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Evaluating the Maastricht Convergence Criteria for New Prospective European Union Members

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Abstract

This paper aims to assess the macroeconomic condition of the four new prospective members, which are Turkey, Croatia, Bulgaria, and Romania, depending on four Maastricht Convergence Criteria in order to determine which candidate is ready to join EMU. We use cointegration approach to analyze cointegrating relations among inflation rates, interest rate, deficit-to-GDP, and debt-to-GDP ratios of four candidates in relation to Germany. Bounds Testing and Engle-Granger Cointegration Approach are applied to all criteria to test convergence. None of the convergence criteria for Turkey and Romania in relation to Germany has been achieved. On the other hand, there is evidence of nominal convergence between Croatia and Germany in terms of deficit-to-GDP ratio and interest rates. Also, there is cointegration between deficit-to-GDP ratio of Bulgaria and that of Germany.

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Keywords: Convergence, Engle-Granger, Bounds Testing.

1. Introduction

Since the existence of European Economic Community by Treaty of Rome in 1957, the enlargement process of European Union (EU) has been a concern for both incumbent and candidate countries. This process consists of economic, politics, social, legal and cultural aspects. Economic aspects include the economic and monetary union which is to be achieved in three stages: Firstly, completion of the internal market and accession to European Monetary System (EMS) of all EU members; secondly, the founding necessary monetary institutions and transference of national monetary responsibility for reserves; thirdly, transition to the European Economic and Monetary Union (EMU).

When candidate countries join EMU, they face with both costs and benefits. They abandon their own monetary unit in favor of a common unit, in turn, they loss the control of their own money supply since European Central Bank holds all the power in its hand. This change related to monetary authority deprives each member of revenues from seignorage and the exchange rate as a tool of macroeconomic stabilization policy.[1]

On the other hand, joining EMU provides some benefits to candidate countries. It causes to reduction in transaction costs, elimination of risk of exchange rate volatility among countries and reduced costs of financial services resulting from the large size of available pools of financial assets. In sum, it can be said that the benefits outweigh the costs by some small margin. However, the economic performance of the candidate countries has to be in line with that of incumbent members in order to adopt the euro rapidly and get greater benefits by joining EMU.

The prospective countries must satisfy certain economic criteria called as Maastricht Convergence Criteria in order to join the EMU. These criteria were stated in 1992 following as:[2]

- An annual rate of inflation of no more than 1.5% above the three best inflation performers in the EU.
- Budget deficit as a percentage of GDP of no more than 3%.
- A government debt to GDP ratio of 60% or less.
- An average long term interest rate no more than 2% above the levels observed in the three countries with the best inflation performance.

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[1] Afxentiou (2000).
[2] Koukouritakis and Michelis (2003).

- No devaluations or revaluations of exchange rates within the two years preceding accession.

This paper aims to assess the macroeconomic condition of the four new prospective members, which are Turkey, Croatia, Bulgaria, and Romania, depending on four Maastricht Convergence Criteria[3] in order to determine which candidate is ready to join EMU.

The remainder of this paper is organized as follows: Literature survey is discussed in Section 2. Cointegration models and method has been introduced in Section 3. Data is explained in section 4. In Section 5, the empirical results are reported and discussed. Concluding remarks are given in Section 6.

2. Literature Survey

Several studies in literature have provided empirical evidence about nominal convergence criteria also called Maastricht convergence criteria. Haug *et al*. (1999) employed system-based cointegration techniques developed by Johansen to determine which European Union countries would form a successful EMU, based on long term behavior of the nominal convergence criteria. The results suggested that not all of the 12 original countries of the EU could possibly form a successful EMU overtime, unless several countries made significant adjustments.

Koukouritakis and Michelis (2003) investigated empirically the prospects of the 10 countries joined recently based on the nominal convergence criteria as well as on real per capita GDPs using conitegration and common trend analysis. The empirical results indicated that the enlargement countries were partially ready to join the Eurozone, and needed further adjustments in their government policies to be fully prepared for joining the EMU.

Hafer *et al*. (1997) used multivariate cointegration techniques to investigate the link among interest rate term structures for a selected group of EU countries, using monthly data over the period 1979-1995. They found co movements in the common trends in the term of structures overtime.

Brada and Kutan (2002) compared the convergence with German monetary policy of the Balkan and Mediterranean country candidates for EU membership with that of countries that have recently joined the EU. Their results show that significant linkages exist between German base money stock and that of recent members of EU;

[3] The last Maastricht Convergence Criterion is excluded from our study.

the same holds true for some candidates such as Slovenia and Croatia. Among the other Balkan economies and Turkey, the ability to follow the policies of the Bundesbank is nonexistent.

Karfakis and Moschos (1990) used the Engle and Granger (1987) bivariate cointegration framework to test for interest rate linkages between Germany and each of the countries including Belgium, France, Ireland, Italy and the Netherlands. They found no cointegration in the pairs of interest rates.

3. Cointegration Models and Method

Cointegration is a necessary condition for co-movement of variables in the long run and, thus for a successful accession of new prospective countries into the EMU.[4] If the variables for the candidate countries are found to be cointegrated with those of Germany, it can be inferred that there exists long run relationship among related variables.

We use cointegration approach to analyze cointegrating relations among inflation rates (Equation 1), interest rate (Equation 2), deficit-to-GDP (Equation 3), and debt-to-GDP ratios (Equation 4) of four candidates in relation to Germany:

$$\ln INF_t = \beta_0 + \beta_1 \ln RINF_t + \varepsilon_t \quad (1)$$

$$\ln IR_t = \beta_0 + \beta_1 \ln RIR_t + \varepsilon_t \quad (2)$$

$$DEF_t = \beta_0 + \beta_1 RDEF_t + \varepsilon_t \quad (3)$$

$$\ln TD_t = \beta_0 + \beta_1 \ln RTD_t + \varepsilon_t \quad (4)$$

where INF_t is the inflation of candidate country, $RINF_t$ is that of reference country; IR_t is the interest rate of candidate country, RIR_t is that of reference country; DEF_t is deficit-to-GDP ratio of candidate country, $RDEF_t$ is that of reference country; TD_t is total debt stock of candidate country, and similarly RTD_t is that of reference country.

Engle-Granger and Bounds test are used in order to estimate the existence of cointegration.

[4] Koukouritakis and Michelis (2003).

Engle-Granger's residual-based ADF test

The two steps of this test are conducted as follows:[5]

1. Estimating the parameters of a cointegrating regression by applying OLS on the nonstationary form of the variables

$$\ln y_t = \alpha_0 + \alpha_1 \ln x_t + \varepsilon_t \tag{5}$$

2. Testing for stationarity of the residuals by using ADF test

Once the variables included in the model are found cointegrated, our next step is to specify and estimate an error correction model (ECM) including the error correction term to investigate the dynamic behavior of the model. The correspondence between co-integration and error correction model is formalized in the Granger Representation Theorem (1983). The size of the error correction term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state.

$$\Delta y_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta y_{t-i} + \sum_{j=0}^{n} \beta_{2j}\, \Delta x_{t-j} + \beta_3\, EC_{t-1} + \varepsilon_t \tag{6}$$

Bounds Testing Approach to Cointegration

The Bounds test procedure (Pesaran et al., 2001) is a recent test, based on the estimation of an unrestricted error-correction model (UECM) using Ordinary Least Squares (OLS) estimator.

$$\Delta y_t = \beta_0 + \beta_1\, y_{t-1} + \beta_2\, x_{t-1} + \sum_{i=1}^{p} \beta_{3i}\, \Delta y_{t-i} + \sum_{j=0}^{p} \beta_{4j}\, \Delta x_{t-j} + \varepsilon_t \tag{7}$$

This approach has two main advantages. Firstly, it can be applied irrespective of whether the regressors are I(0), I(1), or even integrated of the same order. Secondly, Bounds test procedure is robust for cointegration analysis with small sample study.

This approach requires that overall significance of the model should be tested by using Wald Coefficient Test. The F-statistic, obtained from the UECM, is compared with the critical value bounds that stated in Pesaran et al., 2001. If the computed F-statistic is greater than the I(1) critical value bounds, it means the exisnce of cointegration. If the computed F-statistic is less than the I(0) critical value bounds, it

[5] Engle and Granger (1987).

means the nonexistence of cointegration. However, if the F-statistic falls inside these bounds, inference is inconclusive and knowledge of the order of the integration of the underlying variables is required before conclusive inferences can be made.[6]

4. Data

We use the data of inflation rates, interest rates, deficit-to-GDP and debt-to-GDP ratios of four candidates in addition to those of Germany. To assess Maastricht Convergence Criteria, either CPI or WPI is used as the indicators of inflation rates based on mostly quarterly data except Romania. Monthly CPI is included because of quarterly data are not appropriate for time series analysis. The interest rates used in this study are Treasury bill rate, lending rate, interbank rate, and credit rate for selected countries. These rates change from one country to another because of unavailability of data. Budget deficit-to-GDP ratios for each country are calculated based on quarterly data. We study quarterly debt-to-GDP ratios for only Turkey, because the data are not available for the other countries considered in our study.

Most of the data for this study were obtained from the International Financial Statistics (IFS) Database. Other sources, needed to complete the data set, include Central Bank of Turkey, Croatian National Bank, and Deutsche Bundesbank. The sample consists of monthly or quarterly data of varying time spans determined by data availability. Table 1 reports the sample period for each country.

Table 1
Countries in the Sample and Time Periods

Countries	IR	INF	DEF	TD
Turkey	1991:1-2004:4	1991:1-2004:4	1990:1-2005:2	1990:1-2005:2
Croatia	1992:1-2005:3	1992:1-2005:3	1995:2-2005:2	NA
Bulgaria	1992:1-2005:1	1991:1-2005:3	1994:1-2005:3	NA
Romania	1994:1-2005:3	1992:1-2005:12	1996:4-2001:4	NA
Germany	1991:1-2005:3	1991:1-2005:4	1990:1-2005:3	1990:1-2005:2

[6] Pesaran, Shin and Smith (2001).

5. Empirical Results

Unit-root tests, Augmented Dickey-Fuller (ADF), for stationarity are applied on both levels and first differences of all variables for each country at the either 5% or 10% level of significance. The results are presented in Table 2 to Table 5. In order to select the appropriate lag length, we used the Akaike's Information Criteria. The results show that the series are either I(1) or I(0). On the basis of the unit-root tests we apply Engle-Granger (1987) test and Bounds test in order to check whether cointegration exists.

As the first step of Engle-Granger cointegration test we estimated the model using the OLS method. As the second step of Engle-Granger procedure, we check the stationarity of residuals by using the ADF test. At the 5% level of significance, the ADF statistic suggests that deficit-to-GDP ratio of Bulgaria is cointegrated with that of Germany.

The error-correction model, presented in Equation 2, is constructed using residuals from the cointegrating regression, as suggested in Engle-Granger procedure and the results are reported in Table 2 to Table 5. The estimated coefficient of RES(-1) is statistically significant at the 5% level and with the appropriate (negative) signs for Bulgaria. It means that the long-run equilibrium relationship among the variables is valid in OLS regression of Bulgaria.

On the other hand, in our study some of the dependent variables were found as I(0) while independent variables were I(1). Since the Engle Granger Test requires all variables to be in the same order, we could not apply for Engle-Granger approach for these series. Instead we used Bounds Test in order to check the existence of long run relationship. As the first step of Bounds test is based on the estimation of Unrestricted Error Correction Model (UECM) with OLS.

Turkey

Engle-Granger approach was used to test the cointegration of interest rates, inflation, and debt-to-GDP ratio for Turkey. On the other hand, we applied Bounds testing to test the existence of cointegration between deficit-to-GDP ratio of Turkey and that of Germany.

Table 6
Cointegration Test Results for Turkey

	Engle-Granger Cointegration Test Results		
	ADF Test Stat	5% Critical Values	
$\ln INF_t$	-1.72	-3.46	
DEF_t	-1.99	-3.46	
$\ln TD_t$	-0.33	-3.46	
	Bounds Test Results		
	F-stat	5% Critical Value Bounds	
		I (0)	I (1)
$F_{\ln IR}(\ln IR_t \mid \ln RIR_t)$	2.48	4.94	5.73

The results based on Engle-Granger and Bounds testing approach indicate that there exists no cointegration between all variables of Turkey and those of Germany. Therefore it can be inferred that Turkey has achieved none of the Maastricht Convergence Criteria over the last decade.

Croatia

Bounds testing approach was used to test the cointegration of interest rates, inflation and deficit-to-GDP ratio for Croatia. Debt-to-GDP ratio could not be tested due to unavailability of data.

Table 7
Cointegration Test Results for Croatia

Bounds Test Results

	F-stat	5% Critical Value Bounds	
$F_{\ln IR}(\ln IR_t \mid \ln RIR_t)$	9.41	4.97	5.76
$F_{\ln INF}(\ln INF_t \mid \ln RINF_t)$	3.52	4.98	5.77
$F_{DEF}(DEF_t \mid RDEF_t)$	11.97	4.99	5.78

According to empirical results above, it can be said that there exists no cointegration in terms of inflation. The results also approve the existence of cointegration between deficit-to-GDP ratio and interest rate of Croatia and those of Germany. The long-run equations can be shown as follows:

$$\begin{matrix} \ln IR_t = 0.10 + 2.51 \ln RIR_t + e_t \\ t \quad (0.22)(7.27) \end{matrix} \tag{8}$$

$$\begin{matrix} DEF_t = -0.01 + 0.37\ RDEF_t + e_t \\ t \quad (-2.09)\ (0.91) \end{matrix} \tag{9}$$

Bulgaria

To test the cointegrating relation between Bulgaria and Germany for interest rate, inflation and deficit-to-GDP ratio, we used Engle-Granger approach. Deficit-to-GDP ratio could not be tested because of the unavailability of the data as in the other Balkan countries.

Table 8
Cointegration Test Results for Bulgaria

	Engle-Granger Cointegration Test Results	
	ADF Test Stat	5% Critical Value
$\ln IR_t$	-2.62	-3.46
$\ln INF_t$	-1.43	-3.46
DEF_t	-5.24	-3.46

According to the empirical results for Bulgaria, it can be said that deficit-to-GDP ratio shows a cointegrating relation, while the other criteria do not. The long-run equation for deficit-to-GDP ratio can be shown as follows:

$$\begin{matrix} DEF_t = 0.003 + 0.86\, RDEF_t + e_t \\ t \qquad (0.23) \quad (0.91) \end{matrix} \tag{10}$$

The estimated coefficient of one lagged error correction term states that the system needs more than two quarters in order to come back its original long-run equilibrium path.[7]

Romania

We used Engle-Granger approach to test cointegration for interest rate and inflation. However, we applied Bounds test to check whether deficit-to-GDP ratio shows a cointegration or not. Data for debt-to-GDP ratio are not available for the period analyzed, so we could not test this criterion for Romania.

[7] Estimation of ECM results are reported in Table 11.

Table 9
Cointegration Test Results for Romania

	Engle-Granger Cointegration Test Results		
	ADF Test Stat	5% Critical Value	
ln INF_t	-2.74	-3.46	
ln IR_t	-0.15	-3.46	
	Bounds Test Results		
	F-stat	5% Critical Values for Bounds Test	
		I (0)	I (1)
F_{DEF} ($DEF_t \mid RDEF_t$)	2.62	4.94	5.73

The results, based on those tests, represent Romania could provide none of the Maastricht Convergence Criteria during the last decade.

6. Conclusion

We analyzed the macroeconomic condition of the four new prospective members, which are Turkey, Croatia, Bulgaria, and Romania, depending on four Maastricht Convergence Criteria in order to determine which candidate would form a successful EMU. Our empirical results support the view that all candidate countries can not provide the requirements of Maastricht Convergence Criteria at the present.

Since none of the criteria has been achieved by Turkey and Romania over the last decade, it can be said that the policies followed by these countries are independent from those of EU members. As the candidate countries to EU, Turkey and Romania have to make adjustments in their fiscal and monetary policies to meet these criteria. Especially Romania, a country which is expected to join EU in 2007, may face problems in the long-run unless it achieves better macroeconomic performance.

On the other hand, there is evidence of nominal convergence between Croatia and Germany in terms of deficit-to-GDP ratio and interest rates. Also, there is cointegration between deficit-to-GDP ratio of Bulgaria and that of Germany. It means that there may exist partially similarities between the fiscal policies of Bulgaria and Germany. These results suggest that while Croatia is expected to join EU later than Bulgaria, its macroeconomic performance seems to be better relative to Bulgaria.

Finally, we conclude that new prospective countries do not seem to provide all Maastricht Convergence Criteria. If those countries want to join the EMU in the near future, they should make adjustments in their monetary and fiscal policies.

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Appendix

Table 2a
ADF unit root tests for stationarity - Turkey

Variables	Level / First diff.	Without trend	With trend	Conclusion
IR	Level	-2.64 (2)	-4.98 (1)	
		(-2.91)	(-3.49)	I (1)
	First diff.	-8.23 (1)		
		(-2.92)		
INF	Level	2.14 (1)	-0.70 (1)	
		(-2.91)	(-3.49)	I (1)
	First diff.	-3.51 (0)	-4.95 (0)	
		(-2.91)	(-3.49)	
DEF	Level	-1.13 (5)	-3.82 (4)	
		(-2.91)	(-3.48)	I (1)
	First diff.	-5.56 (6)		
		(-2.91)		
TD	Level	-2.46 (2)	-2.55 (2)	
		(-2.91)	(-3.48)	I (1)
	First diff.	-8.18 (1)	-8.12 (1)	
		(-2.91)	(-3.48)	

Table 2b
ADF unit root tests for stationarity - Germany

Variables	Level / First diff.	Without trend	With trend	Conclusion
RIR	Level	-3.78 (6)	-3.45 (6)	
		(-2.92)	(-3.18)*	I (0)
	First diff.			
RINF	Level	0.22 (1)	-1.77 (1)	
		(-2.91)	(-3.49)	I (1)
	First diff.	-4.57 (0)	-4.68 (0)	
		(-2.91)	(-3.49)	
RDEF	Level	-2.74 (4)	-2.68 (4)	
		(-2.91)	-3.48	I (1)
	First diff.	-4.73 (3)	-4.73 (3)	
		(-2.91)	(-3.48)	
RTD	Level	1.12 (5)	1.33 (5)	
		(-2.92)	(-3.50)	I (1)
	First diff.	-3.27 (4)	-3.23 (4)*	
		-2.92)	(-3.18)	

Table 3a
ADF unit root tests for stationarity - Croatia

Variables	Level / First diff.	Without trend	With trend	Conclusion
IR	Level	-386.91 (6)	-549.92 (6)	
		(-2.92)	(-3.50)	I (0)
	First diff.			
INF	Level	-3.53 (6)	-13.68 (6)	
		(-2.92)	(-3.50)	I (0)
	First diff.			
DEF	Level	-4.96 (0)	-5.03 (0)	
		(-2.93)	(-3.52)	I (0)
	First diff.			

Table 3b
ADF unit root tests for stationarity - Germany

Variables	Level / First diff.	Without trend	With trend	Conclusion
RIR	Level	-2.35 (5)	-3.99 (2)	
		(-2.92)	(-3.49)	I (1)
	First diff.	-3.60 (3)		
		(-2.92)		
RINF	Level	0.53 (4)	-2.62 (4)	
		(-2.92)	(-3.50)	I (1)
	First diff.	-3.02 (3)	-2.29 (3)	
		(-2.92)	(-3.50)	
RDEF	Level	-1.26 (3)	-0.97 (3)	
		(-2.94)	(-3.53)	I (1)
	First diff.	-8.17 (2)	-8.09 (2)	
		(-2.94)	(-3.53)	

Table 4a
ADF unit root tests for stationarity - Bulgaria

Variables	Level / First diff.	Without trend	With trend	Conclusion
IR	Level	-2.10 (2)	-3.31 (3)	
		(-2.92)	(-3.50)	I (1)
	First diff.	-6.81 (1)	-6.74 (1)	
		(-2.92)	(-3.50)	
INF	Level	-0.78 (1)	-2.27 (1)	
		(-2.91)	(-3.48)	I (1)
	First diff.	-4.49 (0)	-4.45 (0)	
		(-2.91)	(-3.48)	
DEF	Level	-2.02 (2)	-5.04 (1)	
		(-2.92)	(-3.51)	I (1)
	First diff.	-9.17 (1)		
		(-2.92)		

Table 4b
ADF unit root tests for stationarity - Germany

Variables	Level / First diff.	Without trend	With trend	Conclusion
RIR	Level	-2.39 (5)	-2.89 (3)	
		(-2.92)	(-3.50)	I (1)
	First diff.	-4.05 (4)	-4.20 (4)	
		(-2.92)	(-3.50)	
RINF	Level	0.09 (5)	-2.81 (4)	
		(-2.91)	(-3.49)	I (1)
	First diff.	-2.99 (3)	-1.11 (6)	
		(-2.91)	(-3.49)	
RDEF	Level	-1.68 (4)	-1.92 (4)	
		(-2.93)	(-3.51)	I (1)
	First diff.	-9.20 (2)	-9.08 (2)	
		(-2.93)	(-3.51)	

Table 5a
ADF unit root tests for stationarity - Romania

Variables	Level / First diff.	Without trend	With trend	Conclusion
IR	Level	-0.17 (5)	-2.76 (5)	
		(-2.93)	(-3.52)	I (1)
	First diff.	-5.17 (6)	-5.19 (6)	
		(-2.93)	-3.52	
INF	Level	0.77 (6)	-2.40 (6)	
		(-2.87)	(-3.43)	I (1)
	First diff.	-2.84 (4)	-2.18 (6)	
		(-2.57)*	(-3.43)	
DEF	Level	-3.15 (0)	-3.07 (0)	
		(-3.01)	(-3.65)	I (0)
	First diff.		-6.88 (0)	
			(-3.67)	

Table 5b
ADF unit root tests for stationarity - Germany

Variables	Level / First diff.	Without trend	With trend	Conclusion
RIR	Level	-1.02 (5)	-3.28 (3)	
		(-2.93)	(-3.51)	I (1)
	First diff.	-4.22 (4)	-4.14 (4)	
		(-2.93)	(-3.52)	
RINF	Level	-1. 58 (4)	-3.20 (4)	
		(-2.87)	-3.43)	I (1)
	First diff.	-8.37 (3)	-8.45 (3)	
		(-2.87)	(-3.43)	
RDEF	Level	-0.80 (3)	-4.39 (6)	
		(-3.05)	(-3.79)	I (1)
	First diff.	-3.60 (6)		
		(-3.12)		

Note: To check the unit roots for statonarity, the lagged with minimum Akaike Information Criterion is considered. "* "means that the values are significant at 10% significance level and others values are significant at 5%.

Table 10
The Regression Results

Independent Variables	Coefficient	t-stat	Prob.
Turkey			
ln RIR_t	0.508	4.078	0.000
ln $RINF_t$	50.756	12.861	0.000
$RDEF_t$	-3.147	-2.471	0.016
ln RTD_t	-1.005	-472.540	0.000
Croatia			
ln RIR_t	2.517	7.277	0.000
ln $RINF_t$	16.056	6.802	0.000
$RDEF_t$	0.379	0.916	0.365
Bulgaria			
ln RIR_t	2.108	5.621	0.000
ln $RINF_t$	28.129	18.774	0.000
$RDEF_t$	0.868	0.917	0.364
Romania			
ln RIR_t	1.239	10.857	0.000
ln $RINF_t$	27.361	58.422	0.000
$RDEF_t$	0.250	0.587	0.564

Table 11
Estimated Error Correction Model for Bulgaria

Regressors	Parameter Estimates	T-ratio	Prob.
C	0.005468	0.324462	0.75
DBD(-1)	-0.245206	-1.221219	0.23
DBD(-2)	-0.360039	-2.195517	0.03
BD	0.019058	0.017367	0.99
DBD(-1)	0.079929	0.08055	0.94
DBD(-2)	-0.826335	-0.83996	0.41
RES(-1)	-0.425243	-1.785556	0.08