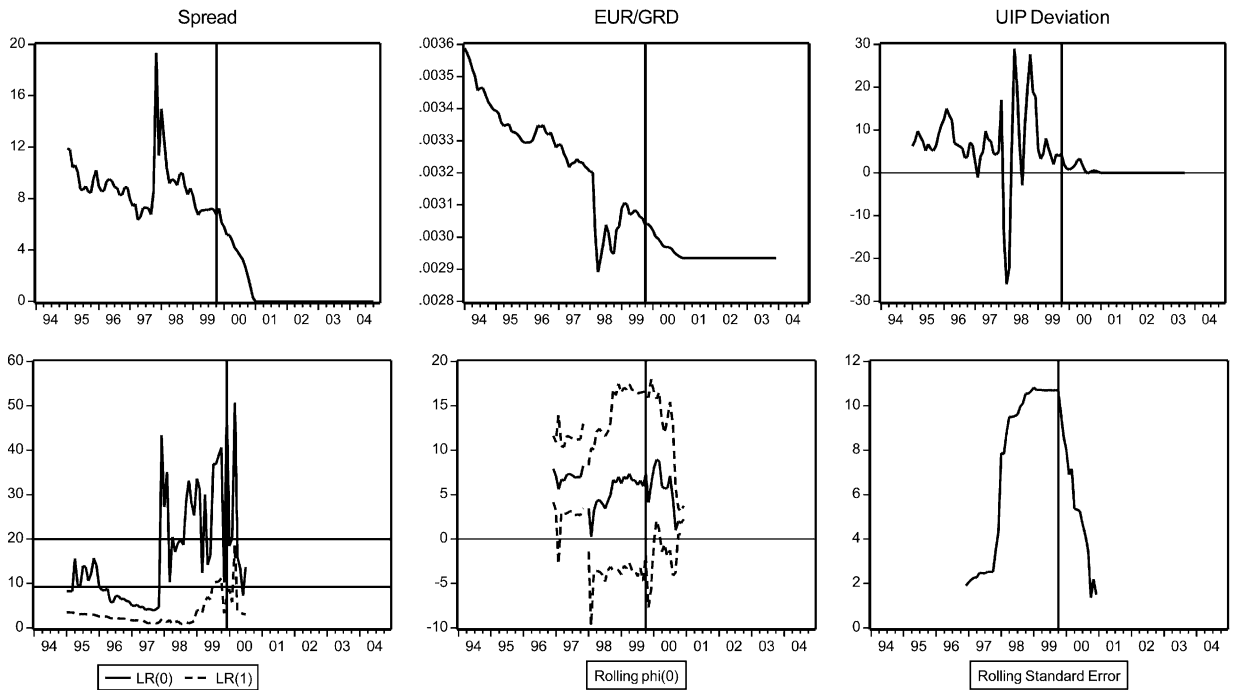

Fig. 1. Results for Greece *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed (2002:6). The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window. Interest rates are found to be cointegrated for the sample beginning at the vertical line

far. Economic convergence of Greece has been analyzed in European Central Bank (2000, 2001) and in June 2000 the ECOFIN council decided that Greece had fulfilled the necessary conditions for EMU entrance. For the following UIP analysis, the 3-month money market rate (Athibor) is taken as Greek interest rate. However, this time series ends in December 2000. Afterwards, the 3-month Euribor is the relevant Greek money market interest rate. In order two have at least 24 observations after the ECOFIN council decision, the Greek money market interest rate is the 3-month Athibor until December 2000 and the 3-month Euribor from January 2001 to June 2002. Accordingly, the 3-month Euribor is the reference interest rate. Exchange rate changes are $s_{t+3} - s_t$. The results of the previously described econometric procedure for Greece are as follows. LR tests for the cointegration rank of Greek and Euro area interest rates indicate that the spread can be assumed to be integrated of order zero since the end of 1999, see figure 1. The figure consists of two rows. The upper row shows from left to right: the difference between Greek and Euro area 3-month money market interest rates, the exchange rate in Euro per Greek drachma, and the ex-post UIP deviations. The lower row shows from left to right: the backward recursive LR trace test statistics together with the asymptotic critical values (sample beginning according to time-axis, sample ending 2002:6), the rolling risk premium and the rolling standard error of the risk premium regression (24 months windows, sample ending according to time-axis). The figures for all other countries are structured in the same way. Since 1999:10, indicated by the vertical line, the LR trace statistic (lower left graph) is not only larger than the asymptotic critical value but also higher than the corrected critical value, see table 1. Furthermore, the LR trace test statistic for the hypothesis that there is at most one cointegration relation (LR(1)) is smaller than the corresponding critical value. Therefore, it can be concluded that both the Euro area and the Greek interest rate are integrated of order one, and that one stationary linear combination exists when the sample starts in 1999:10. At that time, the Greek interest rate has been about 6 percentage points above the Euro area interest rate and the spread stayed positive until the end of 2000. However, according to the test results, the cointegration vector (1, -1) has been an attractor for the Greek interest rate since then. In the corresponding VECM with a constant restricted to the cointegration space, the LR test statistic for the (1, -1)-restriction has a p-value of 9.7%, and the Greek interest rate adjusts significantly (adjustment parameter $\alpha_1 = 0.04$, t-statistic: -2.13) while the Euro area interest rate adjustment coefficient is not significant. Therefore, it is assumed in the following that the spread is stationary since 1999:10. Figure 1 does also show the rolling intercept ϕ_0 and the rolling standard deviation of ε_t. It can be seen that the development of deviations from UIP corresponds quite well to the results of the cointegration analysis. Although the rolling risk premium has not vanished until the introduction of the Euro, the standard error of the innovation process ε_t is decreasing sharply after 1999:10. In time of the ECOFIN decision in June 2000, the risk premium has still been relatively large, such that Greece would

Table 1 Summary of empirical results

Country Sample	Spread I(0) Obs.	Lags Info-Crit.	LR(0) CV	LR(1) CV	LR p	α_1 t-Stat.	ϕ_0 t-Stat.	σ_ε
Greece 95:01–02:06	99:10 33	1 AIC	40.58 20.50	11.17 19.42	0.097	−0.04 −2.13	5.93 1.47	5.23
Sweden 94:01–04:03							0.97 2.03	2.93
Denmark 94:01–04:10	02:08 27	1 SC	28.09 20.64	7.43 11.90	0.550	−0.98 −5.16	0.03 0.15	0.28
U.K. 94:01–04:10							−5.34 −0.63	6.87
Czech Rep. 98:05–04:10							−1.62 −0.58	5.47
Estonia 96:01–04:10	99:01 70	6 AIC/HQ/SC	116.69 66.09	2.75 23.56	0.150	−0.16 −13.08	0.53 6.82	0.09
Hungary 00:01–04:03							4.48 0.72	10.54
Latvia 99:01–04:09							−4.02 −1.02	7.01
Lithuania 99:01–04:10	00:01 58	5 AIC/HQ	64.75 29.79	7.58 18.38	0.107	−0.26 −8.58	0.50 8.33	0.12
Poland 99:01–04:10							1.38 0.13	8.33
Slovakia 97:10–04:10	00:01 58	6 AIC/HQ	37.04 23.35	4.98 9.58	0.022	−0.19 −4.92	5.80 2.15	3.70

Slovenia							0.96	0.88
02:03–04:09							5.21	
Bulgaria	01:11	1	22.88	9.89	0.422	−0.35	0.62	0.79
99:01–04:09	35	AIC/HQ	20.47	10.78		−2.55	2.27	
Romania							7.12	8.56
96:01–04:10							1.55	

Notes: Column 2 (Spread I(0)) indicates since when the spread can be supposed to be stationary and shows the number of observations included in the corresponding VECM, column 3 shows the lag length of the VECM and the information criterion on which the lag length selection relies, column 4 (LR(0)) reports the trace statistic for the hypothesis $r = 0$ together with corrected 5% critical values (sample beginning according to column 2), column 5 (LR(1)) reports the trace statistic for the hypothesis $r \leq 1$ together with corrected 5% critical values and column 6 (LR *p*) is the *p*-value of the likelihood ratio statistic for the test of the restriction (1,−1) on the cointegration vector in the two-dimensional vector error correction model for domestic and euro area interest rate with a constant restricted to the cointegration space. Column 7 (α_1) shows the adjustment coefficient of the domestic interest rate in the corresponding VECM and its *t*-statistic. Column 8 (ϕ_0) shows the estimate of ϕ_0 for the most recent window (1998:7–2000:6 for Greece) and its *t*-statistic. Column 9 (σ_ε) is the standard error of regression for the most recent window.

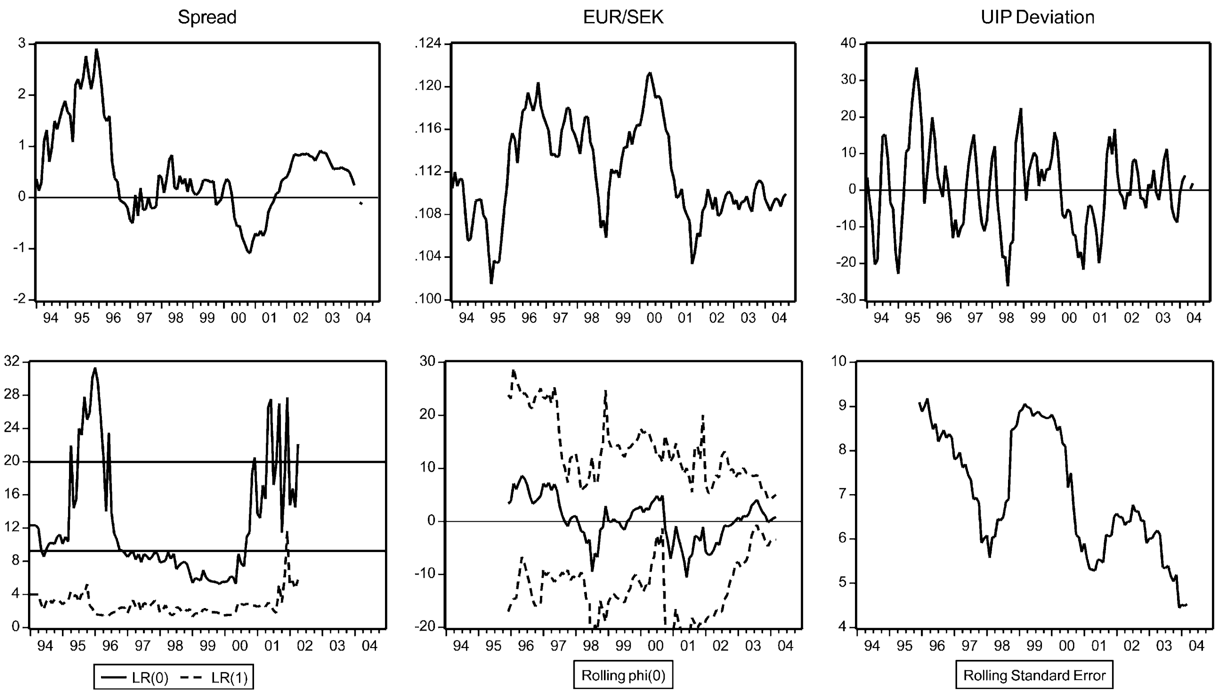

Fig. 2. Results for Sweden *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

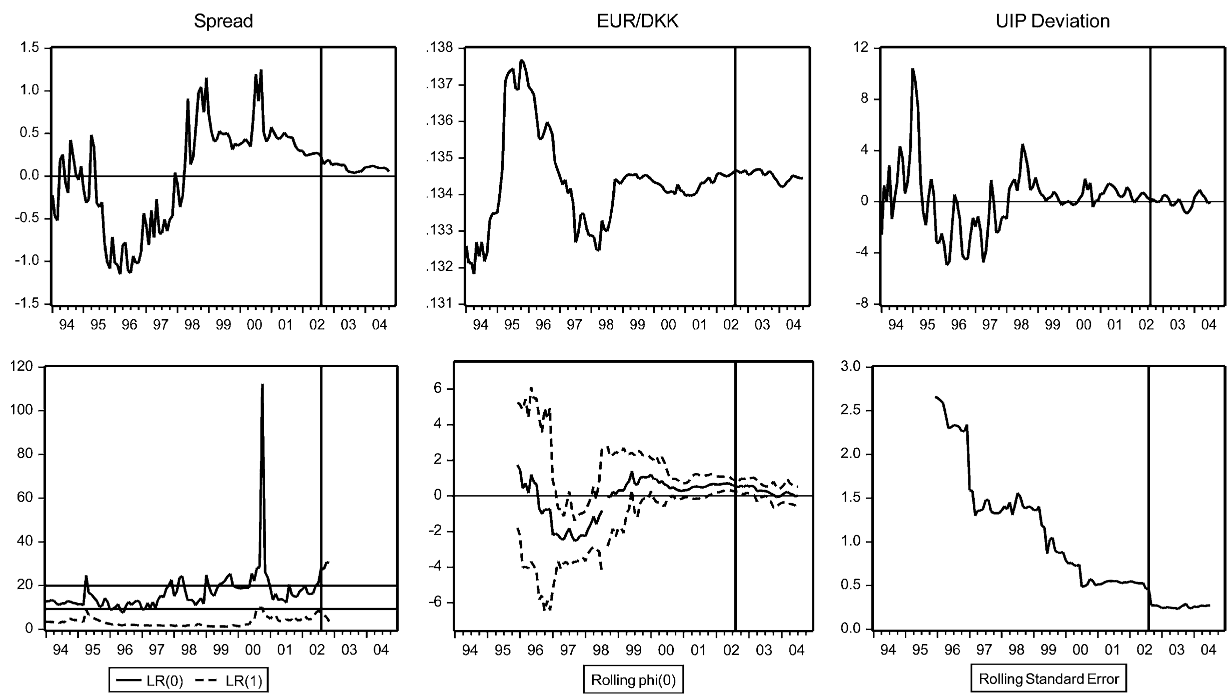

Fig. 3. Results for Denmark *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to AIC) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window. Interest rates are found to be cointegrated for the sample beginning at the vertical line

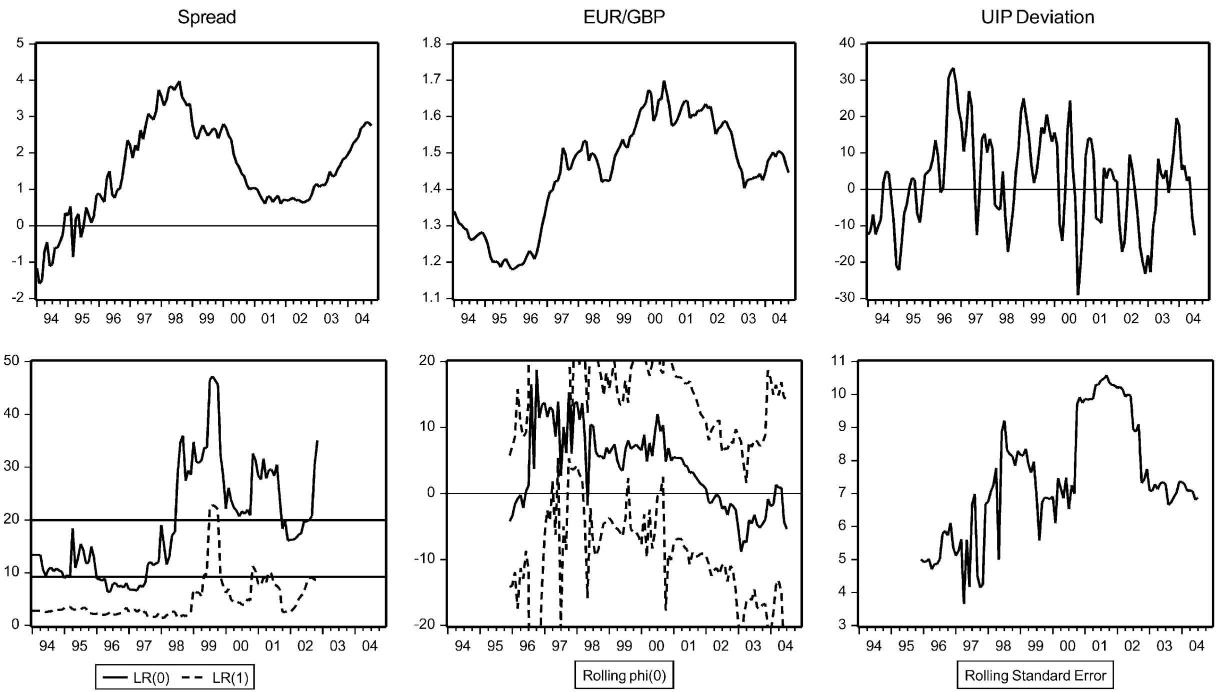

Fig. 4. Results for United Kingdom *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

have been assigned to the medium degree of integration group at that time. Overall, it can be stated that Greece has been very close to integration in the beginning of 2000.[7]

3.2 EU members Denmark, Sweden, and United Kingdom

Denmark and the United Kingdom have a special status with respect to EMU. They are not obliged to adopt the single currency. However, they have the possibility to join the Euro area if they declare that they are willing to join and if they fulfill the necessary conditions, see European Central Bank (2002b). Sweden does not participate in the Exchange Rate Mechanism II (ERM II) but is committed by the EU Treaty to adopt the Euro as soon as convergence has been achieved. The results for these three countries are reported in Table 1 and in Figures 2 to 4. The Danish and Euro area 3-month money market rates can be considered as cointegrated since 2002:8 and there is a very strong adjustment of the Danish interest rate towards the Euro area interest rate. There is currently no significant risk premium and the standard error has decreased to 0.28 which is much lower than in case of Greece in June 2000. Therefore Denmark belongs to group three (high degree of integration). The interest rates of Sweden and United Kingdom are not cointegrated with the corresponding Euro area interest rates. The trace statistic LR(0) exceeds the 5% asymptotic critical value in some of the samples but not the corrected critical value. The risk premiums in both countries are relatively volatile. Sweden and the United Kingdom are classified as belonging to group one (low degree of integration). These results are compatible with the monetary policy strategies of these three countries. While Sweden and United Kingdom are independent inflation targeters, the goal of monetary policy in Denmark is to support Denmarks fixed-exchange rate policy towards the euro.

3.3 The new EU members

The results for the new EU members are presented in Table 1 and Figures 5 to 12. Estonia and Lithuania belong to group three (high degree of monetary integration). They have both adopted a currency board arrangement, Estonia in 1999 and Lithuania (with Euro as anchor currency) in 2002. The interest rate spreads against the Euro area of currently about half a percentage point are stationary and the Estonian and Lithuanian interest rates adjust significantly in direction of the euro area interest rate. The risk premiums are very small and the standard errors have decreased to levels that are even lower than for Denmark. The spread between 3-month Estonian interbank offering rate (Talibor) and Euribor is stationary since

[7]Figure 5 shows also that the exchange rate criterion, that is a stable and non-depreciating currency in the two years prior to Euro area entrance has only been achieved by a sharp devaluation at the time of joining the Exchange Rate Mechanism in March 1998.

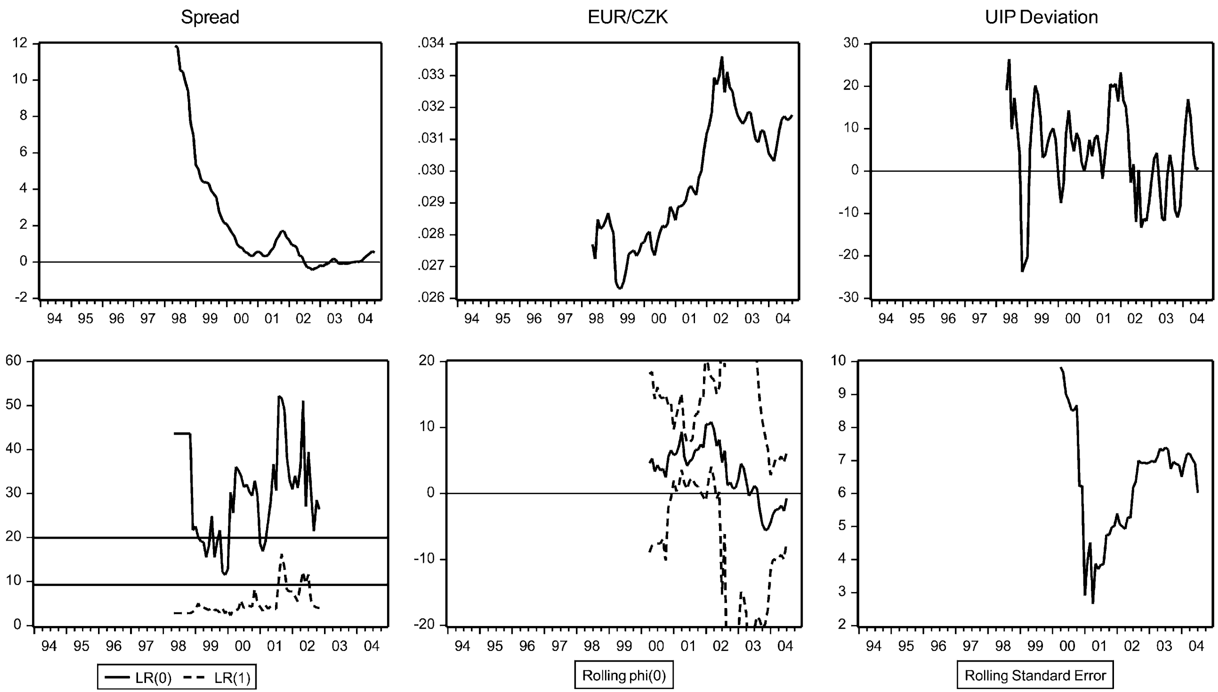

Fig. 5. Results for Czech Republic *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to AIC) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

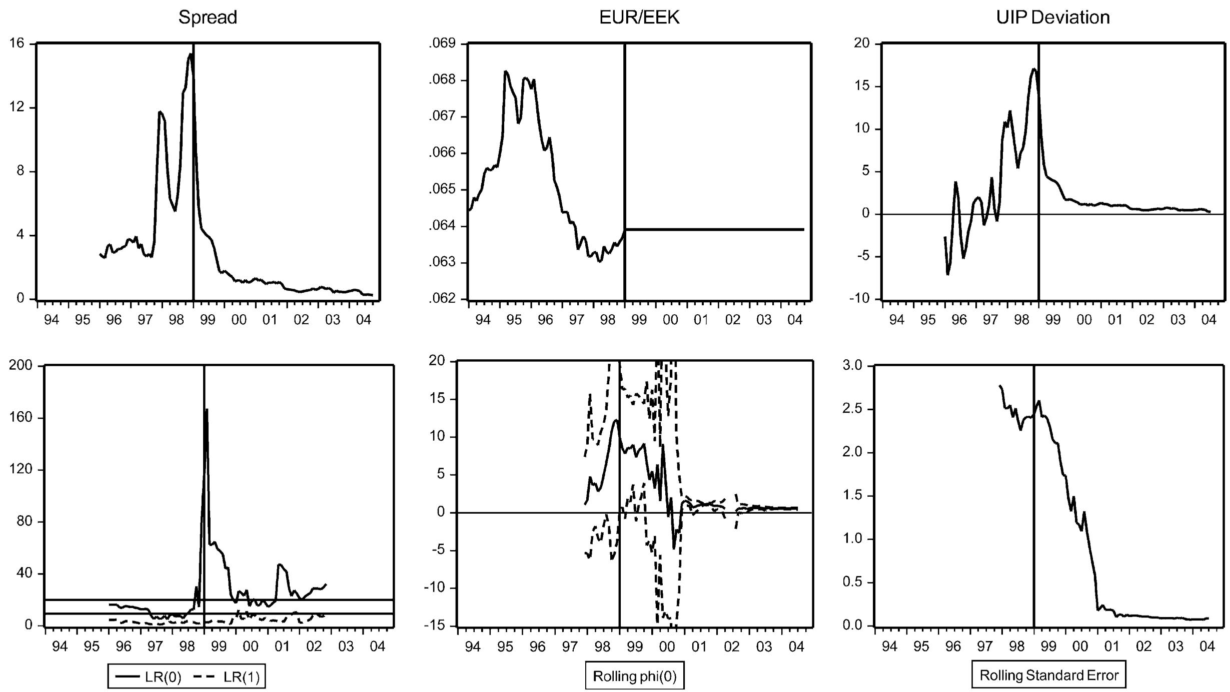

Fig. 6. Results for Estonia *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window. Interest rates are found to be cointegrated for the sample beginning at the vertical line

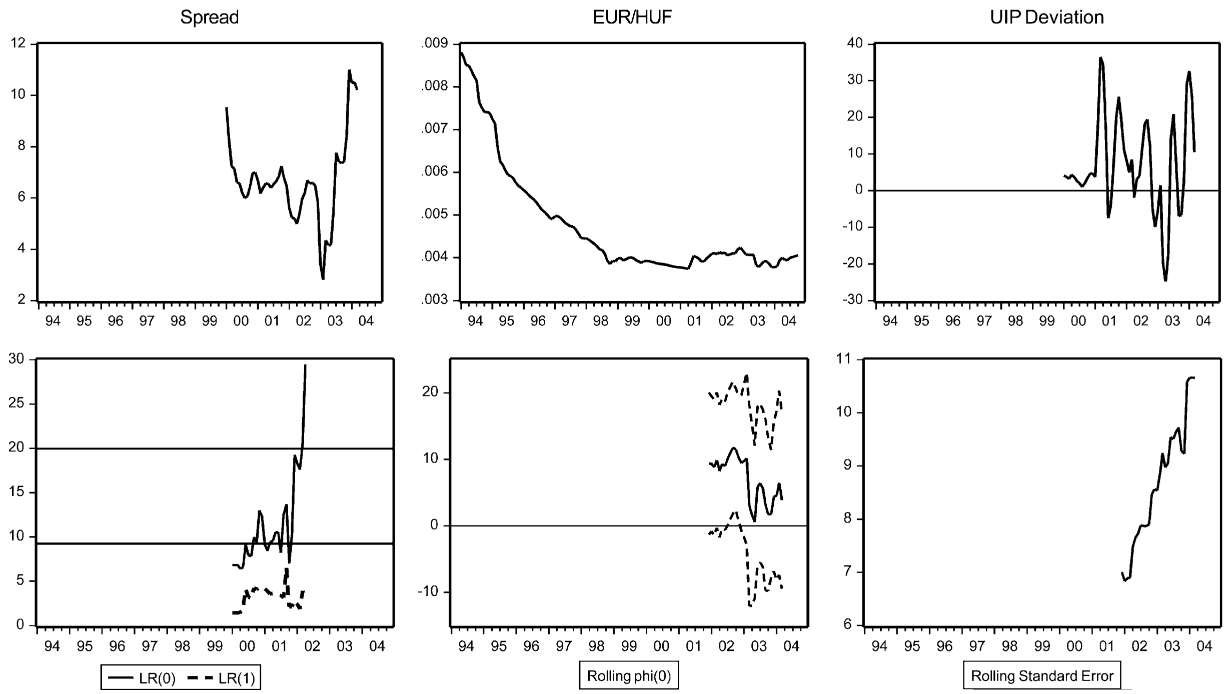

Fig. 7. Results for Hungary *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

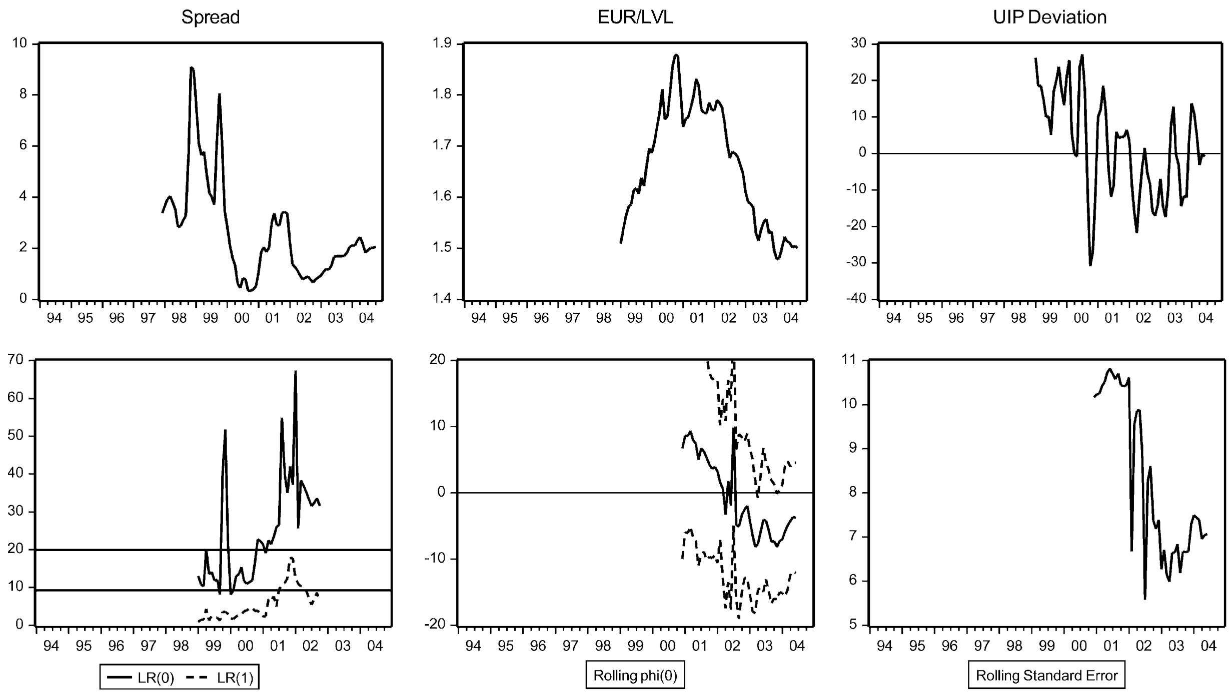

Fig. 8. Results for Latvia *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

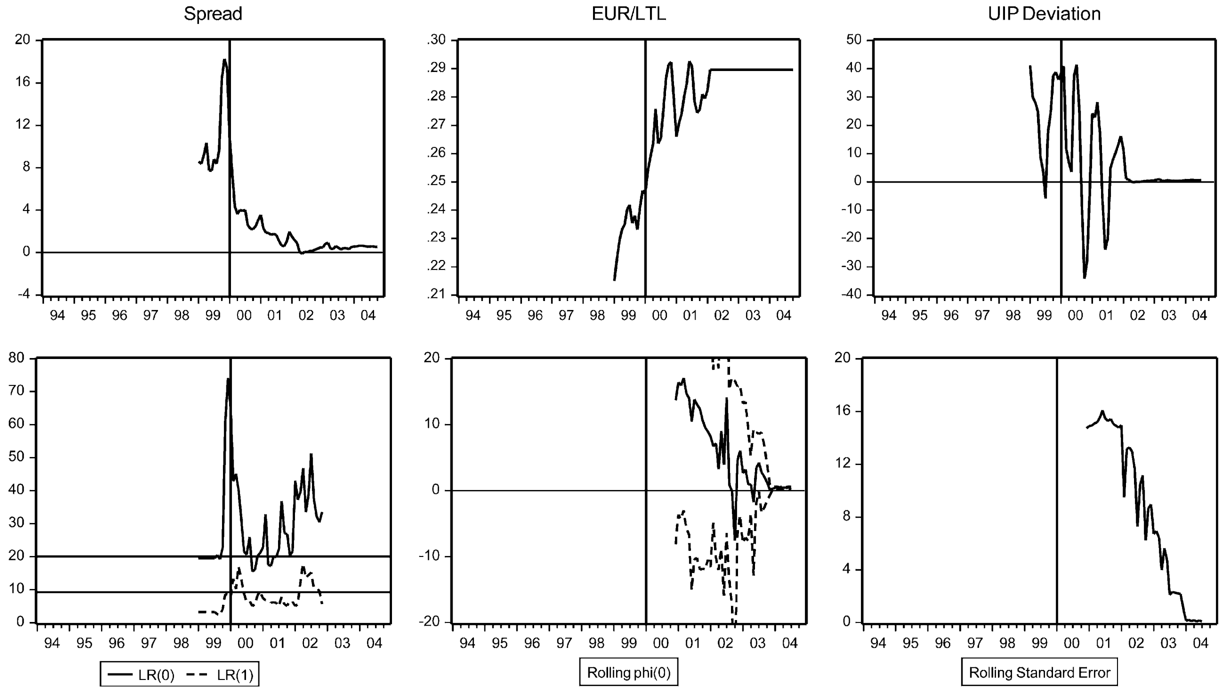

Fig. 9. Results for Lithuania *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window. Interest rates are found to be cointegrated for the sample beginning at the vertical line

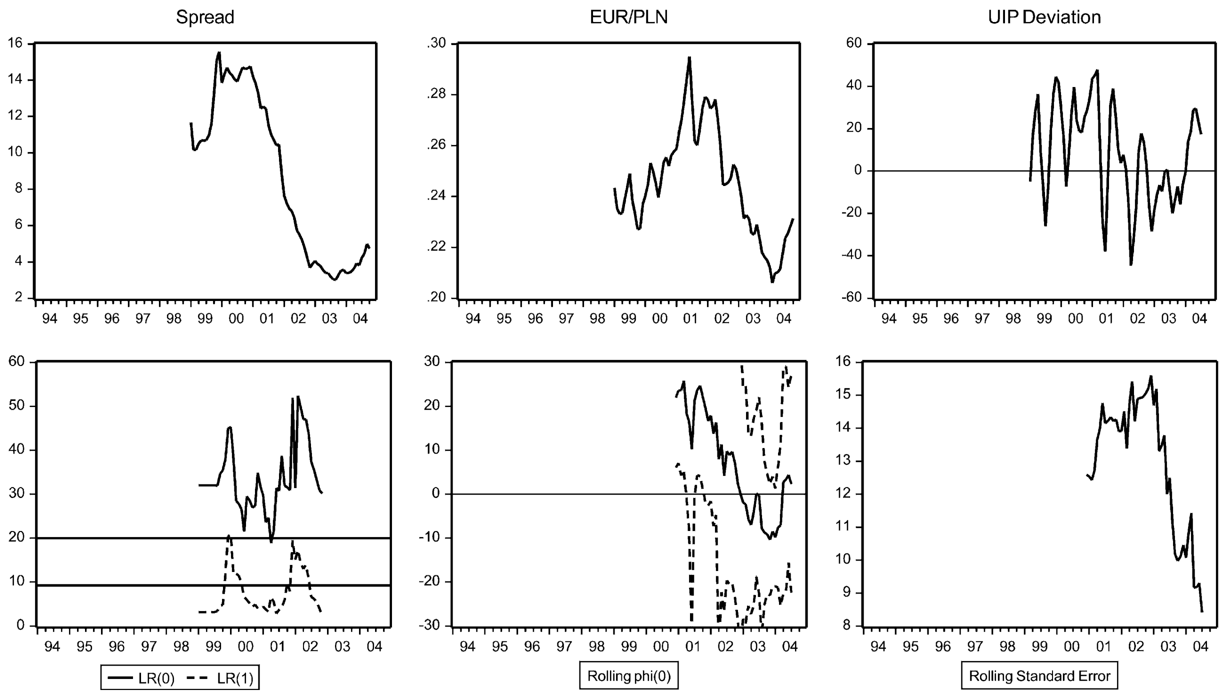

Fig. 10. Results for Poland *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

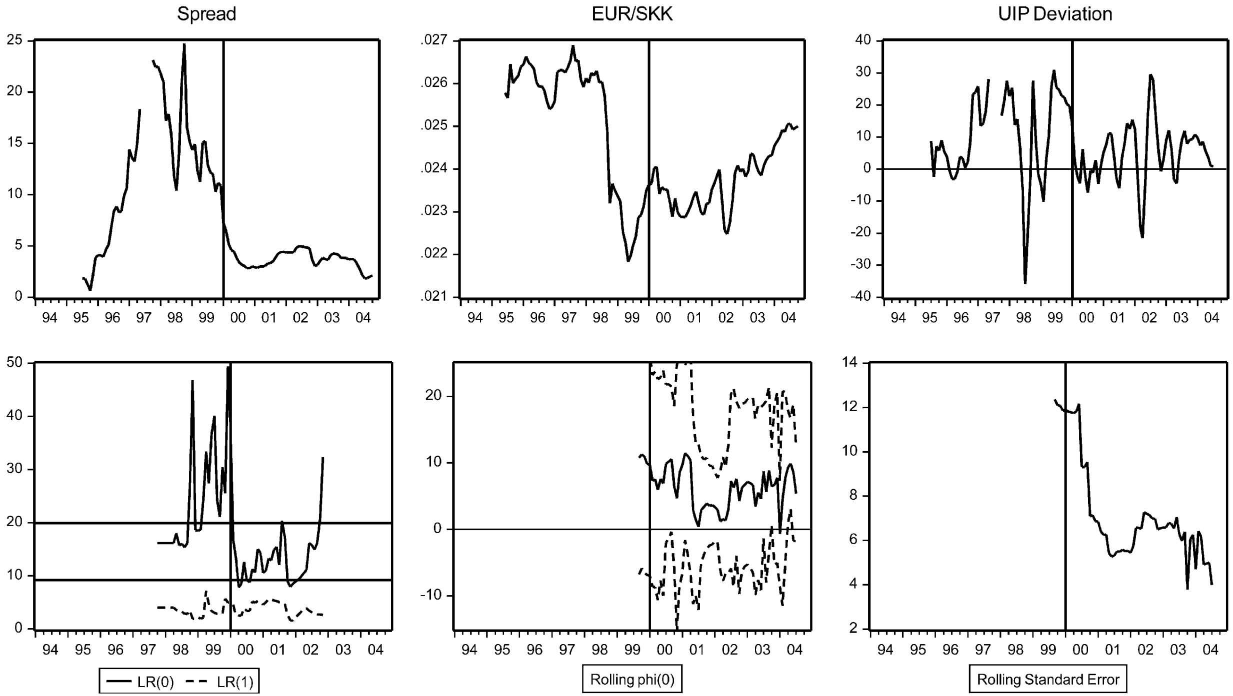

Fig. 11. Results for Slovak Republic *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window. Interest rates are found to be cointegrated for the sample beginning at the vertical line

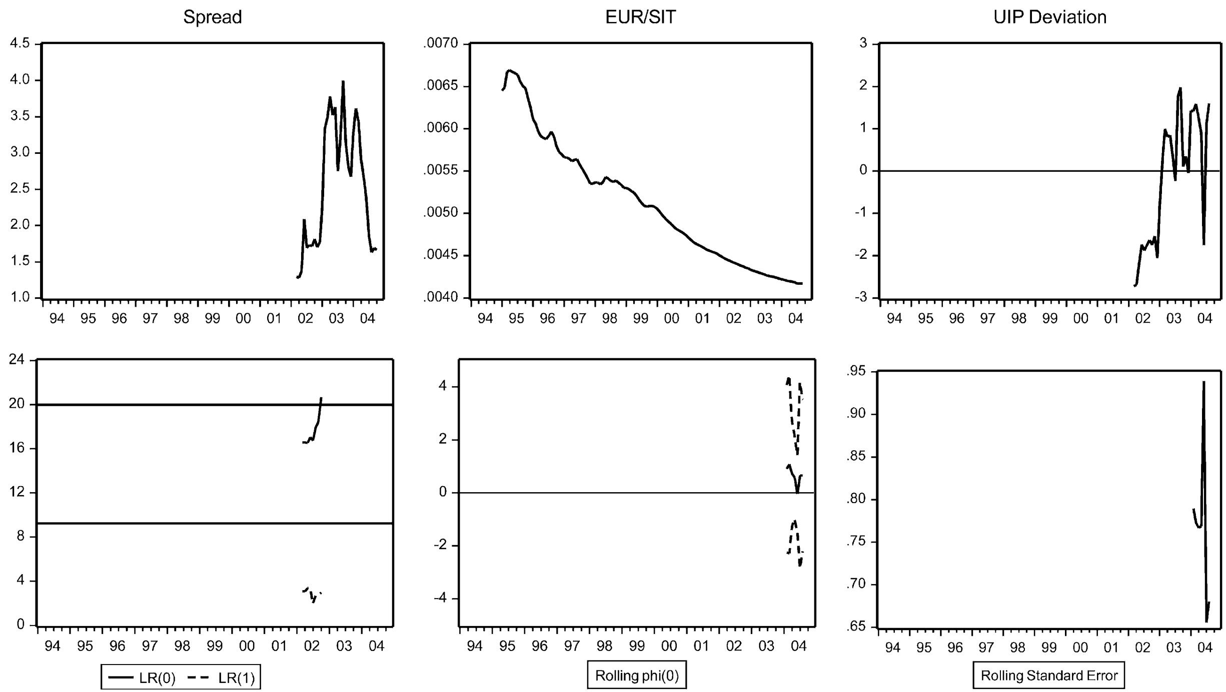

Fig. 12. Results for Slovenia *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

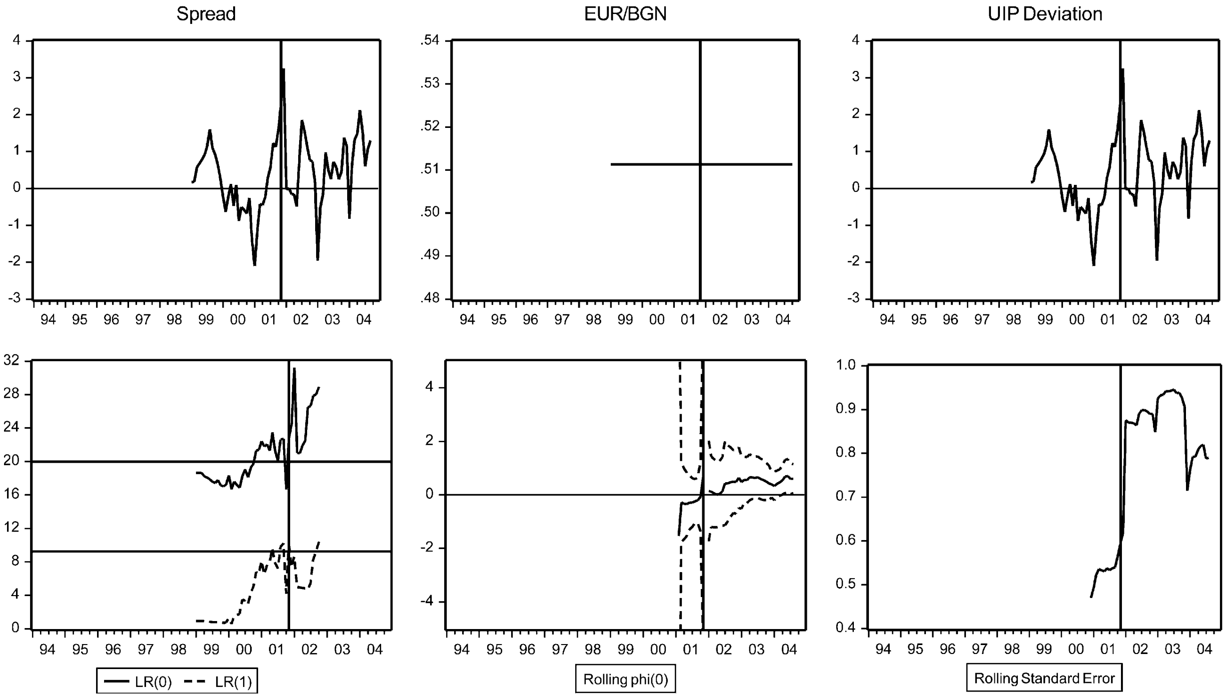

Fig. 13. Results for Bulgaria *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window. Interest rates are found to be cointegrated for the sample beginning at the vertical line

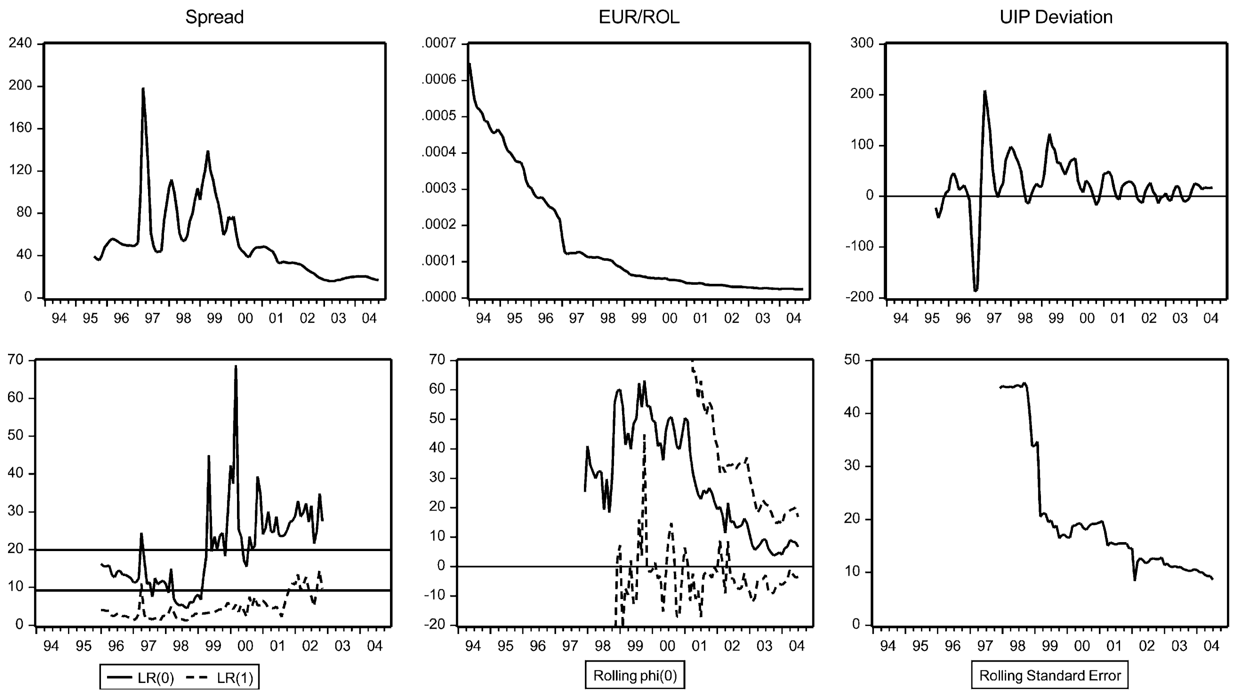

Fig. 14. Results for Romania *Notes:* The upper three graphs show from left to right: the difference between domestic and Euro area interest rates, the exchange rate in Euro per national currency, and ex-post UIP deviations. The lower left graph shows backward recursive LR trace statistics (including a constant restricted to the cointegration space, lag length selection according to HQ) for the hypothesis of at most zero cointegration relations (LR(0), upper solid line is asymptotic 5% critical value) and at most one cointegration relation (LR(1), lower solid line is asymptotic 5% critical value). Time axis corresponds to sample beginning, the sample end is fixed at last available observation. The medium lower graph shows rolling estimates of ϕ_0 (solid line) $\pm$ 2 standard errors (dashed lines). The lower right graph shows the rolling standard error. The window size for the rolling regressions is 24 month and the time axis indicates the end point of the respective window

1999:1 which fits very well with the fact that the Estonian kroon has been fixed against the Euro since January 1999; the Talibor adjusts significantly (adjustment coefficient −0.16, *t*-statistic: −13.08) in direction of the cointegration vector (1, −1); the average risk premium in the most recent window (2001:7-2004:10) is about 0.5 percentage points. The results for Lithuania are similar, for details see Figure 9 and Table 1. Both Estonia and Lithuania participate in the ERM II since June 2004.

The Slovak Republic belongs to the second group (medium degree of monetary integration). 3-month Bribor and 3-month Euribor are cointegrated since the beginning of 2000. The adjustment coefficient for the Slovak interest rate is −0.19 (*t*-Statistic: −4.92) and the risk premium is approximately as high as the Greek one in June 2000. Furthermore, the variability of the risk premium is decreasing, see Figure 11.

The other new member countries Czech Republic, Hungary, Latvia, Poland and Slovenia exhibit only a low degree of monetary integration yet. The domestic and Euro area interest rates are not cointegrated and the risk premiums are relatively unstable. In case of Hungary, the standard error of the risk premium regression is even increasing. This empirical result is compatible with current economic developments in these countries. In Hungary, the debate between central bank and government about exchange rate intervention, the inflation target and the effect of fiscal policy on inflation leads to increasing uncertainty about the future development. This is reflected in the increasing standard error of the rolling risk premium regression. The Polish zloty has depreciated in 2003. This depreciation has partly been stronger than the interest rate differential which led to negative (non-significant) ex-post risk premiums. The Slovenian tolar has also been depreciating continuously such that monetary integration cannot be stated yet. Additionally, the analysis is difficult for Slovenia because the data availability is still relatively poor. However, the Slovenian exchange rate policy seems to be interpreted as sustainable and predictable by the financial markets which is reflected in a relatively low and stable risk premium. Like Estonia and Lithuania, Slovenia participates in the ERM II since June 2004.

3.4 Accession countries: Bulgaria and Romania

Bulgaria has introduced a currency board against the Deutsche Mark in 1997 (since 1999 against the Euro). The Bulgarian and Euro area 1-month money market rates are cointegrated since the end of 2001. A time series for a 3-month money market rate is still not available. Bulgaria is classified as belonging to the second group because of the significant adjustment of the Bulgarian money market rate towards the Euribor. The Risk premium and its variability are higher than in the other two countries that have adopted a currency area framework (Estonia and Lithuania), especially if one takes into account that the maturity is shorter than in case of those countries.

Romania belongs to group one (low degree of monetary integration). The Romanian 3-month money market interest rate (Bubor) is not cointegrated with the 3-month Euribor, the current spread is about 17 percentage points and there is an ex-post risk premium of about 7 percentage points. The

Table 2 Convergence status of central and Eastern Europe Countries

Country	Currency regime	M4	DCEI	DCEI-M	DBRCI	Group
CZ	Managed float	3	81	90	71	1
EE	Currency board	4	84	90	71	3
HU	Target zone	1	71	60	69	1
LV	Peg (SDR)	2	69	65	69	1
LT	Currency board	3	71	85	66	3
PL	Float	2	74	80	67	1
SK	Managed float	2	74	85	69	2
SI	Managed float	3	83	80	76	1
BG	Currency board	4	59	75	63	2
RO	Managed float (USD)	2	41	10	62	1

Notes: M4 refers to the number of the four Maastricht criteria mentioned in the main text that are currently fulfilled in case of the respective country. The three indicators DCEI, DCEI-M and DBRCI (column 4–6) are explained in the text. Group represents the classification based on the UIP analysis described in the text. Currency regime, DBRCI and the relevant statistics for the Maastricht criteria assessment are taken form the data overview in Deutsche Bank Research (2004), DCEI and DCEI-M stem from Frankfurter Allgemeine Zeitung.

decreasing speed of Romanian leu devaluation, the time paths of risk premium and standard error show that Romania exhibits a low level of monetary integration currently but is taking big steps in direction of stabilization and monetary integration.

3.5 Discussion of results

The UIP-based empirical results are now compared to other measures of monetary integration, namely the Maastricht criteria, the Deutsche Bank Research Convergence Indicator (DBRCI) and the Deka Converging Europe Indicator (DCEI). The Deutsche Bank Research Convergence Indicator measures the structural convergence in terms of the adjustment of economic, legal, regulatory and other institutional elements towards the EU average. It is calculated on the basis of 16 variables: real economy (per-capita GDP in PPP terms, unemployment, agriculture as a percentage of GDP, and private-sector share in GDP), growth dynamics (GDP and productivity growth rates), political economy and institutions (indices for legal system, governance, banking sector, liberalization of trade and foreign exchange markets), external sector (current account balance in percent of GDP adjusted for the inflow of foreign direct investment, and trade integration with the EU), monetary and fiscal conditions (inflation, fiscal deficit and public debt), see Deutsche Bank Research (2000, p. 17). The Deka Converging Europe Indicator is calculated by the DekaBank and published in the Frankfurter Allgemeine Zeitung. This indicator lies within a range from zero to 100 and is an average of four sub-indicators – real convergence, institutional design, fiscal stability and monetary integration – based on a macroeconomic scoring model which is explained in DekaBank (2003). The monetary sub-indicator (DCEI-M) includes inflation, long-term interest rate, exchange rate and credit growth. The

Table 3 Spearman's Rank correlation coefficient between indicators of convergence

	M4	DCEI	DCEI-M	DBRCI	Group
M4	1				
DCEI	0.33	1			
DCEI-M	0.57	0.75	1		
DRBCI	0.22	0.88	0.59	1	
Group	0.59	0.15	0.53	−0.03	1

Notes: The various indicators are explained in the text.

following four Maastricht criteria are considered here:[8] inflation rate, interest rate, fiscal balance and public debt. The fifth criterion, which refers to membership in the ERM II, is not considered because none of the new members or accession countries has participated in the ERM II for a period of at least 24 months. Furthermore, the UK, Denmark and Sweden are neglected in the following because the current debate on convergence puts its focus on the central and eastern European countries. Table 2 shows the current exchange rate regimes and five convergence indicators: the number of Maastrict criteria that are fulfilled (1–4), DCEI (0–100), DCEI-M (0–100), DBRCI (0–100), and the degree of integration according to the UIP analysis (1–3). The larger the respective indicator is, the larger is the degree of integration. Table 3 shows Spearman's rank correlation coefficient for all pairs of indicators.[9] The UIP based classification is positively correlated with the Maastricht criteria indicator and with the monetary DCEI, but it is not correlated with the DBRCI and the total DCEI. Both the monetary DCEI and the UIP-based classification imply that Estonia, Lithuania and the Slovak Republic are the countries that have achieved the highest degree of integration among all countries. The two countries in group three, Estonia and Lithuania, have both adopted a currency board regime. However, the UIP-based classification does not simply reflect the currency regime choice. In case of Lithuania, a high degree of monetary integration has been achieved about two years before the Lithuanian litas has been fixed against the Euro. On the other hand, a co-movement of the Bulgarian and the Euro area interest rates can be observed only since the end of 2001 though Bulgaria has established its currency board much earlier. Furthermore, the Slovak Republic has achieved its relatively high degree of monetary integration without adopting a currency board but with managed floating. However, a currency board seems to be helpful as it signals a strong commitment to stability.

A further result is that the convergence process is not a one way street. Some countries have fallen behind their previously already achieved degree of integration, see for example the rolling standard error for the Czech Republic, Hungary and Bulgaria. This underlines the importance of ongoing

[8] For details and a current examination see European Central Bank (2004).

[9] Additionally, Kendall's rank correlation coefficient has been calculated. The results are very similar to those presented in Table 2.

monitoring of the integration process and should be a warning not do underestimate the necessary efforts in order to achieve monetary integration with the Euro area.

4 Conclusions

This paper investigates the degree of monetary integration with the Euro area of potential EMU accession countries. Based on the analysis of ex-post deviations from uncovered interest rate parity, the potential EMU accession countries are classified as belonging to one of three groups: low, medium or high degree of monetary integration. Greece as the only country that joined the Euro area after the introduction of the Euro serves as a reference case. It turns out that Estonia and Lithuania belong to group three (high degree of monetary integration) and exhibit quite stable relationships between domestic interest rate, corresponding Euro interest rate and exchange rate. Greece in time of the ECOFIN decision in June 2000 and the Slovak Republic belong to the second group (medium degree of monetary integration). Group one (low degree of monetary integration) consists of Czech Republic, Hungary, Latvia, Poland and Slovenia. These countries still face high and variable interest rate spreads and deviations from UIP.

Further main results of the analysis are: (i) Compared to the convergence and integration process in Greece, the countries in group one exhibit more instability and uncertainty than Greece two years before its entry into EMU. Therefore, still more effort of these countries is necessary before they may benefit from monetary union. (ii) Economic and monetary convergence do not follow a one way street. Some countries, especially Hungary, are currently falling behind their previously achieved degrees of convergence and integration. (iii) The uncovered interest rate parity relation – augmented by a country-specific risk premium – gives a description of the economic development which is compatible with narrative evidence and a scoring based indicator of monetary convergence. This result supports the inclusion of UIP in open economy macro-models and highlights the importance of country-specific risk premiums for an appropriate model specification.

Though the presented evidence is only a preliminary look on the monetary integration process and does neglect other important fields of convergence, these results are helpful for the assessment of the ongoing convergence process. The empirical procedure described in this paper can be applied subsequently when new data becomes available and may continuously reveal useful information about the monetary integration process.

5 Data

I thank Ulrich Fritsche and Vladimir Kouzine (DIW Berlin), and Torsten Schmidt (RWI Essen) for their support in data collection.

Table 4 Data: Description and sources

Country / Code	i	i^*	s
Greece	3-month Athibor	3-month Euribor	
GR	Feri	ECB MB Table 4.6	IFS 174..EB.ZF
Sweden	3-month Treasury Bill rate	3-month Euribor	
SE	IFS 14460C, CB	ECB MB Table 4.6	IFS 144..EB.ZF, CB
Denmark	3-month Cibor	3-month Euribor	
DK	CB	ECB MB Table 4.6	IFS 128..EB.ZF, CB
United Kingdom	3-month Libor	3-month Euribor	
GB	www.economagic.com	ECB MB Table 4.6	IFS 112..ED.ZF, CB
Czech Republic	3-month Pribor	3-month Euribor	
CZ	CB	ECB MB Table 4.6	CB
Estonia	3-month Talibor	3-month Euribor	
EE	CB	ECB MB Table 4.6	CB
Hungary	3-month interbank rate	3-month Euribor	
HU	CB	ECB MB Table 4.6	CB
Latvia	3-month Rigibor	3-month Euribor	
LV	CB	ECB MB Table 4.6	CB
Lithuania	3-month Vilibor	3-month Euribor	
LT	CB	ECB MB Table 4.6	CB
Poland	3-month Wibor	3-month Euribor	
PL	www.hoga.pl	ECB MB Table 4.6	CB
Slovak Republic	3-month Bribor	3-month Euribor	
SK	CB	ECB MB Table 4.6	CB
Slovenia	1-month interbank rate	1-month Euribor	
SI	CB	ECB MB Table 4.6	CB
Bulgaria	1-month interbank rate	1-month Euribor	
BG	CB	ECB MB Table 4.6	CB
Romania	3-month Bubor	3-month Euribor	
RO	CB	ECB MB Table 4.6	CB

Notes: IFS denotes International Financial Statistics of the International Monetary Fund, ECB MB the monthly bulletin of the European Central Bank. CB refers to the respective national bank's internet homepage. Country codes according to ISO (www.iso.ch/iso/en/prod-services/iso3166ma/02iso-3166-code-lists/list-en1.html) are also given.

References

Batini N, Haldane A G (1999) Forward-looking rules for monetary policy. In: Taylor J B (Ed) Monetary policy rules, The University of Chicago Press, Chicago, 157–192

Bayoumi T, Eichengreen B (1997) Ever closer to heaven? An optimum-currency-area index for European countries. *European Economic Review* 41:761–770

Cheung Y -W, Chinn M D, Garcia Pascual A (2002) Empirical exchange rate models of the nineties: Are they fit to survive? National Bureau of Economic Research *Working Paper* 9393

Chinn M D, Meredith G (1998) Long-horizon uncovered interest rate parity. National Bureau of Economic Research *Working Paper* 6797

DekaBank (2003) Deka Converging Europe Indicator. Unpublished document, available per email from economics@dekabank.de

Deutsche Bank Research (2000) EU Enlargement Monitor Central and Eastern Europe 2

Deutsche Bank Research (2004) EU Monitor 18

Engel C (1996) The forward discount anomaly and the risk premium: A survey of recent evidence. *Journal of Empirical Finance* 3:123–192

European Central Bank (2000) Convergence Report 2000

European Central Bank (2001) The euro area after the entry of Greece. *Monthly Bulletin*, January, 35–41
European Central Bank (2002a) Annual Report 2002
European Central Bank (2002b) Convergence Report 2002
European Central Bank (2004) Convergence Report 2004
Fidrmuc J, Korhonen I (2003) Similarity of supply and demand shocks between the euro area and the CEECs. *Economic Systems* 27:313–334
de Grauwe P (2003a) Economics of monetary union, Fifth edition. Oxford University Press, Oxford
de Grauwe P (2003b) The Euro at stake? The monetary union in an enlarged Europe. *CESifo Economic Studies* 49:103–121
Hamilton J D (1994) Time series analysis. Princeton University Press, Princeton
Johansen S (1995) Likelihood-based inference in cointegrated vector autoregressive models. Oxford University Press, New York
Johansen S (2000) A Bartlett correction factor for tests on the cointegration relations. *Econometric Theory* 16:740–778
Johansen S (2002a) A small sample correction for tests of hypotheses on the cointegrating vectors. *Journal of Econometrics* 111:195–221
Johansen S (2002b) A small sample correction for the test of cointegrating rank in the vectorautoregressive model. *Econometrica* 70:1929–1961
Kim Y, Chow H K (2003) Optimum currency area in Europe: an alternative assessment. *Economics Letters* 81:297–304
Krugman P R, Obstfeld M (2003) International economics, sixth edition. Addison-Wesley, Boston
Levich R M (1989) Is the foreign exchange market efficient? *Oxford Review of Economic Policy* 5:40–60
Lothian J R (2002) The internationalization of money and finance and the globalization of financial markets. *Journal of International Money and Finance* 21:699–724
Lütkepohl H (2001) Vector autoregressions. In: Baltagi B (Ed.) Companion to theoretical econometrics. Blackwell, Oxford 678–699
Mark N C (2001) International macroeconomics and finance. Blackwell Publishers, Malden
McCallum B T (1994) A reconsideration of the uncovered interest rate parity relationship. *Journal of Monetary Economics* 33:105–132
Merlevede B, Plasmans J, Aarle B v (2003) A small macroeconomic model of the EU-accession countries. *Open Economies Review* 14:221–250
Obstfeld M, Rogoff K (1995) Exchange rate dynamics Redux. *Journal of Political Economy* 103:624–660
Orlowski L T (2003) Monetary convergence and risk premiums in the EU accession countries. *Open Economies Review* 14:251–267
Piazolo D (2000) Eastern Europe between transition and accession: an analysis of reform requirements. *Kiel Working Paper 991*, Kiel Institute of World Economics, Kiel
Taylor J B (1993) Macroeconomic policy in a world economy. Norton &Company, New York
Wolters J (2002) Uncovered interest rate parity and the expectations hypothesis of the term structure: empirical results for the US and Europe. In: Klein I, Mittnik S (Eds.) Contributions to modern econometrics: from data analysis to economic policy, Festschrift in honour of Gerd Hansen. Kluwer, 271–282