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Abstract:

We demonstrate that bond yield compression is under way in the countries converging to the euro and that German yields are significant drivers of local currency yields. Based on the evidence from Poland, Hungary and the Czech Republic, we conclude that these new Member States of the European Union are ready to adopt the euro without risking a disruptive shock to their financial stability. This message transpires from investigating the daily volatility dynamics of local bond yields as a function of German yields, conditional on changes in local term spreads, exchange rates and adjustments to central bank reference rates. Similar results of high sensitivity of local currency bond yields to changes in German yields are obtained from testing monthly series of macroeconomic fundamentals. These findings provide evidence of the potential usefulness of term spreads as indicators of monetary convergence.

JEL classification: E43, E44, F36

Keywords: term spread, term premium, yield compression, monetary convergence, new Member States, EMU, conditional volatility, asymmetric GARCH models

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I. Introduction

This paper examines monetary convergence of the European Union new Member States (NMS) to the euro from the standpoint of their local currency bond yields compression in relation to the euro area yields. Our argument is that the possible co-movement between euro candidates' bond yields and German yields may signal that yields have been converging. Consequently, we would expect yield spreads to narrow, as a further indication of monetary convergence being on the right track and financial markets of the euro candidates becoming increasingly integrated. On the other hand, a dynamic divergence of local currency bond yields versus benchmark German yields would prompt us to conclude that convergence is far from complete and that adopting the euro at the present time might be premature, for such action would expose the candidates' financial markets to potentially destabilizing shocks. Yield compression, therefore, may serve as an indicator of the degree of convergence and thus NMS preparedness for adopting the euro.

The importance of bond yield compression has been recognized by the EU policy-makers who have placed the alignment of long-term bond markets among the five Maastricht convergence criteria. Specifically, the fourth criterion requires that the candidates' long-term interest rates do not exceed by more than two percent the average rate of the three EU Member States experiencing the lowest inflation rates.[1]

In order to ascertain yield compression in NMS we investigate whether and to what extent German yields are affecting the government debt markets in three largest NMS, namely Poland, Hungary and the Czech Republic. Our empirical analysis consists of two approaches. First, we examine the time-varying changes in local currency bond yields as a function of (1) convergence expectations built into local term spreads (2) the ten-year German bond yield (viewed as a representative benchmark for the euro area long-term interest rates) and (3) changes in local currency values of the euro. We investigate the conditional volatility dynamics of this relationship based on the daily data series since the beginning of the year 2000, which roughly corresponds to the inception of the ten-year bond markets in the NMS. We employ the

[1] See ECB (2003a) for the prescribed specific measurement procedure of long-term interest rates based on the recommended 10-year maturity of government securities.

TGARCH-M-GED process, which is a combination of threshold GARCH (TGARCH) and the 'in-mean' extension (GARCH-M), estimated with GED residuals. In our second approach, based on monthly data series, we examine changes in local currency bond yields as a function of German yields as well as of macroeconomic fundamentals in order to determine the main drivers of local currency bond yields and the relative role played by German yields. Since the available monthly data series are relatively short, we rely on the OLS estimation.

The paper is organized as follows. Section II draws on related literature on monetary convergence and financial market integration to provide theoretical underpinnings of bond yield compression. Our underlying analytical model is outlined in Section III. The role of German bond yields as drivers of yields in the NMS is examined in Section IV based on volatility dynamics of the daily data series. Their role relative to the macroeconomic fundamentals is analyzed in Section V based on the monthly data series. Section VI encapsulates the main results of our study and includes policy implications for the final passage toward adopting the euro.

II. Bond Yield Compression – An Indicator of Monetary Convergence

Over the past two decades we are observing world-wide convergence of bond yields, the sources of which can be traced to domestic, regional as well as global economic trends and policies. On the global scale, the widespread reduction of capital controls, financial innovations, advances in information technology, and resulting lower transaction costs have all contributed to interest rates convergence.[2] Regional integration efforts have triggered convergence of bond yields as well, particularly the formation and the anticipated enlargement of the European Monetary Union (EMU). For the euro candidates, expectations related to prospects of future accession and

[2] In a noteworthy study of bond yields determinants in New Zealand, Grimes (1994) finds that local bond yields are significantly driven by foreign yields, in addition to domestic short-term interest rates and the ratio of foreign debt to GDP. The apparent yield convergence suggests that, in the context of global financial integration, local bond markets are susceptible not only to internal, but predominantly to external shocks. In a newer study, Eckhold (1998) reaffirms robustness of the bond yield determinants identified by Grimes but, in the spirit of Uncovered Interest Rate Parity, adds currency expectations to the list of key drivers of bond yields.

official programs of monetary convergence play a critical role in dampening long-term bond yields. The increased demand for emerging market debt is also a contributing factor. Yet, a disciplined domestic fiscal policy that reduces the government borrowing needs, i.e. the public debt expansion plays the most pivotal role in driving yield compression.

A major factor increasing financial market integration and contributing to yield compression is the introduction of a single currency. Goldstein and Mussa (1993) and Mussa (2000) point to the dramatic reduction in interest rate spreads and in the volatility of these spreads that occurred on the path to the EMU. They attribute yield compression to the elimination of exchange rate fluctuations among the eleven participating countries resulting from the economic integration brought on by the public policy alignment. The ECB (2003b) reaffirms this argument by noting that there was a significant convergence in the long-term government bond yields in the countries that subsequently adopted the euro in January 1999. This convergence was driven by expectations of the euro adoption and by the consequent elimination of the exchange rate risk.

There seems to be a consensus in the literature pertaining to the EMU that the introduction of a single currency alone is not a sufficient driving factor of bond yield convergence and that harmonization of disciplined national macroeconomic policies plays a significant role. As shown by Bernoth et al. (2004), the debt and deficit indicators, primarily the debt-service ratio explain pronounced disparity in long-term interest rate risk premia among the EU Member States. Interest rate risk premia will not fully converge as long as the differences in the individual member countries' budgetary positions and debt levels remain high. Moreover, the fiscal stance is reflected in the government credit rating and translates directly into the default risk premium. This argument is confirmed by Gjersem (2003) who, besides recognizing the importance of eliminating exchange rate risk, attributes yield convergence to the existence of fiscal policy rules and their monitoring, which ultimately led to the convergence of credit ratings to the highest level. As a result of improved fiscal discipline, bond yields in the euro area converged to historical lows in the period preceding the euro inception. He attributes the remaining spreads on treasury issues within the euro area to the differences in governments' credit ratings, liquidity and the issuance techniques among the independent issuing agents.

Danthine et al. (2001) also point out to the prolonged segmentation of the government bond market across the euro area, which generates liquidity risk in the smaller markets and results in the difference in yields between similar government issues. Hartmann et al. (2003) concur that the euro-area bond market is still segmented, since the pricing of government bonds with identical credit rating has not fully converged. However, Codogno et al. (2003) downplay the role of liquidity and issuance uniformity in perseverance of yield differentials. They provide evidence that further fiscal convergence, specifically in debt-to GDP ratios, is indispensable for reducing yield differentials in the euro area.[3]

The importance of fiscal and monetary policy harmonization for containing interest rate risk premia in the country aspiring to enter the common currency system has found strong support in a number of studies analyzing the driving factors of government bond yields in the euro area. Among others, Côté and Graham (2004) find evidence that following the adoption of Maastricht Treaty currency risk premia declined gradually and were essentially eliminated by the time the euro was launched in January 1999. Their empirical evidence demonstrates that prior to the inception of the euro national bond yields in the EMU countries had converged to yields of Germany, the EMU largest economy. They conclude that progress in macroeconomic policy harmonization was the prevalent contributing factor to convergence of long-term bond yields by driving the convergence of their long-run determinants. According to their study, the introduction of a common currency had a secondary effect. Thus they confirm the previous findings that convergence of national long-term yields results predominantly from the coordination of disciplined fiscal and monetary policies in the context of integrated financial markets.

In sum, on the basis of the single European currency experience we can agree that the interplay of two key factors can significantly advance bond yield convergence, namely (1) the formation of a common currency system or an anticipated entry to such a system and (2) the harmonization of national macroeconomic policies. Nevertheless, it is worthy noting that these two factors alone can not drive convergence to zero differentials for there are other aspects

[3] Their view contrasts with the common belief of market participants and policymakers that traditional liquidity indicators, such as bid-ask spreads, trading volumes, and outstanding amounts, as well as the presence of liquid future contracts explain a substantial part of yield differentials since the EMU inception.

underlying the remaining yield spreads that need to converge as well, such as technical and regulatory ramifications of bond issuance across integrated financial markets.

While the literature on the determinants of bond yields in the EMU countries is quite extensive, the investigation of yield drivers and the empirical evidence on yield compression in NMS have been seemingly scant. It is perhaps due to the relatively short historical record of long-term government debt markets in these countries.[4] The preliminary findings on yield compression seem to be inconclusive. The tests conducted by the International Monetary Fund (2003) based on data series ending as of mid-2003 show that German yields were not significant drivers of local currency bond yields in the converging NMS countries[5]. The obtained results suggest that convergence was far from complete at that time and that financial markets in NMS remained excessively vulnerable to domestic policy shocks. Similar results are reported by Holtemöller (2003) who shows that interest rate risk premia in the Czech Republic, Poland and Hungary over the corresponding euro area rates are still too excessive to conclude that convergence has been successful. He demonstrates that spreads of local over the euro area rates are non-stationary for Hungary and Poland, while stationary for the Czech Republic. In a more optimistic view, Orbán and Szapáry (2004) show that yield compression in the three examined NMS already took place as of January 2004 (which means prior to these countries EU accession) since their spreads over the euro area yields were minimal. They were also considerably narrower than those of Spain, Portugal and Greece on the eve of their respective EU accessions.

The skeptical econometric results on yields compression in NMS may stem from the ramifications of policy mix applied during the early stage of long-term government bond market development. Specifically, lax fiscal policies and monetary strategies based on strict inflation targeting led to high local interest rate risk premia.[6] Those monetary strategies compelled central banks (CBs) to adopt very high interest rates in order to contain inflation. As the

[4] Ten-year government bond was introduced for the first time on January 20, 1999 in Hungary, May 21, 1999 in Poland and May 22, 2000 in the Czech Republic.
[5] The OLS regression of the single-equation model conducted by the IMF is based on monthly data series on local bond yields in the Czech Republic, Hungary and Poland as a function of inflation, three-months-lagged retail sales and German yields (all in first differences). The regressions of one-, five- and ten-year local bond yields show that German yields were not significant determinants of the NMS yields.
[6] Inflation targeting framework was officially adopted by the Czech Republic in January 1998, Poland in January 1999 and Hungary in May 2001.

disproportionately high interest rates resulted in soaring risk premia, they impaired the linkage between the NMS and the euro area bond yields. However, they were indispensable for bringing inflation down closer to the EU levels (Orlowski, 2003). Moreover, inflation targeting strategies have been accompanied by greater exchange rate flexibility, although, to various degrees. Frankel et al. (2005) state that, under flexible exchange rates, the international transmission of bond yields is slower than under fixed exchange rates. Therefore it would not be surprising if local currency bond yields adjustment to the euro area levels took place only recently, following the adoption of inflation targeting and flexible exchange rates in NMS.

Overall, during the recent five-year period both nominal and real interest rates in NMS have fallen sharply outpacing the declining trend in the euro area. This decline precipitated from considerably strengthened financial stability in these countries that led to improved credit ratings, lower risks to investors and, consequently, declining bond yields. Therefore, in spite of the controversies related to the early evidence, one may expect that the integration of NMS government debt markets into the euro area bond markets has increased and that yield compression is taking place. From this standpoint, bond yield compression can be viewed as a proxy indicator for assessing the degree of financial integration, specifically a synchronization of the underlying macroeconomic fundamentals such as inflation expectations, real income and other factors affecting credit risk.

III. A Model of Bond Yields Co-Movement

The term structure of interest rates has gained reputation in the literature for its ability to provide useful information on the current stance of monetary and fiscal policy, as well as future economic activity, real interest rates and inflation (see for instance Mishkin, 1990; Bernanke and Blinder, 1992). More specifically, nominal interest rate movements involve real interest rate movements and changes in expected inflation. Given this framework, we derive our model on the precepts of the Fisher theory and the Expectations Hypothesis (EH) of the term structure. The Fisher formula states that the nominal interest rate R_t is determined by the real interest rate rr_t and the expected rate of inflation $E_t\left(\hat{\pi}_{t+m}\right)$ from period *t* to period *(t+m)*.

$$R_t = rr_t + E_t(\hat{\pi}_{t+m}) \tag{1}$$

According to EH, long-term interest rates are determined by the market expectations for short-term interest rates augmented by a risk component that may vary with the corresponding maturity for a given rate. Thus, a long interest rate R_t^L is the expected short rate $E_t(R_{t+m}^S)$ plus the constant risk premium $(\phi_t^L = \bar{\phi})$. For simplification, we refrain from decomposing the risk premium and will refer to the risk component throughout our paper as "term premium".[7]

$$R_t^L = E_t(R_{t+m}^S) + \phi_t^L \tag{2}$$

Given the above, we can infer the difference between long and short-term interest rates, which defines the slope of the yield curve. This difference is also referred to as the term spread. Based on Fama (1990) who concludes that term spreads can forecast the expected term premia, we want to test whether term spreads can also explain the convergence of bond yields. Term spreads are widely credited in the literature for their usefulness for predicting future macroeconomic conditions. [8] This suggests that they are a good candidate for use as a convergence indicator for they can reasonably encapsulate information about real convergence and inflation expectations that is potentially useful for guiding the convergence to a common currency. Their forecasting relevance is additionally signified by a fact that they are market-determined, thus not subject to revisions.

The nominal term spread for bonds across maturity spectrum is a function of expected changes in the real term spread and expected changes in inflation amplified by the time-varying term premium. If $E(rr_t^L - rr_t^S)$ reflects a direction of expected real term spread, $E_t(\hat{\pi}_t^L - \hat{\pi}_t^S)$

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[7] From the empirical standpoint, the term premium for a converging economy would reflect the difference between the risk premium on national relative to foreign long-term debt and the relative risk premium on short-term debt. Thus by a precise definition, term premium is not simply the difference in spreads across maturities because in reality it involves a default risk component. Broner et al. (2004) make similar point with respect to the analysis of term structure in emerging economies.

[8] The usefulness of term spreads as indicators for monetary policy purposes is demonstrated, among others, by Estrella and Hordouvelis (1991) and Estrella and Mishkin (1997)

represent dynamic inflation expectations for the corresponding time period, and φ_t^L is a time-varying term premium, the nominal term spread can be expressed as

$$R_t^L - R_t^S = E_t(rr_t^L - rr_t^S) + E_t(\hat{\pi}_t^L - \hat{\pi}_t^S) + \phi_t^L \tag{3}$$

The real term spread can be specified as $rg_t = E_t(rr_t^L - rr_t^S)$. In order to ascertain the linkage between the local and the foreign term spreads, we bring in the Uncovered Interest Rate Parity (UIP) condition by including the expected exchange rate movement into our model. Consequently, in an open-economy setting, the differential between the domestic and the foreign nominal term spreads can be expressed as follows

$$(R_t^L - R_t^S) - (R_t^{L*} - R_t^{S*}) = rg_t - rg_t^* + E_t(\hat{\pi}_t^L - \hat{\pi}_t^S) - E_t(\hat{\pi}_t^{L*} - \hat{\pi}_t^{S*}) + \phi_t^L - \varphi_t^{L*} + E_t(s_t^{L-S}) \tag{4}$$

The asterisk denotes foreign variables. This relationship is augmented by the expected depreciation of local currency for the L-S period represented by $E_t(s_t^{L-S})$. The impact of the expected currency movements would have merit particularly in the case of a smaller, open economy, whose CB actively conducts foreign exchange market interventions (Eckhold, 1998). Under such circumstances, transmission of currency movement into long-term interest rates becomes more pronounced.[9]

The difference between the national and the foreign term premia can be captured by

$$\psi_t = \varphi_t^L - \varphi_t^{L*} \tag{5}$$

It is further assumed that the nominal interest rate, which serves as a policy instrument or a reference rate for a local CB in a converging country will be adjusted in response to changes in the domestic nominal interest rate and changes in the foreign reference rate. This notion allows

[9] Recent evidence on transmission of exchange rates into inflation and interest rates in transition economies can be found in Golinelli and Rovelli (2005) and Orlowski (2005a)

for identifying the foreign and the domestic monetary policy rules. Since the foreign CB follows a fully autonomous monetary policy, the foreign policy instrument rule is prescribed by

$$i_t^{CB*} = rg_t^* + E_t(\hat{\pi}_t^{L*} - \hat{\pi}_t^{S*}) + \varphi_t^{L*} \quad (6)$$

In contrast, the local CB of a converging country cannot pursue a similar degree of monetary autonomy as it needs to consider the monetary convergence process. Thus the domestic policy rule is that the adjustment in the domestic policy instrument becomes a function of changes in the local nominal term spread, and the expected exchange rate path. The local instrument rule is specified as

$$i_t^{CB} = rg_t + E_t(\hat{\pi}_t^{L} - \hat{\pi}_t^{S}) + \varphi_t^{L} + E_t(s_t^{L-S}) \quad (7)$$

In essence, such instrument rule seems plausible for an economy converging to a single currency when the CB monetary policy decisions are guided by forward-looking, flexible inflation targeting[10]. As oppose to strict inflation targeting that would require a monetary authority to gear policy decisions to the domestic inflation target only, the flexible inflation targeting framework allows combining the inflation target with a supplemental exchange rate stability objective.

It can be further noted that the local CB may follow an alternative targeting rule that would be more suitable for an advanced stage of monetary convergence characterized by the term premium differential converging to zero ($\psi_t = 0$) and the exchange rate becoming fixed (for instance, upon the euro candidate's entry to the ERM2). Such a rule is derived on the basis of a notion that a successfully orchestrated monetary convergence means that domestic inflation is being brought in line with the foreign inflation forecast during the period leading to the anticipated adoption of a single currency, i.e. in a time horizon L (Orlowski, 2005b).[11] At such

[10] The standard treatment of such instrument rule is that it is a function of observable variables (see Svensson, 2005). However, for a converging economy it seems plausible to assume that it can be based on forecast variables.

[11] In practical terms the euro area inflation forecast should be understood in terms of the Maastricht convergence criterion, which requires the domestic inflation not to exceed 1.5 percent above the average of the three lowest inflation rates among the EU Member States.

advanced stage, economic agents fully and reasonably anticipate convergence of inflation, thus $E_t(\hat{\pi}_t^L) = E_t(\hat{\pi}_t^{L*})$. Given the convergence of long term inflation expectations, the convergence of term premia and the fixed exchange rate, Eq. (6) and Eq. (7) can be combined into the following expression of the domestic policy instrument rule

$$i_t^{CB} = i_t^{CB*} + rg_t - rg_t^* - E_t(\hat{\pi}_t^S) + E_t(\hat{\pi}_t^{S*}) \qquad (8)$$

As completion of the convergence process appears in sight, the local CB will attempt to coordinate the operating inflation target $\overline{\pi}_t^S$ with the foreign inflation forecast for S-period ahead, $E_t(\hat{\pi}_t^{S*})$. Thus CB will respond to the differential between the inflation target and the domestic inflation forecast for S-period by adjusting the policy instrument at the advanced stage of convergence in the following way

$$i_t^{CB} = i_t^{CB*} + rg_t - rg_t^* + \overline{\pi}_t^S - E_t(\hat{\pi}_t^S) \qquad (9)$$

However, at the early stage of convergence, the domestic instrument rule prescribed by Eq. (7) seems to be more practical. By expressing the differential between the domestic and the foreign nominal term spreads in terms of the domestic and the foreign policy rules, i.e. by folding the Eqs. (6) and (7) into (4), the relative to the abroad yield curve process becomes

$$(R_t^L - R_t^S) - (R_t^{L*} - R_t^{S*}) = rg_t + E_t(\hat{\pi}_t^L - \hat{\pi}_t^S) + \varphi_t^L + E_t(s_t^{L-S}) - i_t^{CB*} \qquad (10)$$

Eq. (10) can be rearranged to express local long-term rate as a function of local term spread (as specified by Eq. (3)), foreign long-term yield, the differential between short domestic and foreign interest rate (specified as $\theta_t = R_t^S - R_t^{S*}$), the exchange rate and the foreign CB reference rate. The short-term interest rate differential can be attributed to the country-specific risk conditions. Consequently, the local long-term bond yield process is given by

$$R_t^L = (R_t^L - R_t^S) + R_t^{L*} + \theta_t + E_t(s_t^{L-S}) - i_t^{CB*} \qquad (11)$$

The relationship prescribed by Eq. (11) suggests that movements in long-term bond yields in a country converging to a single currency can be explained by changes in: local term spreads, foreign bond yields, short term yield differentials, exchange rates and foreign CB reference rates. From the standpoint of the main argument underlying our analysis, a significant positive relationship between local and foreign bond yields conditional on changes in the remaining variables implies the presence of yield convergence. Given a significant co-movement between local and foreign yields coupled with narrowing yield differentials, one can reasonably argue that relative risk premia are declining and a successful convergence to a single currency is under way.

IV. Yield Compression in NMS: Volatility Dynamics Analysis

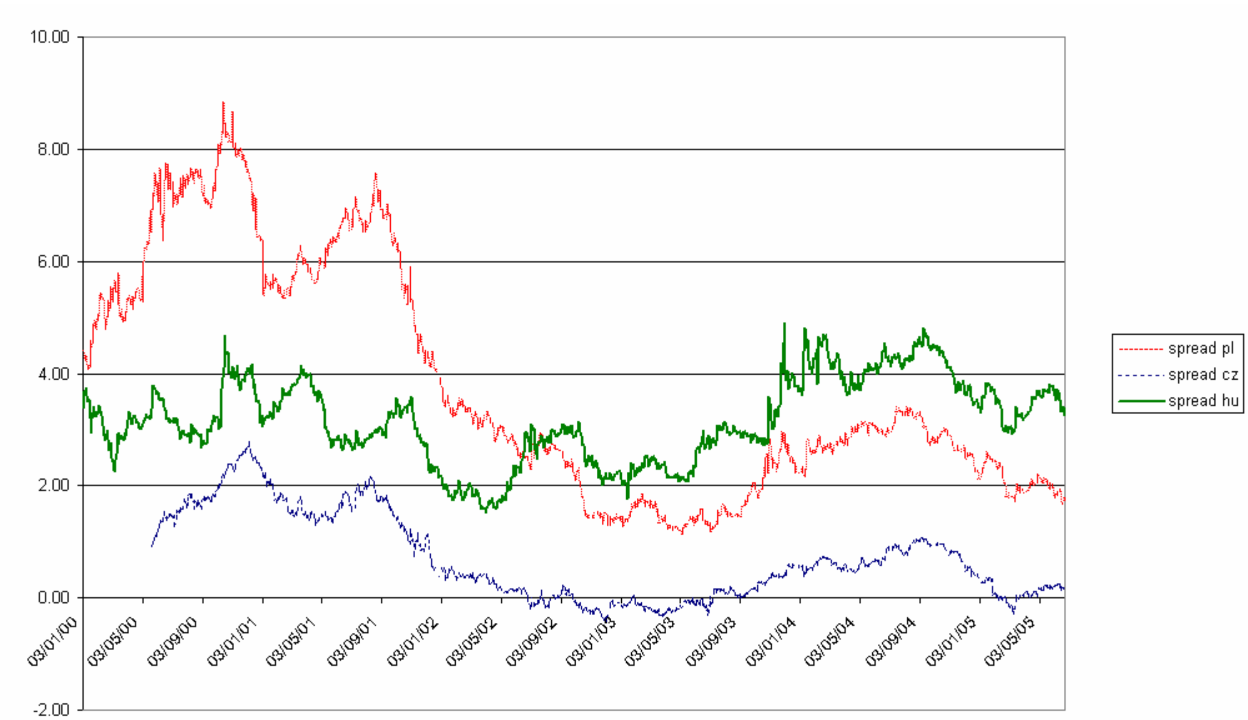
The question before us is whether yields in the euro area, as benchmarked by German bond yields, are significant drivers of national yields in the three examined NMS, which would imply that yield compression is taking place.[12] Our sample period covers 1431 daily observations for Hungary, Poland and Germany for the period January 3, 2000 - June 27, 2005. For the Czech Republic, the sample period begins May 22, 2000 (1331 observations), due to the delayed inception of the long-term bond market. The data are taken from the Bloomberg database (supplemented with Reuters data on ten-year Polish bond yields for January 3 - February 3, 2000 and December 7, 2001 – November 25, 2002, due to unavailability of Bloomberg Generic Network prices for these periods) and from Eurostat (for German MCBY-Maastricht Conditions Bond Yields).

Before testing Eq. (11), it is noteworthy to look at the graphical presentation of national over German MCBY yield differentials (Figure 1) during sample period. The spread between Polish and German ten-year yields was initially extremely high, reaching 9 percentage point in the last quarter of 2000. Since then, it has narrowed considerably to less than 2 percentage points in mid-2005. The evident yield compression stems from a significant decline in inflation

[12] We are taking the ten-year German MCBY as the reference yield for euro area long –term bonds. German yields have maintained the benchmark status since they have continued to display lower yields. For a detailed discussion on benchmark status see Dunne at al. (2002).

expectations attributable to the credible inflation targeting strategy coupled with gradually improved fiscal discipline. Hungary started from a significantly narrower spread than Poland, but has not been able to reduce it further since mid-2002. Its ten-year spread over German yield is now the highest among the three examined countries due the continuously elevated inflation expectations and the struggle to maintain fiscal discipline. In contrast, Czech yields came down to the German levels already in mid-2002, and after a brief period of gradual rising, their spread has recently evaporated again.

Figure 1: Spreads between 10Y government bond of the Czech Republic / Hungary / Poland and Germany



Data Source: Bloomberg (supplemented with Reuters data on Polish ten-year yields for Jan 3 - Feb 3, 2000 and Dec 7, 2001 – Nov 25, 2002 due to unavailability of Bloomberg Generic Network prices for these periods) and Eurostat for German MCBY (Maastricht Conditions Bond Yields).

In order to ascertain co-movement between national and German bond yields we first determine their respective unconditional correlations. We also examine coefficients of elasticity of changes in ten-year national yields to changes in German yields. The results of both tests are shown in Table 1.

Table 1. Unconditional correlation and elasticity coefficients of daily changes in 10Y NMS and German government bond yields

10Y government bond yields of:	Unconditional Correlation Coefficient with 10Y German Yield	German Yield Elasticity Coefficients of Local Yields (double-log of 1st differences)
Czech Republic	0.318	+1.055
Hungary	0.133	+0.897
Poland	0.132	+0.899

Notes: Calculations are based on first differences of daily bond yield indexes for the periods January 3, 2000-June 27, 2005 for Germany, Hungary and Poland, and May 22, 2000-June 27, 2005 for the Czech Republic.

Data source for Tables 1-3: As in Figure 1.

For the entire sample period of daily observations, there is a moderate unconditional correlation between Czech and German yields. In contrast, pairwise correlations of Hungarian and Polish yields with German yields are significantly lower. Thus Czech yields are more integrated with those of the euro area than yields of the two remaining NMS. These findings, to some extent, reaffirm the IMF (2003) and Holtemöller (2003) conclusions that, from the government debt market perspective, NMS are still not ready to join the euro. A more encouraging message stems from the pairwise yield elasticity coefficients. Their positive, close to unity values imply that the daily percentage changes between national and German yields are almost perfectly synchronized.

Nevertheless, the unconditional correlations and elasticity coefficients for the entire sample period are overly simplistic measures for assessing yield compression. More meaningful inference can be drawn when the sample period is divided into two parts: (1) the pre-EU accession (i.e. prior to May 1, 2004) and (2) the post-EU accession period. As shown in Table 2, during the latter period the average bond yields as well as the daily volatility have fallen considerably in the Czech Republic and Poland, and somewhat less in Hungary. The unconditional correlations of both Polish and Hungarian with German yields have become stronger after the EU entry. At the same time, correlation between Czech and German yields has weakened, which is somewhat puzzling. This result might be possibly explained by the fact that the Czech CB allowed for greater exchange rate flexibility by suspending foreign exchange market interventions already about a year prior to the EU accession.

Table 2. Daily volatility and correlation of 10Y NMS and German bond yields during pre- and post-EU accession

	Average yield[1)]	**Standard deviation[1)]**	**Coefficient of variation[1)]**	**Unconditional correlation with 10YGerman yields [2)]**
Czech 10Y bond:				
5/22/2000-4/30/2004	*5.305*	*1.125*	*0.212*	*0.383*
5/1/2004-6/27/2005	4.461	0.675	0.151	0.124
Hungary's 10Y bond:				
1/3/2000-4/30/2004	*7.647*	*0.830*	*0.109*	*0.124*
5/1/2004-6/27/2005	7.637	0.742	0.097	0.198
Poland's 10Y bond:				
1/3/2000-4/30/2004	*8.794*	*2.593*	*0.295*	*0.126*
5/1/2004-6/27/2005	6.365	0.831	0.131	0.233

Notes: computed on the basis of: [1)] levels, [2)] first differences.

We now proceed with the empirical testing of the time-varying conditional co-movements between NMS and German yields on the basis of the model prescribed by Eq. (11). We estimate the time-varying volatility of national yields as a function of German yields and a set of exogenous variables in order to ascertain yield compression more precisely. We employ threshold generalized autoregressive conditional heteroscedasticity (TGARCH) model with the conditional variance in the mean equation (M) combined with the generalized error distribution (GED), which allows for variable kurtosis in the data. [13] The "in mean" extension of the model (GARCH-M) ads the heteroscedastic variance term directly into the regression equation allowing time-varying volatility to be related to expected yields since they are influenced by term

[13] For the comprehensive overview of the ARCH-class models see (Engle, 2004). Their usefulness and applicability for testing volatility dynamics of financial assets is examined by Poon and Granger (2003).

premia. Departing from the normal distribution assumption, specifically, allowing the series to be leptokurtic (GED parameter<2) routinely holds for daily frequency series of financial assets. We further incorporate German yields and local CB reference interest rates as regressors in the conditional variance equation.

Our TGARCH-M-GED procedure consists of the conditional mean and the conditional variance equations (Eqs. 12 and 13 respectively). The conditional mean equation is in essence derived from Eq. (11), however, with several modifications. It examines the local ten-year bond yield R_t^{10Y} as a function of the polynomial (quadratic) spread between five-year R_t^{5Y} and three-month R_t^{3M} local yields, German yields R_t^{10Y*}, the euro value expressed in domestic currency terms as $\log S_t$ and the GARCH conditional variance σ_t^2 (the GARCH in-mean component), which is a proxy for the directional change in the local term premium.[14] It is further assumed that the foreign CB reference interest rate follows a steady, exogenously determined course, thus its autoregressive movement is zero. The resulting mean equation is as follows

$$R_t^{10Y} = \alpha_0 + \alpha_1 (R_t^{5Y} - R_t^{3M}) + \alpha_2 (R_t^{5Y} - R_t^{3M})^2 + \alpha_3 R_t^{10Y*} + \alpha_4 \log S_t + \alpha_5 \sigma_t^2 + \xi_t \qquad (12)$$

All underlying variables are entered in first differenced terms since they are non-stationary at their levels in all examined cases. The quadratic effect of the five-year to three-month spread allows us to ascertain its marginal effect on local long-term yield. Unlike in Eq.(11), the domestic policy instrument variable, namely, the CB reference interest rate i_t^{CB}, is now placed as a regressor in the conditional variance equation in order to emphasize its possible dampening effect on bond yield volatility. Finally, the exchange rate variable is entered as the first difference of the log of the spot value of the euro in local currency terms.

[14]In testing the predictive power of the term spread, it is important to choose the yields of debt securities which are actively traded and which reflect market expectations. Therefore we examine the spread between the five-year government bond yield and the three-month money market rate, which is the available proxy for the three-month yield. This puts us in agreement with Domain and Reichenstein (1998), who argue that the spread between the intermediate- and short-term and not between the long- to short-term yield trails the embedded risk premia.

The conditional variance equation is formulated as the TGARCH(p,q,r) process and specified as

$$\sigma_t^2 = \beta_0 + \sum_{l=1}^{p} \beta_{1l} \xi_{t-l}^2 + \sum_{k=1}^{r} \beta_{2k} \xi_{t-k}^2 \Gamma_{t-k} + \sum_{j=1}^{q} \beta_{3j} \sigma_{t-j}^2 + \beta_4 R_t^{10Y*} + \beta_5 i_t^{CB} \qquad (13)$$

The p-order ARCH terms represented by $\sum_{l=1}^{p} \beta_{1l} \xi_{t-l}^2$ reflect the impact of 'news' or shocks to the current volatility of the bond yield process prescribed by Eq. (12) induced l-periods before. The q-order GARCH terms $\sum_{j=1}^{q} \beta_{3j} \sigma_{t-j}^2$ show the degree of persistency in volatility. The leverage threshold effects or r-order TARCH terms $\sum_{k=1}^{r} \beta_{2k} \xi_{t-k}^2 \Gamma_{t-k}$ reveal the degree of asymmetry of shocks to volatility, in which Γ_{t-k} are k-period dummy variables assuming the value of one for all the observed negative shocks $(\xi_{t-k} \langle 0)$ and zero for the positive ones. Two additional regressors are built into the conditional variance equation in order to capture their perceived impact on volatility of local currency bond yields: (1) German yields, and (2) the CB reference rates. Due to non-stationarity at their levels, both of these regressors are entered in first differenced terms.

Inevitably, some of the key fundamental variables that are likely to drive local bond yields, such as inflation, output gap, etc., are not incorporated since these estimations are based on daily data frequency. In all tested cases, empirical estimations with the log-likelihood maximizing GED residuals allow for alleviating the danger of a serious overestimation of volatility, which would be the case if the normal (Gaussian) distribution assumption were imposed (GED=2).

The results of selected empirical estimations of Eqs. (12) and (13) are shown in Table 3. We have chosen the most robust estimation representations on the basis of maximizing the likelihood ratio and minimizing the Akaike and Schwartz information criteria. The obtained evidence implies that daily changes in German yields significantly affect changes in national yields in all three examined countries, as indicated by the high statistical significance of their estimated α_3 coefficients in the conditional mean equation. These coefficients have all correct, positive signs, which suggest that both German and national yields tend to move in the same direction. The impact of conditional changes in German yields on national yields is the most pronounced for the Czech Republic, while it is somewhat weaker for Poland and considerably less significant for Hungary. In the conditional variance equation, changes in German yields inversely affect volatility of national yields, but this effect is significant only in the case of Poland. This suggests that a possible increase in German yields is likely to mitigate the conditional volatility of Polish yields. Adversely, the decline might exacerbate volatility of national yields. The obtained results carry an important message for policy-makers in NMS as they are all seemingly concerned about sustaining financial markets stability and lowering risk premia to investors.

Table 3. Volatility dynamics of yield compression - estimation representations of Eqs.(12) and (13)

	Czech Republic	**Hungary**	**Poland**
Conditional mean Eq. (12)			
α_0 constant term	-0.016 (-1.06)	0.001 (1.27)	-0.042 (-4.57)***
α_1 (5Y-3M yield)	0.301 (22.41)***	0.469 (53.94)***	0.300 (28.06)***
α_2 (5Y-3M yield)^2	-0.283 (-3.49)***	-0.061 (-2.04)**	-0.098 (-4.08)***
α_3 (German 10Y yield)	0.204 (11.40)***	0.075 (6.15)***	0.174 (6.79)***
α_4 (EUR exchange rate)[1)]	0.365 (1.81)*	3.335 (16.13)***	0.979 (5.79)***
α_5 (GARCH)[2)]	0.319 (0.11)	-0.315 (-4.45)***	-0.007 (-4.19)***
Cond. variance Eq. (13)			
β_0 constant term	0.001 (16.34)***	0.001 (4.88)***	0.001 (5.31)***
β_{11} ARCH(1)	0.261 (5.98)***	0.591 (4.79)***	0.393 (5.10)***
β_{12} ARCH(2)	0.045 (1.51)	-0.021 (-0.31)	-0.032 (-0.54)
β_{13} ARCH(3)	na	na	0.078 (1.60)*
β_{14} ARCH(4)	na	na	0.213 (3.40)***
β_2 TARCH(1)	na	-0.433 (-3.28)***	na

β_3 GARCH(1)	0.255 (46.47)***	0.527 (6.87)***	0.356 (4.62)***
β_4 (German 10Y yield)	0.001 (0.33)	0.001 (0.18)	-0.009 (-5.15)***
β_5 (c. bank reference rate)	-0.002 (-1.44)	-0.002 (-1.75)*	-0.005 (-10.89)***
GED parameter	1.303 (83.64)***	0.732 (26.52)***	0.899 (24.18)***
adjusted R-squared	0.150	0.041	0.068
Log likelihood	2628.18	2215.56	1789.41
Akaike Info. Criterion	-3.936	-3.081	-2.483
Schwartz Info. Criterion	-3.885	-3.030	-2.428
Durbin Watson stat.	2.09	1.80	2.45

Notes: 1) Δlog of domestic currency value of one EUR, 2) log(GARCH) for Czech Republic and Poland and GARCH for Hungary. Significance at 1 percent ***, 5 percent **, and 10 percent *.

Data Source for central bank reference rates: Czech National Bank, National Bank of Hungary, National Bank of Poland.

The term spread and its marginal effect contain useful information on local bond yields as well. The term spread coefficients are all positive and very significant implying that long-term bond yields tend to fall with the declining spreads, which underpins the occurrence of the NMS yield compression. There is also a strong negative marginal (quadratic) effect in all three countries, which reflects the marginal impact of a change in term spread on long-term bond yields. In the Czech case, a higher ten-year yield is associated with a steeper yield curve as implied by the low value of estimated α_2 coefficient. This effect is weaker in the two other NMS. Apparently, transmission of possible inflation expectations along the yield curve is more pronounced in the Czech Republic than in Poland or Hungary. However, the Hungarian yield curve tends to be most elevated, primarily due to a strong positive effect of the currency depreciation on long-term yields (reflected by the high estimated value of α_4).

Evidently, the impact of currency depreciation on local currency bond yields varies across these countries. The estimated α_4 coefficients imply that currency depreciation almost instantly raises yields in Hungary and Poland, while its effect in the Czech Republic is less pronounced. On the basis of higher value of the α_4 coefficient for Hungary relative to Poland it can be argued that there is stronger transmission of the exchange rate risk into the interest rate in Hungary. Thus the high value of this coefficient seems to validate the Hungarian CB commitment to exchange rate stability within the flexible inflation targeting framework.

The GARCH conditional variance in the mean equation has a negative sign and is significant only for Hungary and Poland, which implies that the conditional risk premia in these two countries have been steadily declining. In contrast, the GARCH conditional variance does not affect changes in Czech yields, simply because the conditional risk premium might have evaporated there by now.

The estimated conditional variance equations show a strong impact of the previous-period news about volatility on current volatility dynamics of bond yields, as implied by high and significant ARCH(1) coefficients. Higher-order ARCH effects quickly dissipate in the Czech Republic and Hungary. By contrast, there are significant higher-order ARCH effects detected for Poland suggesting that yields volatility is subject to seemingly diverse external shocks of unspecified duration in this country. This result is not surprising as Poland has been recently struggling to control political risk and maintain fiscal discipline (both factors might have infused some instability to the country's bond market).

There is a significant asymmetric first-order leverage effect in the case of Hungary only[15]. The TARCH(1) estimated coefficient has a negative sign suggesting that the shocks suppressing volatility in the preceding period $(\xi_{t-1}\langle 0)$ further reduce the actual volatility of bond yields and this impact is much stronger than a possible propagation of volatility induced by positive shocks $(\xi_{t-1}\rangle 0)$.

As expected, the GARCH(1) effect is quite pronounced in all three examined cases. Its estimated coefficient is the highest for Hungary indicating high persistency in yield volatility. The GARCH(1) effect is weaker for Poland and even less pronounced for the Czech Republic. Furthermore, the sum of ARCH and GARCH terms is considerably lower in the Czech case

[15] Higher-order TARCH and GARCH effects have been tested in all three cases and proven to be entirely insignificant.

relative to the two remaining countries, indicating a strong, ongoing convergence of volatility of Czech yields to the steady-state. The convergence effect is less pronounced in the case of Poland, as the sum of both terms is closer to unity. In contrast, there seems to be a divergence in volatility from the steady-state in the case of Hungary since the sum of ARCH and GARCH terms exceeds unity.

In concurrence with our initial assumptions, GED parameters are consistently lower than 2.0 implying a leptokurtic data distribution with thick tails and thin waist in all three cases. In practical terms it means that yield volatility tends to be contained during tranquil market periods while it is exacerbated at turbulent times. This is a common feature of developing financial markets that remain vulnerable to exogenous shocks (Engle, 2004). Such vulnerability of NMS bond markets revealed by the obtained GED parameters underscores legitimacy of a cautious approach to adopting the euro, as a premature accession to a single European currency would likely entail large, potentially destabilizing shocks to the candidates' financial markets.

In sum, the empirical tests are most robust for Czech bond yields indicating a strong evidence of volatility convergence to the steady state and their relatively strong co-movement with German yields. The tests are a bit less robust for the remaining two countries. In the case of Poland, the ambiguous ARCH effects seem to obfuscate the argument about volatility convergence. However, the two regressors augmenting the conditional variance equations are significant there. Evidently, declining German yields as well as reductions in the CB reference rate tend to exacerbate bond yield volatility in Poland.

In this section we have been able to demonstrate that German yields are significant drivers of local yields in the time-varying conditional volatility framework. Noticeably, our findings are quite different from the early results obtained by the IMF (2003) as well as by Holtemöller (2003). We subsequently attempt to reaffirm the conclusions stemming from the time-varying analysis of the daily data series by investigating co-movements between the local and the German long-term bond yields on the basis of monthly-reported macroeconomic fundamentals.

V. Yield Compression Based on Fundamentals

The examination of yield compression in relation to macroeconomic fundamentals provides useful insights for assessing vulnerability of bond markets to changes in key financial and real economy variables. In order to capture such effects, we test sensitivity of changes in yield spreads between NMS and German bonds to changes in inflation differentials, exchange rates and domestic output growth rates. Separately, we test changes in local currency bond yields as a function of a set of selected domestic and euro area variables. The tests are comparable to those performed by the IMF (2003), however, we use exclusively the ten-year yields and their spreads over the ten-year German yields, in consistency with the Maastricht criterion of long-term interest rates convergence.

In line with the theoretical model developed in Section 3, we consider the following determinants of bond yields in NMS:

- German yields and the expected changes in the nominal exchange rate, as implied by the UIP condition
- the required long-term real rate and the expected inflation rate as they relate to the international Fisher effect
- the output gap as the real activity indicator, for ascertaining CB's reactions to business cycle developments.

Long-term forecasts of exchange rates and inflation rates pose a technical constraint, due to the relatively small sample of observations since the inception of NMS bond markets. Therefore, we choose lagged or forwarded variables instead of their dynamic forecasts. In principle, the dynamic inflation and exchange rate forecasts ought to be based on the convergence process towards a single currency, i.e. the fact that within the next decade all three countries will likely adopt the euro. Nevertheless, the exact date of entry, the final conversion exchange rate and the future inflation path are still unknown and subject to extensive descriptive and empirical analyses.

The catch-up process may in particular entail inflation rates exceeding the German ones even after having joined the EMU. The German long-term yields will therefore serve as a benchmark for pricing the NMS long-term debt, but augmented with the inflation and the exchange rate risk premia (Orlowski, 2003). In the tests that are reported in this Section we assume that such risk premia are determined on the basis of changes in macroeconomic fundamentals, assuming that their current dynamic changes may signal their future developments. The selection of independent variables for our tests is based on four criteria. First, the current inflation rate becomes important when the expected and the observed values differ significantly, i.e. if the uncertainties pertaining to the inflation rate are quite high (the inflation risk premium is elevated). Second, the nominal exchange rate changes are priced in if they carry information about the EMU entry rate. However, they may also stem from adjustments in the policy instrument, i.e. the CB reference rate. Third, both the CBs of NMS and the ECB policy reference rates are taken into consideration. Although the CB reference rate is usually not expected to be important for the pricing of long-term assets, it is believed to have an impact through the term structure of interest rates and it reflects the CB's inflation forecasts or expectations. Fourth, we include real activity indicators, namely, the output gap measure stated in terms of deviations from the Hodrick-Prescott filter of interpolated quarterly GDP series, and the straight (interpolated) series of quarterly year-on-year GDP growth rates. The former is assumed to indicate policy responses to the business cycle, while the latter mirrors real returns of the economy.

Because of the limited monthly data series for the ten-year bond yields available only since the inception of NMS long-term bond markets, we employ the ordinary least square (OLS) procedure. Due to non-stationary of all tested variables at their levels, we perform the tests on first differences of these variables. Hence, the examined relationships are aimed at proving the extent to which bond yields are driven by changes in the selected fundamental variables. The tests are based on monthly data series for the sample periods January 2000 – March 2005 for Hungary and Poland, and June 2000 – March 2005 for the Czech Republic. The data are taken from the IMF-International Financial Statistics (consumer prices) and the NewCronos database (GDP, exchange rates, CB rates, ten-year government bond yields). The CPI and GDP are entered as first-differences of their growth rates, the exchange rate is the one-month difference of the log of the nominal exchange rate to the euro.

Table 4. Bond yield compression in relation to macroeconomic fundamentals

	Czech Republic	**Hungary**	**Poland**
Dependent variable: Spread between 10yr GB of NMS and Germany Independent variables↓			
constant term	-0.0023 (-0.11)	0.0274 (0.62)	-0.0310 (-0.68)
CPI inflation differential	lag 1 0.091 (2.03)	lag 0 0.1816 (1.92)	Na
log of nominal exchange rate	na	lag 0 7.057 (2.41)	lag 0 4.034 (2.13)
reference rate spread -local versus ECB	na	lag 0 0.1579 (2.33)	Na
ECB reference rate	lag 0 0.3024 (2.61)	na	lag 0 0.6763 (2.63)
GDP growth rate	lag 2 0.2511 (1.85)	na	lag 6 0.3384 (2.51)
autoregressive correction	AR1 0.3389 (2.96)	AR2 -0.2059 (-1.96)	AR1 0.2460 (2.27)
adjusted R^2 Durbin-Watson stat. log likelihood Schwartz info. Criterion	0.362 1.750 28.996 -0.650	0.316 2.266 -19.012 0.932	0.332 1.977 -21.505 1.012
Dependent variable: 10y GB of NMS Independent variables↓			
constant term	-0.0003 (-0.01)	-0.0240 (-0.52)	-0.0005 (-0.01)
German 10y GB	lag 0 0.8477 (6.98)	lag 0 0.6400 (2.22)	lag 0 0.9890 (3.42)
CPI inflation rate	lag 1 0.1651 (3.86)	na	Na
log of nominal exchange rate	na	lag 0 6.7660 (2.26)	lag 0 4.2304 (2.24)
CB reference rate	na	lag 0 0.2241 (2.32)	Na
ECB reference rate	lag 0 0.2155 (2.08)	na	Lag 0 0.6054 (2.33)
GDP growth rate	lag 2 0.2401 (2.05)	na	lag 6 0.3030 (2.19)
autoregressive correction	AR1 0.2968 (3.69)	AR2 -0.1746 (-1.60)	AR1 0.2694 (2.58)
adjusted R^2 Durbin-Watson stat. log likelihood Schwartz info. Criterion	0.689 1.715 36.924 -0.853	0.303 2.292 -20.714 0.986	0.423 1.994 -20.694 1.052

Notes: all variables are in first-differenced terms; nominal exchange rates are local currency values of one euro; t-statistics are in parenthesis; the sample periods are: January 2000 March 2005 for Hungary and Poland, and June 2000 – March 2005 for the Czech Republic.

Data Source: IMF- International Financial Statistics and NewCronos Database.

The test results are shown in Table 4. The upper part of the table contains the estimation representations of the functional relationship of the spread between the NMS and German long-term yields as a function of selected independent variables. The lower part assumes local yields as dependent variables. The obtained results consistently prove prevalent co-movements between local and German yields. Thus in essence, local yields in all three countries are significantly driven by German yields. The estimated sensitivity coefficient between both variables for Poland (reported in the lower part equation) is very close to unity implying that German yields have become almost perfect drivers of local yields. The same coefficient is marginally lower for the Czech Republic and somewhat lower for Hungary. In contrast, sensitivity of local yields to changes in the remaining independent variables is quite diverse in the examined countries.

In the Czech Republic, the CPI-based inflation differential over the German inflation, as well as the two-months-lagged GDP growth rate appear to be statistically significant. Arguably, adjustments in the ECB reference rate affect significantly Czech yields, more than changes in the Czech CB reference rate do. This discrepancy seems to suggest that the Czech bond market is strongly integrated with the euro area bond markets and yields are influenced by the ECB monetary policy, which further implies that the Czech CB policy is no longer fully autonomous. Moreover, changes in the exchange rate do not directly affect Czech yields, which is understandable since the euro value in the Czech koruna has been quite stable during the past fifteen years with only minor nominal trend appreciation. Thus evidently, the financial markets seem to expect the current trend-rate to be already quite close to the euro entry rate, which makes long-term bond yields less susceptible to exchange rate shocks. The GDP growth rate, based on our proxy measure defined above, is a significant determinant of Czech yields. In general terms, the significance of the inflation rate and the current GDP growth rate variables suggests that the markets continuously rely, at least partially, on the country-specific information. Nevertheless, the importance of both German yields and the ECB reference rate indicate that the local financial markets are already reasonably integrated with the euro area markets, thus pricing of local assets is sensitive to the euro market dynamics.

A different combination of fundamental variables drives long-term bond yields in Hungary. As in the remaining two countries, local yields are driven by German yields, although the adjustment process is only partial, since the coefficient for Hungary has a lower estimated value than those for Poland and the Czech Republic. As in the Czech case, the local inflation rate is an important factor in the pricing of bonds. Unlike in the Czech case but similarly to Poland, the Hungarian exchange rate is a significant determinant of Hungarian bond yield, so is the CB reference rate. Clearly, the Hungarian yields are rather disconnected from adjustments in the ECB reference rate. This effect in combination with somewhat weaker translation of German into local yields implies that integration of the Hungarian with the euro area bond markets is less pronounced. Therefore, the local market might be more vulnerable to domestic rather than external shocks, which likely stems from relatively higher inflation rates than those in the remaining two countries, coupled with a more ambiguous CB monetary policy targeting strategy. The Hungarian CB relies on a dual-targeting monetary policy framework by focusing its attention on both low inflation and exchange rate stability objectives, while the Polish and the Czech CB prioritize stable, low inflation targets allowing the exchange rate to float almost freely. Consequently, the Hungarian bond markets remain highly sensitive to inflation expectations and exchange rate developments. Hence, the predominant impact of domestic variables makes the outlook for inflation and the exchange rate highly uncertain.

As indicated above, German yields are important drivers of bond yields in Poland. In addition, Polish yields are significantly affected by changes in the exchange rate, the GDP growth rate and the ECB reference interest rate. As in the Czech case, the GDP growth rate and the ECB reference rate seem to encapsulate real returns to investors, thus they serve as benchmarks for pricing long-term assets. The absence of the inflation rate along with the inclusion of the exchange rate might mean that the Polish markets expect a lasting inflation convergence, with some inflationary pressures stemming from the accelerated real GDP growth. Furthermore, the high volatility of the Polish zloty exchange rate in euro terms under the purely floating exchange rate (since April 2000) has made it very difficult to ascertain the future euro conversion rate, as well as the ERM2 reference rate, which adds an exchange rate risk premium to the local long-term bond pricing. The negligible importance of the Polish CB reference rate during the analyzed sample period seems to suggest that its policy instrument has been adjusted in response to the short- to medium-term inflation forecasts but not to the long-term inflation projection. In hindsight, Polish bond yields are significantly driven by German yields, the ECB rate and the exchange rate, all of which imply a high degree of integration with the euro area financial markets.

In sum, German yields play an important role in the determination of long-term bond yields in all three NMS. Moreover, our tests also reveal that the adjustments in the ECB reference rate significantly affect bond yields in Poland and, to a lesser degree in the Czech Republic, but not in Hungary. The strong influence of the euro area variables indicates a discernible degree of financial market integration, which underpins the ongoing monetary convergence to the euro. By comparison, the impact of changes in domestic variables on bond yield dynamics is rather uneven. The observed diverse reactions stem very likely from the prevalent differences in the NMS monetary policies that follow various inflation targeting prescriptions, and from the differences in their exchange rate regimes.

VI. A Synthesis and Policy Suggestions

Our analysis shows that there is a considerable progress in integration of Polish, Hungarian and Czech financial markets with the euro area markets. This general claim is underscored by the empirical evidence that German bond yields have become significant drivers of local currency bond yields in these converging countries. We prove this point by analyzing the TGARCH-M-GED daily volatility dynamics of local currency bond yields as a function of German yields, local term spreads and the exchange rates. We further verify the evidence on the co-movements between the NMS and German bond yields by examining sensitivity of local yields to monthly changes in fundamental variables, including inflation differentials, exchange rates, GDP growth rates, as well as the local CBs and the ECB reference interest rates.

In sum, we provide statistical evidence that monetary convergence of the euro candidate countries is taking place, which in turn implies that the examined NMS might be ripe for adopting the euro without risking potentially destabilizing shocks to their financial markets. As their bond markets become increasingly integrated with the euro area bond markets, their vulnerability to such shocks is less pronounced.

It is worthy noting that the actual path of bond yield compression has been periodically assessed by the ECB in its 'Convergence Reports'. The most recent 2004 Report shows that the average ten-year bond yield in the Czech Republic during the reference period September 2003 – August 2004 was 4.7 percent, well-below the Maastricht reference value of 6.4 percent (ECB, 2004). However, Poland and Hungary did not meet the benchmark yield; their average ten-year yields were 6.9 and 8.1 percent respectively. Yet, NMS yields are expected to fall below the revised Maastricht benchmark in the near future, as they have been gradually declining, reaching 6.4 percent in Hungary, 4.9 percent in Poland, and 3.2 in the Czech Republic at the end of June 2005.

In spite of the encouraging evidence on bond yield compression, serious challenges to financial stability in NMS are not out of sight. As proven by our analysis of the yield volatility dynamics, rising market interest rates are likely to exacerbate fluctuations of local currency bond yields, thus they may reverse the course of yield convergence. Without doubt, there are continuous pressures on NMS nominal interest rates attributable to renewed inflation expectations, which stem from aggregate supply shocks (including the recently sharp increase in energy prices), as well as aggregate demand shocks. Therefore, it is imperative that the converging countries continue pursuing monetary policies aimed at containing inflation. But the efforts to reduce risk premia are unlikely to succeed if they remain solely on the part of CBs. They need to be supplemented with disciplined fiscal policies. Needless to say, a continuous commitment to fiscal consolidation is crucial for a successful convergence to the euro.

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