ECONSTOR
Make Your Publications Visible.

A Service of
ZBW
Leibniz-Informationszentrum Wirtschaft
Leibniz Information Centre for Economics

Gabrisch, Hubert; Orlowski, Lucjan T.

Working Paper

A Dynamic Approach to Interest Rate Convergence in Selected Euro-candidate Countries

IWH Discussion Papers, No. 10/2009

Provided in Cooperation with:
Halle Institute for Economic Research (IWH) – Member of the Leibniz Association

Suggested Citation: Gabrisch, Hubert; Orlowski, Lucjan T. (2009) : A Dynamic Approach to Interest Rate Convergence in Selected Euro-candidate Countries, IWH Discussion Papers, No. 10/2009, Leibniz-Institut für Wirtschaftsforschung Halle (IWH), Halle (Saale), https://nbn-resolving.de/urn:nbn:de:gbv:3:2-8769

This Version is available at:
https://hdl.handle.net/10419/29975

Standard-Nutzungsbedingungen:

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

Terms of use:

Documents in EconStor may be saved and copied for your personal and scholarly purposes.

You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.

If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.

WWW.ECONSTOR.EU

Mitglied der Leibniz-Gemeinschaft

Institut für Wirtschaftsforschung Halle
Halle Institute for Economic Research

A Dynamic Approach to Interest Rate Convergence in Selected Euro-candidate Countries

Hubert Gabrisch and Lucjan T. Orlowski

May 2009 No. 10

IWH-Diskussionspapiere
IWH-Discussion Papers

A Dynamic Approach to Interest Rate Convergence in Selected Euro-candidate Countries

Hubert Gabrisch and Lucjan T. Orlowski

May 2009 No. 10

Authors: *Hubert Gabrisch,*

Head of Research, Halle Institute for Economic Research
Kleine Märkerstraße 8, 06108 Halle (Saale), Germany.
Tel. +49 (0) 345 7753830.
E-mail: Hubert.Gabrisch@iwh-halle.de

Lucjan T. Orlowski

Professor of Economics, John F. Welch College of Business – Sacred Heart University, and Research Professor – Halle Institute of Economic Research
5151 Park Avenue, Fairfield, CT 06825. USA.
E-mail: OrlowskiL@sacredheart.edu

The responsibility for discussion papers lies solely with the individual authors. The views expressed herein do not necessarily represent those of the IWH. The papers represent preliminary work and are circulated to encourage discussion with the author. Citation of the discussion papers should account for their provisional character; a revised version may be available directly from the author.

Comments and suggestions on the methods and results presented are welcome.

IWH-Discussion Papers are indexed in RePEc-Econpapers and in ECONIS.

Herausgeber:
INSTITUT FÜR WIRTSCHAFTSFORSCHUNG HALLE – IWH
Prof. Dr. Ulrich Blum (Präsident), Dr. Hubert Gabrisch (Forschungsdirektor)
Das IWH ist Mitglied der Leibniz-Gemeinschaft

Hausanschrift: Kleine Märkerstraße 8, 06108 Halle (Saale)
Postanschrift: Postfach 11 03 61, 06017 Halle (Saale)
Telefon: (0345) 77 53-60
Telefax: (0345) 77 53-8 20
Internetadresse: http://www.iwh-halle.de

A Dynamic Approach to Interest Rate Convergence in Selected Euro-candidate Countries

Abstract

We advocate a dynamic approach to monetary convergence to a common currency that is based on the analysis of financial system stability. Accordingly, we empirically test volatility dynamics of the ten-year sovereign bond yields of the 2004 EU accession countries in relation to the eurozone yields during the January 2, 2001 until January 22, 2009 sample period. Our results show a varied degree of bond yield co-movements, the most pronounced for the Czech Republic, Slovenia and Poland, and weaker for Hungary and Slovakia. However, since the EU accession, we find some divergence of relative bond yields. We argue that a 'static' specification of the Maastricht criterion for long-term bond yields is not fully conducive for advancing stability of financial systems in the euro-candidate countries.

JEL Classification: E44, F36.

Keywords: interest rate convergence, common currency area, new EU Member States, interest rate risk, GARCH

A Dynamic Approach to Interest Rate Convergence in Selected Euro-candidate Countries

Zusammenfassung

Diese Studie befürwortet einen dynamischen Ansatz zur Analyse montärer Konvergenzprozesse der Euro-Kandidatenländer. Der dynamische Ansatz basiert auf der Analyse der Stabilität der Finanzsysteme. Wir testen die Volatilitätsdynamik der Risikoaufschläge auf die langfristigen Zinssätze für fünf der im Mai 2004 der EU beigetretenen Länder, wobei die Risikoprämie durch die Differenz zwischen dem EU-Durchschnitt und den neuen Mitgliedsländern bei den durchschnittlichen Renditen auf langfristige Staatspapiere wiedergegeben wird. Die täglichen Daten bilden den Zeitraum vom 2. Januar 2001 bis zum 22. Januar 2009 ab. Es zeigen sich durchaus unterschiedliche Kopplungen in den Bewegungen der Renditen; die stärkste Kopplung besteht für die Tschechien, Slowenien und Polen, eine schwächere für Ungarn und die Slowakei. Seit ihrem EU-Beitritt zeichnet sich allerdings auch eine Divergenz zwischen den Renditen der fünf Länder und dem Euro-Durchschnitt ab. Daraus schließen wir, dass eine „statische“ Definition des Maastricht-Kriteriums für Renditen auf langfristige Staatspapiere nicht ausreichend ist, um Fortschritte in der Stabilität der Finanzsysteme der Euro-Kandidatenländer zu diagnostizieren.

JEL Classification: E44, F36.

Schlagworte: Zinskonvergenz, Währungsunion, neue EU-Länder, Zinsrisiken, GARCH

A Dynamic Approach to Interest Rate Convergence in Selected Euro-Candidate Countries

I Introduction

The central argument of our study is that monetary convergence to a common currency should be assessed on the basis of dynamic criteria and measures, not on static, single-moment thresholds. A successful convergence ought to reflect stability of the converging country's financial system, coupled with achieving minimum financial risks, as reflected by the lowest inflation-, interest rate-, and exchange rate-risk premia over the corresponding variables in a common currency area. A similar dynamic treatment applies also to fiscal and real economy convergence, which we leave out of this study for separate analyses.

We are led to believe that our approach is particularly applicable for the 2004 and 2007 EU entrants that are expected to adopt the euro in the near future. Upon the examination for their eligibility to adopt the euro, they are expected to attain the Maastricht criteria of monetary and fiscal convergence. The official monetary convergence criteria are specified as static thresholds, not as dynamic processes.[1] A static specification of monetary convergence thresholds entails significant risks: a candidate country may just be lucky to attain static or specified at their level-terms criteria of convergence, for instance, by applying excessively tight monetary policy in the period preceding the eligibility examination, at the expense of significant welfare costs. In a different vein, the candidate may miss the criteria in spite of pursuing a prudent mix of monetary and fiscal policies prior to examination, due to a temporary economic slowdown and deflation in the common currency area. We therefore argue that a successful convergence ought to be based on dynamic trends reflecting advances in the financial system stability and the low risk environment in the candidate countries.

We attempt to examine whether a dynamic convergence of interest rate risk has in fact taken place in the euro-candidate countries. We deal with interest rate, or more specifically, with ten-year government bond yield convergence, since the declining path of in-

1 The Maastricht benchmarks of monetary convergence include the inflation, the long-term interest rate, and the exchange rate criteria. Specifically, the candidate's headline inflation cannot be higher than 1.5 percentage points above the average of the three lowest inflation member countries. The yield on the candidate's long-term sovereign bond should not be higher than two percentage points above the average yield in the three lowest inflation member countries. The exchange rate should fluctuate within the ERM2 band for at least two consecutive years, without the domestic currency devaluation.

flation differentials vis-à-vis the eurozone and exchange rates has been widely examined in the literature (Orlowski 2003, 2008a; Matoušek and Taci 2003; Kutan and Yigit 2005; Kočenda et.al 2006; DeGrauwe and Schanbl 2005; Kočenda and Valachy 2006; Poghosyan and Kočenda 2007). Convergence of bond yields, which is in our opinion an important, direct reflection of gains in financial stability, has received an in-depth analytical treatment only recently (Holtemöller 2005; Kim et.al 2006; Orlowski and Lommatzsch 2005; Baltzer et.al 2008). Such dynamic convergence reflected by diminishing risk premia on long-term sovereign bond yields is crucial for sustainable price stability and systemic soundness of the candidates financial systems. It also lowers probability of potentially destabilizing nominal shocks upon their actual adoption of the euro.

For the purpose of examining the interest rate risk or volatility convergence of bond yields we employ the generalized autoregressive conditional volatility models, with the in-mean variance and generalized error distribution specification (GARCH-M-GED). In hindsight, risk convergence is detected if the in-mean variance coefficient is negative, and when the sum of ARCH and GARCH terms is less than one. Our model of bond yield convergence is tested empirically during the January 2, 2001-January 22, 2009 sample period for the 2004 EU accession countries that have been pursuing relatively flexible monetary policies, i.e. Poland, Hungary, the Czech Republic, Slovakia and Slovenia.[2] We exclude currency board countries (i.e. the Baltic States) as their policy regime eliminates the exchange rate risk while distorting inflation and interest rate risks, particularly in the presence of Balassa-Samuelson effects (DeGrauwe and Schnabl, 2005).

In Section II of the paper we review the pertinent literature. We subsequently proceed to empirical investigation of interest rate risk. The time pattern and data characteristics of the ten-year sovereign bond yields of the euro-candidates are analyzed in Section III. Volatility dynamics of their bond yields relative to the average yield in the eurozone member countries are examined in Section IV. The concluding Section V summarizes our findings and offers policy suggestions.

2 We have chosen to exclude the 2007 EU entrants, i.e. Bulgaria and Romania, from our analysis due to insufficient data for examining the time pattern of their bond yields over a full business cycle period. They have introduced secondary trading of 10Y government bonds only recently: Bulgaria in January 2003 and Romania in April 2005. In addition, Bulgaria has followed a currency board policy regime.

II Interplay between Convergence and Stability in the Literature

Although the history of politically-determined monetary convergence and fiscal criteria for EMU entry is rather brief, there is already an extensive literature on this subject. The available studies examine rationality and compliance with the convergence criteria stemming from appropriate policies of governments and central banks, particularly in light of the Stability and Growth Pact. One strand of the literature investigates the links between real and nominal convergence (see e.g., Halpern and Wyplosz 2001; Brada et al. 2002; Mihaljek and Klau 2004; Angeloni et al. 2005; De Grauwe and Schnabl 2005; Kočenda et al. 2006), with a specific consequences for real convergence when the Balassa-Samuelson effects are evident. We disregard possible nominal-real links and concentrate our investigation on nominal convergence only, as the main motivation and purpose of our study. In general terms, the literature offers two approaches to the fulfillment and sustainability of nominal convergence.

One approach is based on investigation whether the monetary and fiscal Maastricht criteria show long-run properties in their convergence toward the 'static' Maastricht thresholds. The time series of the respective aggregates are tested for ß- and σ-convergence or for co-integration. Kočenda et al. (2006) augment the convergence estimations by examining stochastic convergence in the residual. They find significant inflation and interest rate convergence, but limited fiscal convergence, which indicates the lack of fiscal sustainability. Brada and Kutan (2001, 2002) and Brada et al. (2002) apply a rolling co-integration approach, and find evidence of convergence for some variables, including M2 and prices, but none for other key monetary policy variables. Figuet and Nenovsky (2006) in their examination of Bulgaria and Romania employ an error-correction model that untangles long-term co-integration of nominal, real and financial variables from short-run deviations and interpret the short-term adjustment to the long-run dynamics as convergence. They find convergence for price levels, interest rates and their spreads between Bulgaria and the EU, but not for Romania. They explain this result with an important institutional difference between the two countries – Bulgaria's monetary policy is bound by a currency board, while Romania follows a more flexible monetary policy. As mentioned above, the currency board normally distorts country-specific inflation and interest rate risks, which could unfold particularly fiercely after adoption of the euro. This literature offers important insights into the ongoing process of fulfilling the Maastricht criteria. However, we are concerned with several problems that might question the countries' readiness to adopt the euro.

First, the convergence approach is taken from and linked to growth theory. But the Maastricht monetary and fiscal criteria refer to policies, which are difficult to encapsulate in a common theoretical framework. We are inclined to ask whether and how politically induced regime shifts may affect convergence, interpreted as the fulfillment of the

pre-determined thresholds. The case of Slovenia might be illustrative: the country fulfilled all convergence criteria ahead of the euro adoption in 2007, but inflation rates diverged thereafter. Kenen and Meade (2003) provide another example. They discuss the narrowing of the exchange rate criterion for new EU members from a ±15% to a ±2.5% bandwidth, and warn against higher financial crisis risk for the countries in case the revision would be applied to them.

Second, our reservation against the transfer of real convergence approaches to monetary phenomena seems particularly important within the context of today's volatile nominal economy. The ongoing turmoil in global financial markets generates unbalanced contagion and spillover effects on different countries with diverse financial systems and macroeconomic fundamentals (Orlowski 2008b). Central banks and governments around the globe have recently intervened on several occasions since mid-August 2007 to mitigate heightened liquidity pressures, in order to: (i) ease concerns about an emerging credit crunch, (ii) prevent bank failures, and (ii) cushion the adverse impact of the financial market turmoil on the real economy. It seems necessary to develop a theoretical and empirical framework for the evaluation of convergence in risks. Such framework goes certainly beyond the evaluation of the actual achievement of the Maastricht convergence criteria.

Third, there is yet another theoretical argument that encourages our departure from a static toward a dynamic risk approach. The co-movement in time of economic aggregates of integrating countries or regions is driven by two completely different factors: the integration of commodity and input markets, and the similarity of structures and institutions. For example, presumed convergence of long-term interest rates of two countries might be achieved through a combination of strong cross-border investments spurred by financial integration, with dissimilar structural and institutional characteristics of financial and budgetary sectors. Alternatively, it could be achieved through low integration and highly similar structural and institutional characteristics. In the first case, the risks of financial instability after an exogenous shock remain high despite the apparent convergence. The adjustment of structures and institutions towards a common pattern takes more time compared to the financial integration in the eurozone, if it happens at all. Therefore, the probability of occurrence of a regional financial crisis is embedded in the asymmetric distribution of shocks among the converging countries. The unbalanced contagion effects in the new EU Member States (NMS) from the ongoing global financial crisis might serve as a good example for the conflict between the intensity of strong financial inflows and outflows and the prevalent differences in financial and fiscal institutions.[3]

3 In particular, countries such as Hungary with a weak fiscal discipline and a vulnerable monetary system dominated by lending activities of international banks are likely to experience extreme difficulties to compensate for the detrimental effects of sudden capital withdrawals on the financial and real sectors.

This third argument relates our research to the theory of optimum currency area. In an attempt to assess the EU in its properties of being an OCA, Bayoumi and Eichengreen (1993) offer a method for the separating shock transmissions from the long-run adjustment component in the time series of member countries. They test synchronization of business cycles by calculating bivariate correlation coefficients for de-trended time series of output. They find low synchronization among EU countries compared to the United States, prior to the euro introduction. Their study reveals prevalence of asymmetric shock transmissions and high risks of regional output crises after adopting the common currency. A recent strand of the literature tests the hypothesis of a possibly endogenous character of currency areas. It follows a seminal study by Frankel and Rose (1998), who argue that similarity of structures and institutions is the product of a common currency and single monetary policy, and not necessarily it's pre-requisite. The main arguments raised in this literature are based on estimation of correlation coefficients on: increasing trade intensities (Frankel and Rose 1998), as well as specialization patterns and the degree of financial integration (Imbs 2004; Schiavo 2008). In general terms, the studies seem to find evidence for increasing business cycle synchronization, or real convergence, and declining risks of regional output crises in the eurozone.

There are only a few studies that transfer the idea of taking shock responses as indicator for monetary risks and the stability of the Maastricht criteria. The studies we know, concentrate on the impact of fiscal institutions on interest rate spreads, which serve as a proxy of financial risk disproportions across regions. For example, Hallerberg et al. (2004) and Hallerberg and Wolff (2006) analyze the impact of qualitatively different fiscal institutions on sovereign risk premia in EU countries, and find: (i) the impact of the quality of fiscal institutions on the spread, and (ii), the improving quality of fiscal institutions in the EU members during the course of their preparation for the euro adoption. We follow another methodological approach that has been also applied by Poghosyan and Kočenda (2007) in their study on foreign exchange risks in NMS and by Orlowski (2008a) for interest rate and inflation differentials between NMS and eurozone. These studies employ a multivariate GARCH-M model, which regards the conditional covariance terms and excludes arbitrage possibilities. Poghosyan and Kočenda (2007) find that monetary policy has an important effect on the behavior of exchange rates in NMS. Orlowski (2008a) shows that relative interest and inflation rates over the eurozone might provide a useful basis for advancement of inflation targeting policy regimes in the converging economies. These studies further detect important differences across the countries due to underlying systemic differences between them. The appealing idea behind their methodology is to investigate the in-mean GARCH variances. These variances might be unstable and even increasing, thus require particular attention. A basic assumption of convergence is a decreasing in-mean GARCH variance in the time series, i.e. a diminishing risk. Hence, information about the stability and risks cannot be just linearly extrapolated from historical data. It is better captured by the dynamics of the in-mean variance in the conditional mean equation. A further appealing advantage is that one can use financial variables with long-term time series. Moreover, one can probably

circumvent the problem of finding and calculating institutional variables, often for few moments in time only. The GARCH estimator grasps the aggregate effects of all the institutional and structural asymmetries, regardless whether real or nominal convergence can be actually observed in the long-period time-series. The sign of the in-mean GARCH variance coefficient reflects increasing or decreasing risk for nominal convergence. Considering these advantages, we have chosen to apply this method to the interest-rate convergence criterion.

III Time Pattern of Bond Yields

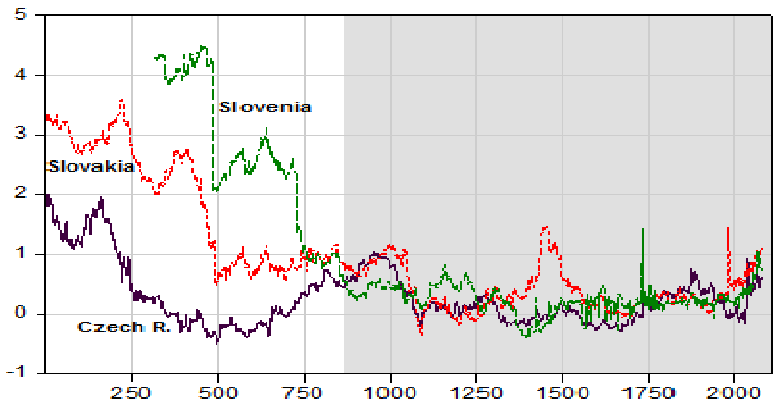
Sovereign bond markets in Central and East European countries have undergone a notable progress at the advanced stage of economic transition and during active preparations for accession to the European Union. Long-term bonds could not be introduced at the early stage of transition from central planning to a market economy as modern fiscal policies had to be developed and the inflation drivers (such as the Balassa-Samuelson effects) had to stabilize in order to make dynamic inflation forecasts more reliable. With the improved predictability of inflation, the term structure of the government bond yields became more stable, so did the risk premia on long-term bonds. For these reasons, long-term government bond trading could be launched only at a more advanced stage of transition. In the examined 2004 EU accession countries, secondary market trading of ten-year bonds was initiated in the beginning of: January 1999 in Hungary, May 1999 in Poland, May 2000 in the Czech Republic, January 2001 in Slovakia, and March 2002 in Slovenia.

During the early period following their inception, long-term bond markets in these countries were not fundamentally stable. As shown in Figures 1a and 1b, risk premia of 10Y bonds yields in the May 2004 EU accession countries over the average 10Y bond yield of the fifteen members (EUR15) that comprised the eurozone at the end of 2008 were considerably elevated, ranging from 680 basis points (bps) in Poland, to just under 200 bps in the Czech Republic. It is, therefore, not surprising that the sovereign bond yield compression of these countries to eurozone bond yields has not taken place at the early period, as proven by Holtemöller (2005), Kim et.al (2006) and Baltzer et.al (2008). During the course of active preparations for their EU accession, disciplined fiscal and monetary policies along with the declining inflation have helped reduce these premia considerably. Since 2004, however, the risk premia in the examined countries have evolved in different directions. Bond yields in the countries that moved decisively toward adopting the euro, i.e. in Slovenia and Slovakia, as well as in the Czech Republic have become recently fully aligned with the EUR15 yield (Figure 1a)[4]. The risk premium in Poland has been markedly reduced to the recent level of around 150 bps, while the premium in Hungary has remained considerably elevated at around 400 bps (Figure 1b).

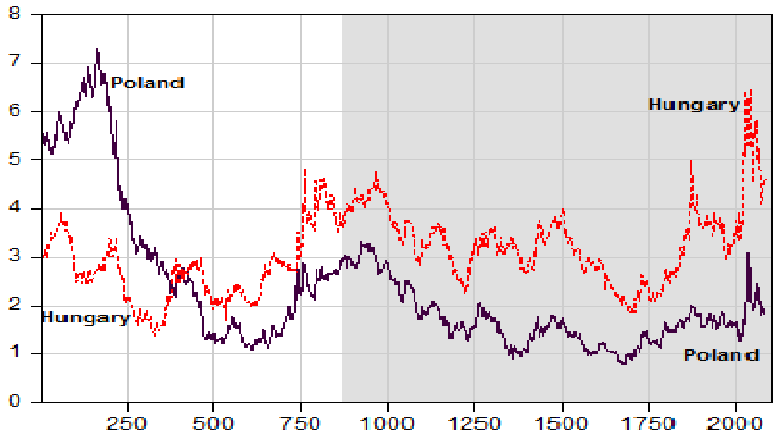
The detected dispersion in risk premia of 10Y sovereign bond yields in NMS is seemingly attributable to the prevalent differences in their fiscal discipline, macroeconomic fundamentals and the risk structure of capital inflows. As shown in Table 1, the government budget deficit is the largest in Hungary, which underpins the excessive, staggering interest rate risk premium over the average eurozone bond yield. In line with the top-

4 Slovenia has adopted the euro since January 2007 and Slovakia since January 2009.

Figure 1:
Spreads between the May 2004 EU Accession Countries' and EUR15 Ten-Year Bond Yields
1a: Spreads between sovereign and EUR15 average bond yields for the Czech Republic, Slovakia, and Slovenia



1b: Spreads between sovereign and EUR15 average bond yields for Poland and Hungary



Notes: January 2, 2001 – January 22, 2009 daily average data series (2104 observations). The vertical axis numbers represent full percent or '00 basis points (bps). The shaded area shows the post-EU accession (May 2004) period.

Data source: Datastream.

heavy budget deficit, Hungary's public debt and inflation remain to be the highest among the examined NMS. Moreover, the lack of fiscal discipline is taking a toll on Hungary's real economy growth – its real GDP growth rate has become the weakest within the analyzed group of countries. The analysis in Table 1 that is based on 2007 data excludes Slovenia, which already was a member of EUR15 at that time. It includes

Slovakia, which met all the Maastricht convergence criteria by a safe margin two years prior to its euro adoption in 2009. Poland and the Czech Republic also met the convergence criteria in 2007, as verified in Table 1, but they may face difficulties maintaining them in the aftermath of the current global financial crisis and economic slowdown. They apparently have missed a 'bona fide' chance to adopt the euro at the same time as Slovakia. Moreover, some of the NMS that are still experiencing positive real GDP growth in 2009 are likely to fail the Maastricht inflation criterion for the reasons independent of their own economic policies. This temporary setback is caused by the economic recession and deflationary tendencies in the EU member countries that are most severely affected by the global economic crisis, which contribute to a drop in the Maastricht reference rate for inflation.[5]

Table 1:
Underlying Fundamentals and Euro-Convergence Indicators (2007 data)

	Real GDP growth rate	General Gov.t budget (%GDP)	Public debt (%GDP)	HICP inflation rate	10Y Gov.t Bond Yield	Corporate fixed income securities (%GDP)	Stock market capitalization (%GDP)
Czech R.	6.6	-1.6*	28.7*	3.0*	4.3*	19.5	35.9
Hungary	1.3	-5.5	66.0	7.9	6.7	14.1	31.5
Poland	6.5	-2.0*	45.2*	2.6*	5.5*	5.0	43.8
Slovakia	10.4	-2.2*	29.4*	1.9*	4.5*	9.2	18.6
Eurozone (EUR 15)	-	-3.0 (ref.rate)	60 (ref.rate)	3.2 (ref.rate)	6.5 (ref.rate)	81.4	73.8

* Denotes fulfilment of Maastricht criteria

Data Source: ECB Convergence Report – April 2008.

In hindsight, the euro-candidates with the exception of Hungary fulfilled Maastricht convergence criteria in 2007; however, their budget deficits and overall convergence may be jeopardized by the current economic and financial turmoil. In spite of the present difficulties, the NMS need to foster institutional depth and resilience of their financial markets – they clearly lag in this area behind the eurozone financial system as shown in Table 1. Deeper, more resilient financial markets are likely to cushion possible nominal shocks associated with the euro adoption in the foreseeable future.

5 Specifically, the Maastricht inflation reference rate reached 1.8 percent in February 2009, based on the Eurostat data (i.e. the average rate for Ireland, Portugal and Spain plus 1.5 percent). At the same time, the annualized inflation based on the harmonized index of consumer prices reached 3.6 percent in Poland and 2.9 percent in Hungary. Even the two new eurozone members, i.e. Slovakia and Slovenia would have failed the inflation test with the annual rates of 2.4 and 2.1 percent respectively. Only the Czech Republic met the inflation criterion scoring 1.7 percent.

IV Volatility Dynamics Analysis

A deeper insight into dynamic changes and systemic foundations underpinning convergence of interest rate risk in the euro-candidate countries is provided by the time-varying analysis of volatility dynamics of 10Y bond yields. As noted above, we conduct this analysis for the 2004 EU accession countries that follow relatively flexible monetary policies.

Prior to reporting the results of volatility dynamics tests, we wish to display selected descriptive statistics of 10Y Maastricht convergence bond yields of the Czech Republic, Hungary, Poland, Slovenia and Slovakia at their levels for the daily series that begin on January 2, 2001 and end on January 22, 2009. The bond yields of NMS are compared with the average yields on 10Y sovereign bonds of EUR15.

Table 2:
Ten-Year Maastricht Convergence Bond Yields – Selected Descriptive Statistics
- January 2, 2001 – January 22, 2009 daily average series -

	Czech Republic	Hungary	Poland	Slovakia	Slovenia**	EUR15
Mean	4.55	7.35	6.58	5.26	5.11	4.26
Max/Min	7.03/3.18	10.78/5.35	12.30/4.41	8.29/3.09	9.62/3.55	5.38/3.07
Dec 2008 avg level	4.30	8.31	5.70	4.72	4.56	4.07
Standard Deviation	0.87	0.81	1.80	1.43	1.58	0.54
Skewness	+0.95	+0.54	+1.55	+0.90	+1.52	+0.09
Kurtosis	3.50	3.34	4.59	2.66	4.34	2.43
Unit root ADF stat.*	-2.70	-2.48	-2.04	-2.18	-3.09	-1.72
Correlation with EU12	+0.84	+0.35	+0.76	+0.87	+0.69	1.00
Linear time trend	-0.0008	+0.0001	-0.0020	-0.0017	-0.0021	-0.0004

* McKinnon critical values for ADF unit root test at 5% probability are -2.86 in all cases; ** March 18, 2001 – January 22, 2009 series for Slovenia.

Source: Own calculations based on Datastream and ECB data.

As shown in Table 2, the mean value of the Hungarian bond yield is the highest among the examined NMS, so is its risk premium over the EUR15 mean. The lowest risk premium over EUR15 based on the mean is detected for the Czech Republic. The Czech Republic also reached the lowest bond yield as well as the spread over EUR15 bonds in December 2008. The yields in the two new eurozone members, Slovenia and Slovakia, were reasonably close to the EUR15 average. The yields on Polish and Hungarian bonds were respectively 163 bps and 424 bps above the EUR15 average. The data distribution

of 10Y bond yields is right-skewed (skewness>0) for all countries in our sample indicating prevalence of positive over negative deviations from the mean. It is also mainly leptokurtic (kurtosis>3) or 'long-tailed', except for Slovakia and EUR15, which implies a wide dispersion of yields or elevated risk during turbulent times. At the same time, it suggests that NMS financial markets tend to be highly unstable during the periods of elevated global market risk. Evidently, a sufficient institutional resilience of NMS financial systems against exogeneous shocks has not been fully developed. As it could be reasonably expected, nominal bond yields at their level terms follow a non-stationary trend in all examined countries, except Slovenia. Hungarian bond yields display weak correlation with EUR15 yields due to their fragile macroeconomic fundamentals, while correlation of the remaining NMS with EUR15 bond yields is strong. Moreover, the linear time trend of NMS bond yields is declining by more than the EUR15 average yield, indicating their ongoing convergence or declining risk premia. Hungary is again an exception; the linear trend path of its bond yield is rising.

For the purpose of our empirical testing, we develop the following model examining co-movement between domestic R_t^C and common currency or eurozone R_t^E bond yields. The basic stochastic model of bond yield co-movement is

$$R_t^C = \beta_0 + \beta_1 R_t^E + \xi_t \tag{1}$$

Considering non-stationarity of the examined bond yields at their levels (shown in Table 2), we convert the model variables to their first-differenced terms denoted by r_t. In addition, the baseline model is augmented with the binary variable DEU_t assuming the value of 0 for the period preceeding the EU accession and 1 for the post-accession daily series. In the estimated equation we also consider the interaction variable $DEU_t * r_t^E$ in order to ascertain a change in the co-movement between the domestic and the eurozone bond yields since the EU accession. The augmented model is prescibed by

$$r_t^C = \beta_0 + \beta_1 r_t^E + \beta_2 DEU_t + \beta_3 (DEU_t * r_t^E) + \xi_t \tag{2}$$

Time-varying volatility dynamics of co-movements between the NMS and the eurozone bond yields is examined on the basis of the GARCH(p,q)-M two-equation system. The conditional mean equation is derived from Eq.2 and is supplemented with the GARCH in-mean conditional variance M component σ_{t-1}^2. The conditional mean equation is represented by

$$r_t^C = \beta_0 + \beta_1 r_t^E + \beta_2 DEU_t + \beta_3 (DEU_t * r_t^E) + \beta_4 \sigma_{t-1}^2 + \xi_t^{'} \tag{3}$$

The inclusion of the GARCH variance in the mean equation allows for ascertaining the overall convergence (or divergence) of government bond yields; therefore for determining declining (or increasing) interest rate risk. Convergence of bond yields (decreasing interest rate risk) is detected when $\beta_4 \langle 0$, while divergence occurs when $\beta_4 \rangle 0$. An estimated

value of the β_1 coefficient is expected to be close to or higher than one if a given change in the eurozone average bond yield drives significantly the euro-candidates' yields in the same direction. A negative estimated value of β_2 would imply a further interest rate decline during the post-EU accession period. However, a negative value of β_3 would suggest interest rate divergence since the EU accession. Our data generating process assumptions include also the generalized error distribution (GED) parameterization to account for a possible leptokurtosis in the data, which is realistic for bond markets and has been also detected from the examination of the bond yields at their level-terms shown in the Table 2.

The corresponding conditional variance equation is specified as

$$\sigma_t^2 = h_0 + h_1 \xi_{t-1}^{'2} + ... + h_p \xi_{t-p}^{'2} + g_1 \sigma_{t-1}^2 + ... + g_q \sigma_{t-q}^2 \tag{4}$$

The ARCH terms $h_p \xi_{t-p}^{'2}$ represent the impact of 'news' or shocks to volatility from p-periods before, while the GARCH terms $g_q \sigma_{t-q}^2$ reflect persistency in volatility carried from q-periods before. In particular, we are focusing on the sum of ARCH and GARCH coefficients; if its value is less than unity it implies diminishing volatility (as a proxy of declining interest rate risk).

The selected, most robust results of the GARCH-M-GED tests based on Eqs.(3) and (4) for each NMS bond yield are shown in Table 3. The orders of p for ARCH and q for GARCH terms for each NMS bond yield series have been chosen on the basis of minimum Schwartz information criterion (SIC) and maximum log-likelihood.

The estimated β_1 coefficients (sensitivity of relative change in domestic to eurozone bond yields) in the conditional mean equation imply that the changes in the NMS bond yields respond to the concurrent changes in the eurozone average yields in the same direction. The co-movement between the domestic and the eurozone bond yields (i.e. the estimated value of the EUR15 bond yield coefficient β_1) is the strongest in the cases of the Czech Republic and Slovenia, followed by Poland. It is markedly weaker in the cases of Hungary and Slovakia. This interaction is statistically significant for all countries. The in-mean variance or log(GARCH) variable in the conditional mean equation is highly significant only in the case of Poland – the negative sign of the estimated β_4 coefficient indicates diminishing volatility of bond yields (declining interest rate risk) over the entire sample period. There is no evidence of major changes to the examined interaction between the domestic and the eurozone bond yields during the post accession period, as implied by the insignificant estimated DEU coefficients β_2. However, the negative signs of the estimated coefficient β_3 of the interaction variable $DEU_t * r_t^E$ for all NMS with the exception of Slovakia indicate some divergence in the time pattern of the domestic and the eurozone bond yields during the post-EU accession period[6]. This di-

6 This finding is also confirmed by *Baltzer, et al.* (2008) who demonstrate that NMS government bond markets have been increasingly affected by adverse shocks in eurozone markets, particularly since the 2004 EU accession.

version may stem from a weakening political will of the Polish and the Czech governments to join the euro, particularly during the first two years following the EU accession. More importantly, it stems also from exacerbated interest rate risk in these emerging European market economies related to pronounced contagion effects of the 2007-2009 global financial crisis (IMF 2009).

Table 3:
GARCH-M-GED estimation results for 2004 EU accession countries
- Dependent variable: daily average changes in domestic 10Y Maastricht Convergence Government Bond Yields -

	Czech R.	Hungary	Poland	Slovakia	Slovenia
Cond. mean equation:					
Constant term	-0.001	0.001	-0.012***	0.018	-0.005
EUR Bond Yield	0.727***	0.197***	0.304***	0.047***	0.892***
Log(GARCH)	0.001	-0.001	-0.002***	-0.003	0.001
DEU	0.004	-0.002	-0.001	0.002	-0.001
DEU*EUR yield	-0.227***	-0.196***	-0.078***	0.101***	-0.875***
Cond. variance equation:					
Constant term	0.001**	0.001	0.001***	0.001**	0.004
ARCH(1)	0.061*	0.478***	0.048*	0.184***	0.142***
ARCH(2)	-0.018	-0.051	0.021	-0.022	0.030
ARCH(3)	0.057	-0.120	0.037	0.039***	0.006
ARCH(4)	-0.065	0.024	0.030	0.033*	-0.018
ARCH(5)	0.267***	0.259	0.193***	-0.011	-
ARCH(6)	-0.248***	-0.280*	-0.289***	0.023	-
ARCH(7)	-	-	0.089***	0.001	-
ARCH(8)	-	-	-0.083***	0.014*	-
ARCH(9)	-	-	0.053***	-	-
GARCH(1)	0.944***	0.838***	0.895***	0.137	0.398
GED parameter	0.770***	0.410***	0.834***	1.018***	1.5 fixed
Diagnostic statistics:					
Schwartz Info. Criterion	-4.190	-2.749	-3.236	-4.246	-2.648
Log likelihood	4423.4	2920.1	3440.1	4480.7	2387.2

Notes: GED parameter is fixed for Slovenia at 1.5; DEU assumes the value of 1 for the post-EU accession period (since May 4, 2004); the daily series begin January 2, 2001 (March 18, 2001 for Slovenia) and end on January 22, 2009 (2104 observations). *** denotes statistical significance at 1%, ** at 5% and * at 10%.

Source: Authors' own calculations based on Datastream data.

The estimated results of the conditional variance equation indicate a non-uniform, highly unstable impact of shocks or 'news' about volatility from the preceeding periods, demonstrated by the complex structure of ARCH p-orders. The impact of such shocks

on volatility of bond yields is rather instantaneous in the cases of Hungary and Slovakia. In contrast, there is a considerably slower decay of new information about volatility from the previous periods in the cases of the Czech and the Polish bond yields, as implied by significant high-order ARCH terms.

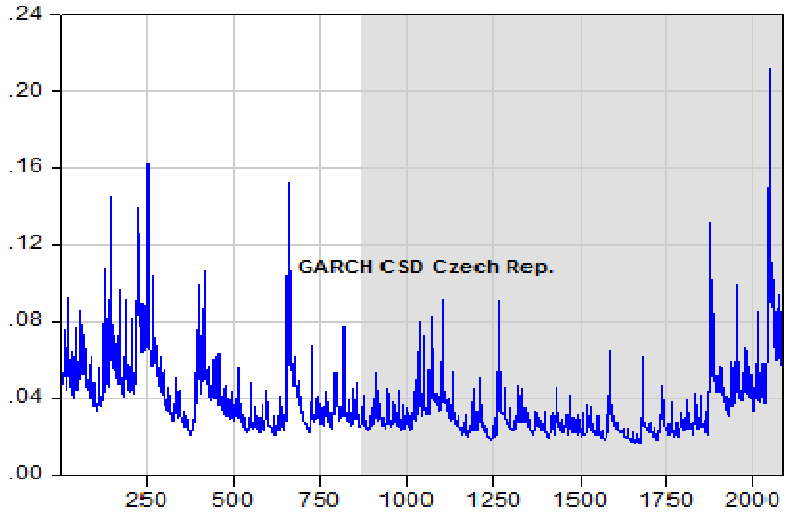
The conditional volatility series is highly persistent in all examined NMS, as implied by high first-order GARCH terms, except for Slovenia and Slovakia, where shocks or innovations to volatility play a much stronger role. Nevertheless, the sum of ARCH and GARCH coefficients for all countries does not exceed unity, which means a declining path of volatility, thus evidence of diminishing interest rate risk. However, the volatility series for all five countries is clearly leptokurtic (all GED parameters are less than 2), which implies that volatility of NMS bonds tends to be exacerbated during turbulent market periods. This finding demonstrates that NMS bond markets remain to be excessively vulnerable at times of elevated market vicissitudes.

The results of diagnostic indicators, i.e. the relatively high log likelihood and the low SIC estimates imply that the examined series are fairly robust and stable in each country's bond yield series. In sum, it can be concluded that the volatility of long-term bond yields is gradually declining in the examined countries, which underpins the ongoing, albeit rather slow compression of interest rate spreads over EUR15.

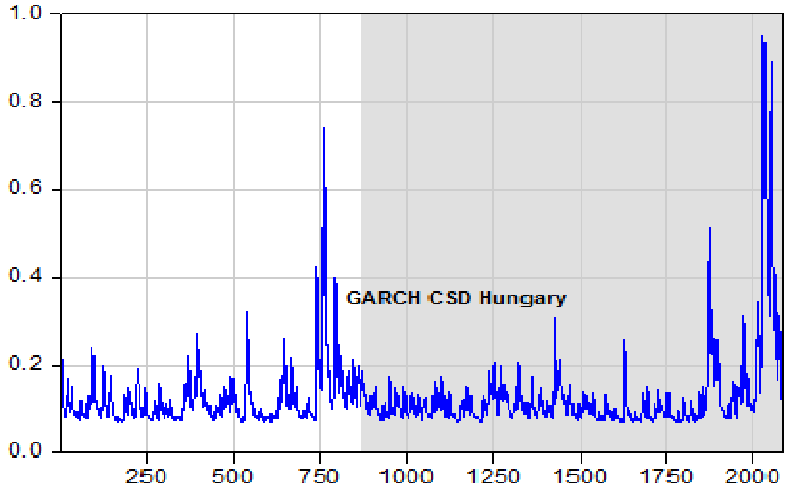
Further insights in terms of time-varying properties of the volatility dynamics of NMS bond yields can be detected from the graphical time-distribution of the GARCH conditional standard deviation (GARCH-CSD) series estimated from Eqs.(3) and (4). Figure 2a displays the GARCH-CSD distribution for the Czech Republic. Volatility of the Czech bond yields was visibly elevated during the first two years of the sample period, i.e. in 2001-2002 (observations 1-700). During the period preceding the EU accession, volatility of the Czech bond yields was considerably lower. However, during the post-accession period that is denoted by the shaded area (observations 870-2104) the analyzed volatility was initially subdued. But it has elevated considerably during the most recent two-year period; notably as a result of contagion effects from world financial markets. In contrast to the Czech case, the numerical values of GARCH-CSD for Hungary (Figure 2b) are much higher. Moreover, there is no visible convergence of interest rates, and the volatility of the examined series during the 2007-2009 global financial crisis has been way too excessive. There is a significant decline in volatility of the Polish bond yields during the same sample period (Figure 2c), with a strong dampening effect since the EU accession. There is certainly a significant increase in volatility of the Polish bond market during the recent period of the global financial distress, however, to a lesser degree than in the case of Hungary. However, the levels of GARCH-CSD for the Polish bond yields have been recently somewhat higher than for the Czech yields, indicating that Poland may still have to expedite efforts toward achieving greater financial stability. In spite of a smaller, less-capitalized bond market in Slovakia, its GARCH-CSD has been relatively stable over the entire sample period, yet again except during the

Figure 2:
GARCH conditional standard deviation residuals generated from estimations in Table 3

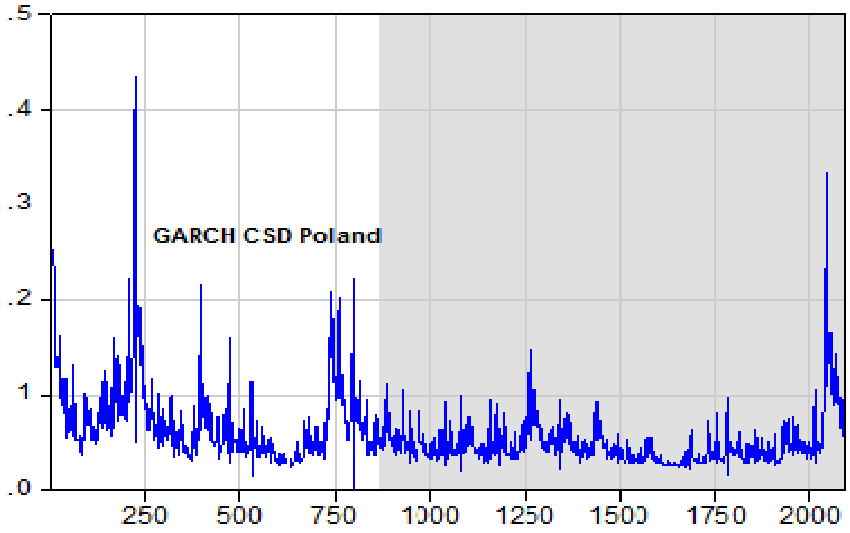
2a: The Czech Republic



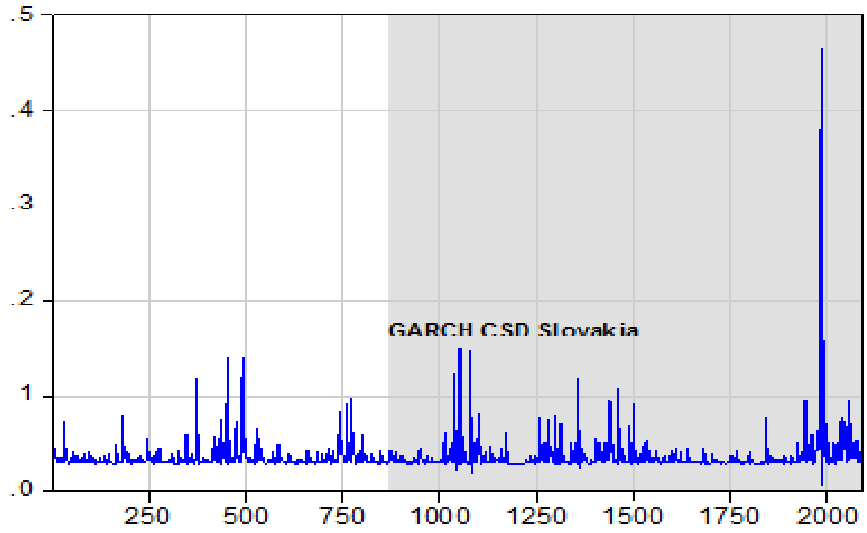
2b: Hungary



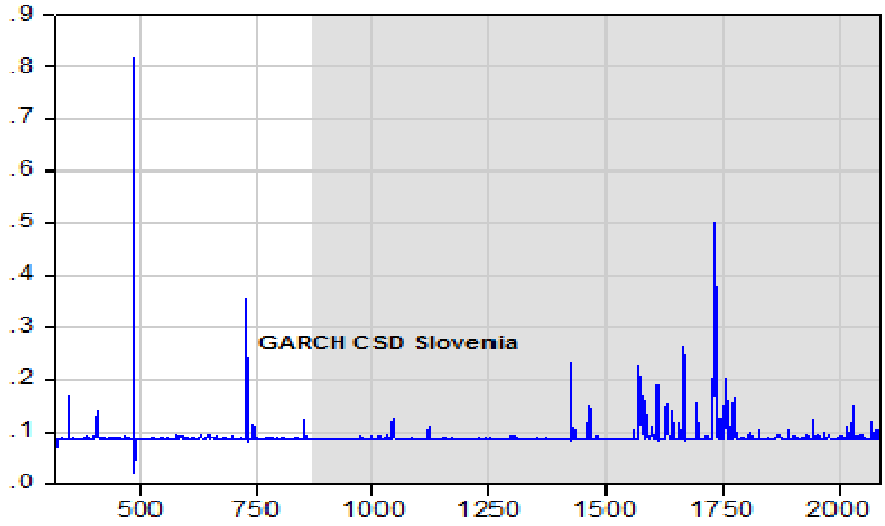
2c: Poland



2d: Slovakia



2e: Slovenia



The shaded areas show the post-EU accession (May 1, 2004) period. Daily series January 2, 2001 – January 22, 2009 (2104 observations)

Source: Authors' estimations based on Datastream data.

most recent global financial market jitters (Figure 2d). The GARCH-CSD series of the Slovenian bond yields is a particularly interesting case. Volatility of the Slovenian yields (Figure 2e) has been consistently very low since the quick expiration of the significant shock in December 2002. It jumped somewhat on the eve of the euro adoption in January 2007, in response to qualms related to the unpredictable effects of that move. But in contrast to the other cases, the conditional volatility of Slovenian bonds has not increased during the current financial crisis, which proves that the euro adoption has provided Slovenian bond market with an effective cushion against of global market risk.

In hindsight, there is a progress in stability of bond markets and the evidence of declining risk premia in the countries that have recently joined the eurozone, i.e. Slovenia and Slovakia, as well as in Poland and Czech Republic. Similar stability gains are not seen in Hungary, where decisive policy measures ought to be enacted in order to improve economic fundamentals and develop resilience of its sovereign bond markets against potential shocks. The recent global financial crisis poses a serious threat to stability of NMS markets. Our analysis implies that the Slovenian decision to adopt the euro prior to this crisis was a critical contributing factor to the fundamental stability of the country's sovereign bond market.

V A Synthesis

Our study examines the ability of the euro-candidate countries to mitigate interest rate risk as reflected by decreasing volatility of the ten-year sovereign bond yields in relation to the corresponding yields in the eurozone. We devise a model analyzing the co-movements between the domestic and the eurozone government bond yields, which includes a post-EU accession binary variable and the interaction variable between the post-accession dummy and eurozone average bond yield as additional regressors. We test the model for NMS that have joined the EU since 2004 and applied relatively flexible monetary policies, i.e. the Czech Republic, Poland, Hungary, Slovakia and Slovenia. We employ GARCH tests with the in-mean conditional variance and generalized error distribution parameterization (GARCH-M-GED) to investigate the time-varying, dynamic changes in the volatility of the euro-candidates bond yields.

We find evidence of a pronounced co-movement between the NMS and the eurozone long-term bond yields. The effect is the strongest in the countries with solid macroeconomic fundamentals and stable financial markets (the Czech Republic and Slovakia), while it is the weakest in the unstable environment of Hungary. The low risk premia for the countries that have recently adopted the euro, i.e. Slovenia and Slovakia, as well as for the Czech Republic and Poland indicate improvement in their financial stability and creditworthiness. The co-movement of long-term government bond yields is the weakest in the case of Hungary and shows some divergence during the post-EU accession period. The Hungarian bond yields show increasing volatility and misalignment with the eurozone yields due to the country's deteriorating fundamentals. Hungary almost attained the Maastricht-specified reference rate for long-term interest rates at the end of 2007, but our volatility analysis shows that the Hungarian and the eurozone bond yields are increasingly out of sync. Our assessment is confirmed by the recent derailment of the Hungarian risk premium and divergence of bond yields since 2007. The wider spread of the Hungarian over the eurozone bond yields has been apparently exacerbated by the combination of the deteriorating Hungarian economic fundamentals and the contagion from the global financial crisis.

In hindsight, our study advocates a dynamic treatment of monetary convergence to a common currency. We argue that a 'static', level-specification of convergence targets, such as the articulation of the Maastricht criteria, does not reflect adequately the dynamic processes that are indispensable for ensuring long-term stability of the financial system in the converging country. In general terms, such processes include institutional advancement and capacity building of financial markets and intermediaries. Therefore, we focus on dynamic, time-varying changes in interest rate risk premia proxied by convergence of government bond yields.

Institutional strengthening of financial markets and intermediaries, coupled with disciplined fiscal policies and monetary regimes based on inflation targeting have contrib-

uted to the declining interest rate risk premia in the examined countries. However, following the 2004 EU accession and particularly in the most recent two-year period, the sovereign bond yields display rising volatility, stemming mainly from the proliferation of the global financial risk. Contagion effects of the global financial crisis affect the euro-candidates unevenly; being more pronounced in the countries with unstable fundamentals. Under such circumstances, the Czech Republic and Poland are likely to find it increasingly difficult to maintain their successful path of interest rate convergence, which may inhibit their efforts to adopt the euro in the foreseeable future.

References:

Angeloni, I.; Flad, M.; Mongelli, F. (2005): Economic and Monetary Integration of the New Member States. Helping to Chart the Route. European Central Bank Occasional Paper, No. 36.

Baltzer, M.; Capiello, L.; De Santis, R. A.; Manganelli, S. (2008): Measuring Financial Integration in NEw EU Member States. European Central Bank Occasional Paper, No. 81.

Bayoumi, T.; Eichengreen, B. (1993): Shocking Aspects of European Monetary Integration, in: F. Torres; F, Giavazzi (eds), Growth and Adjustment in the European Monetary Union. Cambridge University Press: Oxford.

Brada, J. C.; Kutan, A. M. (2001): The Convergence of Monetary Policy Between Candidate Countries and the European Union. Economic Systems 25 (3), pp. 215.231.

Brada, J. C.; Kutan, A. M. (2002): Balkan and Mediterranean Candidates for European Union Membership. Eastern European Economics 40 (4), pp. 31-44.

Brada, J. C.; Kutan, A M.; Zhou, S. (2002): Real and Monetary Convergence within the European Union and Between the European Union and Candidate Countries: A Rolling Cointegration Approach. William Davidson Institute Working Paper Series No 458.

DeGrauwe, P.; Schnabl, G. (2005): Nominal versus Real Convergence: EMU Entry Scenarios for New Member States. Kyklos 58 (4), pp. 537-555.

Figuet, J.-M.; Nenovsky, N. (2006): Convergence and Shocks in the Road to EU: Empirical Investigations for Bulgaria and Romania. University of Michigan -William Davidson Institute Working Paper No. 810.

Frankel, J. (2004): Real Convergence and Euro Adoption in Central and Eastern Europe: Trade and Business Cycle. Correlations as Endogenous Criteria for Joining EMU. Faculty Research Working Papers RWP04-039. Harvard University.

Hallerberg, M.; Strauch, R.; von Hagen, J. (2004): The Design of Fiscal Rules and Forms of Governance in European Union Countries. ECB Working Paper Series No. 419.

Hallerberg, M.; Wolff, G. B. (2006): Fiscal Institutions, Fiscal Policy and Sovereign Risk Premia. Deutsche Bundesbank. Discussion Paper Series 1: Economic Studies No 35/2006.

Halpern, L.; Wyplosz, C. (2001): Economic Transformation and Real Exchange Rates in the 2000s: The Balassa-Samuelson Connection. United Nations Economic Commission for Europe. Discussion Paper Series 2001.1

Holtemöller, O. (2005): Uncovered Interest Rate Parity and Analysis of Monetary Convergence of Potential EMU Accession Countries. International Economics and Economic Policy 2 (1), pp. 33-63.

Imbs, J. (2004): Trade, Finance, Specialization, and Synchronization. Review of Economics and Statistics 86 (3), pp. 723-734.

Kenen, P. B.; Meade, E. E. (2003): EU Accession and the Euro: Close Together or Far Apart? International Economics Policy Briefs, No. PB03-9, October 2003.

Kim, S. J.; Lucey, B. M.; Wu, E. (2006): Dynamics of Bond Market Integration Between Established and Accession European Union Countries. Journal of International Financial Markets, Institutions and Money 16 (1), pp. 41-56.

Kočenda, E.; Valachy, J. (2006): Exchange rate volatility and regime change: a Visegrad comparison. Journal of Comparative Economics 34(4), 727-753.

Kočenda, E.; Kutan, A.; Yigit, T. (2006): Pilgrims to the Eurozone: How Far, how Fast? Economic Systems 30 (4), pp. 311-327.

Kutan, A. M.; Yigit, T. (2005): Real and Nominal Stochastic Convergence: Are the New EU Members Ready to Join the Euro Zone? Journal of Comparative Economics 33 (2), pp. 387-400.

Matoušek, R.; Taci, A. (2003): Direct Inflation Targeting and Nominal Convergence: The Czech Case. Open Economies Review 14 (3), pp. 269-283.

Mihaljek, D.; Klau, M. (2004): The Balassa-Samuelson effect in Central Europe: A disaggregated analysis. Comparative Economic Studies 46 (1), pp. 63-95.

Orlowski, L. T. (2003): Monetary Convergence and Risk Premiums in the EU Accession Countries. Open Economies Review 14 (3), pp. 251-267.

Orlowski, L. T. (2008a): Relative Inflation Forecast as Monetary Policy Target for Convergence to the Euro. Journal of Policy Modeling 30 (6), pp. 1061-1081.

Orlowski, L. T. (2008b): Stages of the 2007/2008 Global Financial Crisis: Is there a Wandering Asset-price Bubble? Economics E-Journal Discussion Paper No. 43.

Orlowski, L. T.; Lommatzsch, K. (2005): Bond Yield Compression in the Countries Converging to the Euro. University of Michigan – William Davidson Institute Working Paper No. 799.

Poghosyan, T.; Kočenda, E. (2007): Macroeconomic Sources of Foreign Exchange Risk in New EU Members. University of Michigan – William Davidson Institute Working Paper No. 898.

Schiavo, S. (2008): Financial Integration, GDP Correlation and the Endogeneity of Optimum Currency Areas, Economica, 75(297), 168-89.