Zentrum für Europäische Integrationsforschung
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Rheinische Friedrich-Wilhelms-Universität Bonn

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Working Paper

B 25
2004

ISSN 1436-6053

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# *Exchange Rate Risk and Convergence to the Euro*

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***Abstract:***

This paper proposes a new monetary policy framework for effectively navigating the path to adopting the euro. The proposed policy is based on relative inflation forecast targeting and incorporates an ancillary target of declining exchange rate risk, which is suggested as a key criterion for evaluating the currency stability. A model linking exchange rate volatility to differentials over the euro zone in both inflation (target variable) and interest rate (instrument variable) is proposed. The model is empirically tested for the Czech Republic, Poland and Hungary, the selected new Member States of the EU that use direct inflation targeting to guide their monetary policies. The empirical methodology is based on the TARCH(p,q,r)-M model.

**JEL classification: E42, E52, F36, P24.**

**Key words:** exchange rate risk, inflation targeting, monetary convergence, euro area, new EU Member States

This version September 2004

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Acknowledgement: I am indebted to the University of Bonn – Center for European Integration Studies (ZEI) for sponsoring this research. I am grateful to Jürgen von Hagen, Tai-Kuang Ho and Jizhon Zhou for valuable comments and suggestions.

## I. Introduction

The new Member States (NMS) that were recently admitted to the European Union (EU), also became participants of the European Monetary Union (EMU) with derogation on joining the euro at some later time upon meeting the required criteria. This means that they face a critical task of designing and implementing appropriate monetary and exchange rate policies that will lead to a successful, ultimate monetary integration, allowing them to replace their national currencies with the euro.

The conditions for adopting the euro have been spelled out by the Maastricht convergence criteria in a simple, plainspoken fashion. In addition to the requirements of containing inflation, ensuring stability of long-term interest rates, reducing budget deficits and imposing the limit on public debt expansion, these rather rudimentary criteria also call for achieving exchange rate stability. The prescribed vehicle for meeting the currency stability criterion is the Exchange Rate Mechanism II (ERM II) that the prospective euro entrants need to participate in for at least two years prior to adopting the euro. The principle of ERM II is to allow the participating currency to float within a normal intervention band around the predetermined and irrevocable conversion rate to the euro without resorting to devaluation of any kind. However, the assessment of meeting the exchange rate stability criterion is left to interpretations and judgment based on analysis of the deviations from the prescribed band (Jonas, 2004)[2].

This paper postulates an alternative approach to assessing currency stability that places an emphasis on the policymakers' ability to reduce the exchange rate risk. A diminishing exchange rate risk is suggested as a key criterion for evaluating currency stability and thus the effectiveness of monetary convergence to the euro. The exchange rate risk approach offers advantages over the Maastricht specification of currency stability because it underscores the nexus between the currency stability and the overall stability of the financial system. This approach is derived from a perceived link between the risk and uncertainty in financial markets in general and in foreign exchange markets

[2] Initially the ERM I intervention band was set at +/-2.5 percent around a central parity rate. However, following the 1992 currency crisis, the band was widened to +/-15 percent, where it formally remains today.

in particular, and the public confidence in the convergence process. The exchange rate volatility is exogenous to the monetary policy sphere of influence. It stems, among other sources, from a country's shaky outlook for fiscal discipline and an inadequate resilience of its financial system to various types of internal and external shocks. Beyond doubt, a country will be ready for adopting the euro when the volatility of its exchange rate reaches a 'normal' level. In the case of NMS, this level is determined by a somewhat higher inflation and higher benchmark interest rates relative to the euro area, which transpire from transition-related processes, such as the Balassa-Samuelson effect (Egert, 2003; Begg.et.al., 2003; De Grauwe and Schnabl, 2004; Mihaljek and Klau, 2004).

The exchange rate risk approach and specifically, the proposed criterion of declining risk premium is viewed as one of the key components of a broader monetary policy strategy suitable for navigating the path to the euro. As a foundation of this strategy, this paper proposes a monetary policy operational framework based on *relative inflation forecast targeting* (RIFT). A primary assumption of this strategy is that the long-term inflation target of the prospective candidate is identical with that of the common currency area. In other words, the candidate's inflation will have to converge to the inflation target of the common currency area. As a result, the long-term inflation target differential is zero, which implies that the small candidate country is in essence an inflation 'target-taker'. Therefore in order to achieve the inflation convergence in the long-run, the operational framework of the candidate's monetary policy needs to respond to the changing differentials between the candidate's and the common currency area inflation forecasts.

This study attempts to evaluate the exchange rate risk in the three NMS that officially rely on direct inflation targeting (DIT) to guide their monetary policies, namely, the Czech Republic, Poland and Hungary. While pursuing the monetary convergence to the euro, these countries face a challenge of incorporating the exchange rate stability target into their DIT framework that is ingrained with prioritizing low inflation targets over alternative policy goals.

The empirical methodology is based on the asymmetric generalized autoregressive conditionally heteroscedastic process with the variance in the mean equation GARCH-M (or TARCH(p,q,r)-M) of the first-order autoregressive movements of (logs) of national currency rates against the euro as a function of forwarded inflation differentials and lagged short-term interest rate differentials vis-à-vis Germany.

Considering the time-varying dynamics of exchange rate risk, this study focuses on short-term interplay between exchange rate volatility and risk premium, which may not necessarily hold in the long-run, real-sphere adjustments. In the short-run, a decline in exchange rate volatility usually entails a lower risk premium demanded by market participants. But in the presence of acceleration of real economic activity, the path of the risk premium becomes harder to predict (Watson, 2004). Thus given the ambiguity of the long-run dynamics, this analysis focuses exclusively on nominal volatility and nominal convergence and not on real exchange rate trends. This analytical approach is derived from the assumption that the widely-investigated real currency appreciation has faded away by now, at least in the three examined NMS, as implied by Égert et. al. (2003). This real appreciation that was prevalent at an earlier stage of economic transition stemmed from the initial under-valuation as well as the trend-appreciation in equilibrium real exchange rate (Roubini and Wachtel, 1999), the symptoms of which seem to be dissipating with the final passage toward the euro.

Furthermore, this paper departs from the treatment of the prospective euro entrants as an isomorphic bloc that is prevalent in the literature. Instead, it highlights the differing systemic foundations that are important for nominal convergence to the euro. Consistently, the empirical investigation is based on individual countries' time series analysis and not on multi-country panel data.

Section II encapsulates discussion about the policy dual-target, i. e. inflation and exchange rate, for the economies converging to the euro and outlines the proposed RIFT operational framework. A model illustrating interactions between the exchange rate risk and the inflation differential, as the key policy target variable, and the interest rate differential, as the instrument rule variable, is outlined in Section III. The empirical analysis based on the TARCH-M methodology is presented in Section IV. The concluding Section V divulges policy suggestions for an effective exchange rate risk management in the process of monetary convergence to the euro.

## II. Synchronization of Dual-Target: Low Inflation and Exchange Rate Risk

In their preparations for adopting the euro the monetary authorities of the NMS are facing a challenge of devising the optimal policy strategy that will guarantee price stability without hampering the economic growth. The literature pertaining to optimal monetary policy solutions that are presumed to facilitate the convergence process presents a wide range of proposals. They include a leap to unilateral euroization, or the earliest possible adoption of the euro (Begg, et. al., 2003), monetary strategies based on flexible exchange rate targeting (Bofinger and Wollmershäuser, 2001 and 2002), and flexible DIT policies with an ancillary objective of exchange rate stability (Eichengreen, 2001; Orlowski, 2001b, 2003, 2004b; Jonas and Mishkin, 2003). The flexible variant of DIT appears to be conducive to achieving the principal goals of convergence because its strategic and operational framework facilitates price stability as well as the overall financial stability of the converging transitional economies, as underscored for instance by Tuma (2003) and Orlowski (2001b, 2004b). Thus in essence, a flexible DIT framework that gives some consideration to exchange rate stability appears to be a proper venue for achieving both a lower inflation and exchange rate risk.

In the literature on this subject, some stylized facts or points of mutual agreement can be identified. First, there is a common caption that the candidates to the euro would have to somehow incorporate the exchange rate stability objective into their policies. It remains rather indisputable that the process of adopting the euro might be compromised if monetary authorities demonstrate a benign neglect approach to their national currency fluctuations against the euro to the very end of the convergence path (von Hagen and Zhou, 2004). Second, inflation or price convergence cannot be achieved at the expense of a significant output decline, which is likely to take place if real interest rates or, as prescribed by Orlowski (2003), the inflation risk premia continue to be excessively high. And third, a currency board arrangement is the first-best policy solution for smaller NMS, such as the Baltic States, whose financial markets are less developed and highly volatile. Flexible exchange rates would make it difficult for policy-makers to extract appropriate market signals for policy adjustments. In contrast, larger NMS with sufficiently developed financial markets may opt for more autonomous variants of monetary policy with flexible exchange rates (Jonas and Mishkin, 2003).

It now becomes clearer that the monetary policy strategy of the larger NMS that prescribe to more flexible exchange rate regimes will come full circle on their long road from the inception of economic transition to adopting the euro. The process that began with adopting currency pegs and was followed by diverse exit strategies that led to flexible exchange rates would have to end with a stable national currency alignment with the euro. This means that the objective of diminishing exchange rate risk needs to be taken into consideration.

Flexible exchange rate regimes were adopted by the three NMS through various policy adjustments[3]. They can be summarized as follows. The Czech National Bank (CNB) was forced to abandon a rigid currency peg and apply a managed float of the Czech koruna (CKR) in May 1997 in response to the early contagion effects from the Asian financial crisis. It has pursued a DIT policy accompanied by a managed float since January 1998. The National Bank of Poland (NBP) adopted a DIT framework as of January 1999 and allowed the Polish zloty (PLN) to float fully in April 2000 by abandoning the previous crawling band system – a peg with crawling devaluation within a wide +/-15 percent intervention band. The National Bank of Hungary (NBH), a late entrant to the inflation-targeting club, maintained a crawling devaluation regime with a narrow (+/- 2.25%) band until 2001. It adopted a DIT regime in May but abandoned the crawling devaluation only in October of that year replacing it with an ERM II-shadowing mechanism. As a reference rate, it initially set the Hungarian forint (HUF) at 276.1 to the euro, with a +/-15 percent intervention band.

In sum, the applied exit strategies from currency pegs differed in the three NMS both in terms of timing and the degree of exchange rate flexibility. As a result, Poland is now pursuing a relatively strict DIT policy framework with a pure float, the Czech Republic relies on a similar DIT policy but with a managed float, and Hungary follows a flexible DIT with inflation and exchange rate stability targets within the ERM

[3] A detailed examination of changes in monetary and exchange rate regimes in Central and East European countries can be found, for instance in von Hagen and Zhou (2004) , Corker, at. al. (2000) or Orlowski (2001b, 2003). A comprehensive analysis of features of inflation targeting regimes in industrial and developing countries is presented by Levin, Natalucci and Piger (2004).

II-shadowing arrangement. Because of these systemic differences, the actual interplay between inflation and exchange rate risk, as policy target variables, and interest rates, as the instrument variable, is likely to differ among these countries. Nevertheless, these interactions may become more uniform as the prospective euro entrants will have to adjust their policies in order to facilitate an effective monetary convergence, which in essence means placing a greater emphasis on exchange rate stability. Thus they will face a challenge of dealing with a dual-target, one-instrument strategy on the final passage toward the euro (Jonas, 2004).

The dichotomy between the low inflation and the exchange rate stability targets may entail possible policy conflicts. Among them is a danger that a renewed commitment to a currency peg may inhibit the authorities' ability to exercise a simultaneous control over money supply, thus also inflation, particularly when a country is open to capital flows (Taylor and Obstfeld, 2004). If a peg is believed to be sustainable in the long-run, a growing economy with liberalized capital account may encounter large capital inflows that always translate into inflation. This specific concern for the euro candidates is expressed by Csermely (2004) who predicts a peak of capital inflows upon their entry to ERM II, as this will provide implicit guarantees of exchange rate stability. If this prediction holds, the partial move toward the soft peg is likely to trigger a temporary inflation shock.

An equally intense conflict between both policy objectives may occur if a central bank follows a strict inflation targeting policy in the presence of large autonomous shocks to aggregate demand. In order to mitigate inflationary consequences of such shocks, a central bank may impose a strong premium on domestic interest rates by monetary tightening. The higher interest rate risk premium will quickly amplify the exchange rate risk premium thus undermining the goal of exchange rate stability. Without doubt, a transparent, forward-looking monetary policy could alleviate propagation of exchange rate risk. If, however, a foreign exchange market intervention aimed at stemming the currency appreciation is applied, it would have to be sterilized with an open market sale of domestic bonds in order to mitigate possible inflationary effects of accumulating foreign currency reserves. Such intervention may turn out to be extremely costly to the government.

Further conflicts between the low inflation and exchange rate stability objectives arise from the transition-related Balassa-Samuelson effect. This effect implies that an increasingly open economy experiences fast productivity gains in the tradable goods sector due to technological improvements brought forth by foreign direct investment. Higher productivity and capital-labor ratios drive up wages in this sector and bid up wages in the non-tradable goods sector as well. In order to maintain profit margins, prices of non-tradables rise faster than those of tradables. The resulting relative price adjustment contributes to higher inflation that, in the growing economy that attracts sizeable direct foreign investment, is reflected in currency appreciation. Hence, when Balassa-Samuelson effects prevail, balancing the contradictory objectives of low inflation and currency stability will prove to be a challenge for policy-makers. The expiration of these effects is likely to ease a conflict between the two monetary objectives in the economy converging to a common currency area. Therefore, a slower, more gradualist passage toward the euro may be a more prudent convergence strategy than a leap to euroization.

A more general argument in favor of a gradualist approach to the euro adoption is that the prospective entrants need to complete necessary institutional and structural reforms that will ease possible conflicts between various monetary policy objectives. For instance, the financial markets of the candidates need to be adequately prepared for averting possibly destabilizing transmission of nominal shocks from the euro area. The same rule pertains to the transmission of nominal shocks on the real economy of the euro candidates. As proven empirically by Jones and Kutan (2004), nominal shocks in the euro area have a significantly greater destabilizing effect on the Hungarian than on the euro area industrial production. In this sense, there is also a conflict between exchange rate and output stability objectives.

Nevertheless, the main conflict area in a final passage toward the euro will be a discord between low inflation and exchange rate stability. In order to manage dichotomy between the two objectives, the prospective entrants will face a challenge of finding a suitable policy framework. As indicated above, there is a long-run identity between the inflation goals of both parties in a monetary framework encompassing a small economy converging to a large common currency system. Since the implied difference between the dynamic inflation targets of both parties is zero, the converging country needs to base the operational framework of its monetary policy on the relative inflation forecast targeting. The proposed RIFT operational framework means that the candidate's central bank will react to changes in the differential between domestic and the foreign inflation forecast. In order to secure the effective monetary convergence, the RIFT policy ought to be forward-looking, thus enabling financial market expectations to mitigate any prevalent exchange rate risk premia. In contrast, a backward-looking policy based on actually observed inflation differentials would likely exacerbate the existing risk premia, particularly if the supporting policies (the fiscal stance and wage flexibility) are out of tune. Most importantly, the RIFT framework certainly accommodates a dual operating target situation, that is, a combination of the relative (predicted) inflation and exchange rate stability objectives, with a gradually increased emphasis on the latter. Under specific conditions, achieving both objectives might be exclusive, that is a fulfillment of one, namely lowering inflation, may jeopardize realization of the other, i. e. precipitate the exchange rate risk.

Without doubt, a converging economy ought to give priority to the objective of lowering inflation, before placing an emphasis on exchange rate stability. It is because price stability or low inflation is a prerequisite for exchange rate stability, not the other way around, as it is underscored by the causal effects detected in the empirical literature, including those shown in Table 1 and discussed in Section IV of this study. For this reason, the RIFT framework needs to be based on the hierarchical rather than the equal or balanced treatment of the stated operating targets.[4]

In sum, it is imperative for the prospective euro entrants to devise a robust monetary policy framework that will shield their economies from disruptive effects of capital account volatility by discouraging any presumption of implicit exchange rate guarantees (Schadler, 2004). If independent monetary policies are to be continued,

[4] The distinction between hierarchical and equal mandates for inflation and output stability targets has been recently introduced by Meyer (2004), who argues in favor of a balanced or 'dual' treatment granted to both targets on the basis of the recent experience of the U.S. Federal Reserve. However, this distinction has been prescribed as 'not very useful' by Svensson (2004) who notes that inflation is a policy choice-variable while the output target is subject to estimation. Svensson's preference of the hierarchical approach with a priority assigned to the inflation target seems more applicable to devising a policy framework for a converging economy that faces a problem of weighting and sequencing the inflation and exchange rate stability operating targets.

whether based on strict inflation targeting or, as suggested in this study, on the RIFT operational framework, an ancillary objective of reducing the exchange rate risk needs to be embarked upon. In this way, the process of convergence to the euro will entail a gradual, although never complete relinquishing of monetary autonomy. However, if a candidate country is subject to large asymmetric shocks, relaxation of monetary autonomy is likely to precipitate exchange rate volatility. Consequently, as the monetary policy autonomy vanishes, the responsibility for dampening the exchange rate volatility will stretch beyond its boundaries. This means that the candidate's ability to reduce the exchange rate risk premium will be increasingly attributable to the outlook for its fiscal discipline along with an improvement in wage and price flexibility[5]. If the risk premium (prescribed further in this study by $\theta_t$) remains high, a country will not be ripe for adopting the euro.

In order to understand the sources of the conflict between low inflation and a declining exchange rate risk, an analytical model combining both objectives in an environment of a converging economy can be devised.

## III. Interactions between Exchange Rate Risk and Policy Instrument Variables

The main purpose of the dual-target, one-instrument model for a converging economy is to show interactions between exchange rate volatility and a minimized inflation differential as target variables and the interest rate differential as an instrument variable. Construction of the model begins from the purchasing power parity (PPP) condition

$$s_t = p_t - p_t^E \qquad (1)$$

The log of nominal exchange rate expressed in terms of national currency value of the euro is denoted by $s_t$, $p_t$ and $p_t^E$ are respectively domestic and the euro area inflation rates (logs of CPI).

[5] There is persuasive evidence in the literature on a robust relationship between a fiscal policy outlook and the exchange rate risk premium, particularly for the economies converging to a common currency system. For instance, Giorgianni (1997) shows that expectations of fiscal contraction significantly contributed to lowering of the exchange rate risk premium in Italy in the pre-EMU period 1987-1994.

The second important component of a standard model of exchange rate determination is an interest arbitrage equation

$$\hat{s}_{t+\tau,t} - s_t = i_t - i_t^E + \gamma b_t \sigma_t^2 \qquad (2)$$

Domestic and the euro area nominal interest rates, specifically those that serve as short-term policy monitoring rates, are denoted by $i_t$ and $i_t^E$ respectively, while $\hat{s}_{t+\tau,t}$ represents the expected exchange rate for $\tau$-periods ahead. This component is an expected market spot exchange rate under uncovered interest parity (UIP) conditions and a forward rate in the covered interest parity (CIP) framework. One can presume that the period $\tau$ corresponds with the timing of either the intended entry to the common currency area or the convergence examination period at which the formal requirements are to be met by the candidate country. The term $\gamma b_t \sigma_t^2$ represents the overall exchange rate risk premium that depends on liquidity trade and denotes the excess forward domestic currency depreciation over the unbiased UIP condition. As implied above, this exchange rate risk premium is attributable mainly to the fiscal policy outlook (Giorgianni, 1997; Favero and Giavazzi, 2004) as well as wage and price flexibility. The risk premium term is derived from a standard portfolio choice model with a constant absolute risk aversion $\gamma$ (Jeanne and Rose, 2002; Bacchetta and van Wincoop, 2004). The conditional variance of the next period's exchange rate $\sigma_t^2$ is a critical component of exchange rate risk, while $b_t$ is the unobserved net supply of foreign currency based on non-speculative (liquidity) trade having a normal distribution $\mathrm{N}(0,\sigma_b^2)$.

Consistently with the proposed RIFT policy framework, the PPP equation can be further expanded by incorporating conditions that are inherent or intrinsic to the process of monetary convergence to a common currency area. Taking into consideration the DIT framework pursued by a small economy converging to a large common currency bloc, the PPP condition can be rewritten as

$$\hat{s}_{t+\tau,t} - s_t = \Delta p_t - \Delta p_t^E - (\overline{p}_{t+\tau,t}^d - \overline{p}_{t+\tau,t}^E) \qquad (3)$$

The dynamic variables $\Delta p_t$ and $\Delta p_t^E$ represent the first-order autoregressive movements in the domestic and the euro area inflation, $\bar{p}_{t+\tau,t}$ reflects the domestic and $\bar{p}^E_{t+\tau,t}$ the common currency area inflation targets for $\tau$ -periods ahead. If a central bank applies a flat linear target trajectory, rather than a descending trajectory or diminishing year-end target levels, the future period target is identical with the current period target $\bar{p}_t$, thus the target uniformity becomes fully consistent with the proposed RIFT framework. We maintain this RIFT underlying assumption thereinafter as it appears to be applicable to advanced stages of preparations to the euro adoption, when a solid foundation of policy credibility has been established. Moreover, for a converging economy the inflation target relative to abroad should not matter. Consistently with the assumption of effective monetary convergence, the domestic inflation target is 'derived' from the foreign inflation target. In essence, a small economy converging to a large economic bloc becomes a 'target-taker' as it cannot afford to formulate and pursue its monetary policy in isolation. Thus the resulting difference between both inflation targets ought to be equal to zero. In addition, if the policy credibility of a prospective entrant's central bank fully matches that of the common currency area, in practical terms the ECB, changes in domestic inflation emulate those in the euro area, i.e. $\Delta p_t = \Delta p_t^E$. However, if there is a credibility gap between the candidate's central bank and the ECB, the inflation trend in the candidate country will be augmented by a higher risk premium stemming from a credibility differential. By assumption, this premium, denoted by $\theta_t$, corresponds with the inflation pressures accumulated during the past period $n$ of the active convergence policy. Therefore, it can be prescribed as the differential in the integrated volatility over the period $t$ to $k$ or the difference in cumulative conditional variances for the k-period autoregressive movements in $\Delta p_t$ and $\Delta p_t^E$ that is specified as

$$\int_0^k \sigma^2_{t+\tau} d\tau - \int_0^k \sigma'^2_{t+\tau} d\tau = \theta_t \qquad (4)$$

The terms $\sigma^2_{t+\tau}$ and $\sigma'^2_{t+\tau}$ represent the conditional variances of $\Delta p_t$ and $\Delta p_t^E$ respectively.

In essence, the risk premium prescribed by (4) is associated with the cumulative record of domestic versus the euro area price instability. A higher degree of domestic inflation variability may stem, for instance, from the disparity in money growth rates between the candidate and the euro area. In particular, the prospective euro entrant may have experienced a fast-track monetization that 'catches up' with the degree of monetization in the common currency area (Orlowski, 2004a). Ultimately, a faster growth of money exerts pressure on domestic inflation and contributes to the exchange rate volatility.

When domestic and foreign inflation targets are fully aligned, the PPP condition augmented by the accumulated, systemic exchange rate risk premium becomes

$$\hat{s}_{t+\tau,t} - s_t = \Delta p_t - \Delta p_t^E + \theta_t \tag{5}$$

The candidate country's central bank may adopt a policy reaction function $L_t$ that combines both objectives, a lower exchange rate risk and domestic inflation converging to the euro area inflation forecast or target. If the reaction function is formulated as a combination of weighted unconditional variances of inflation and exchange rate, it can be designed as

$$L_t = \tfrac{1}{2}\left\{\left[\left(\Delta p_{t+\tau,t}^d - \Delta p_{t+\tau,t}^E\right) + \theta_t\right]^2 + \lambda\left(\hat{s}_{t+\tau,t} - s_t\right)^2\right\} + \tfrac{1}{2}\left[\operatorname{var}\left(\Delta p_t^d\right) + \lambda \operatorname{var}\left(s_t\right)\right] \tag{6}$$

The convergence process is successful if the limits of the intertemporal loss function represented by Eq. (6) are fulfilled by $\Delta p_{t+\tau,t}^d - \Delta p_{t+\tau,t}^E + \theta_t$ converging or equal to $\hat{p}_{t+\tau,z}$, which means that the difference between the domestic inflation expectations augmented by the prevalent exchange rate risk and the euro area inflation expectations needs to converge to the inflation target common for the candidate and the euro area. Eq. (6) represents an *explicit* loss function since it shows interplay between two target variables – low inflation and exchange rate stability. It assumes that the risk factor $\gamma b_t \sigma_t^2$ shown in Eq. (2) is roughly equal to the exchange rate risk premium $\theta_t$, both approaching zero, thus indicating a successful exchange rate risk convergence. A temporary excess exchange rate risk can be presented as a Markov process[6]:

$$\gamma b_t \sigma_t^2 - \theta_t = \beta_s \left(\hat{s}_{t+\tau,t} - s_t\right) \tag{7}$$

Convergence of both risk factors is successfully executed when

$$\lim \left\{\beta_s \left(\hat{s}_{t+\tau,t} - s_t\right)\right\} \to 0 \tag{8}$$

Taking into consideration the above-prescribed convergence process, the consistency between the UIP and PPP conditions, which has been initially formulated by Eqs. (2) and (3), can be restated as

$$\hat{s}_{t+\tau,t} - s_t - \theta_t = \rho\left(\Delta p^d_{t+\tau,t} - \Delta p^E_{t+\tau,t}\right) + (1-\rho)\left(i^d_t - i^E_t\right) \tag{9}$$

The functional relationship prescribed by Eq. (9) is consistent with an implicit loss function as it reflects interactions between the instrument variable (the interest rate) and the dual-target variables. As implied by this model, parameter $\rho$ can be defined as a multiplier translating the impact of inflation expectations relative to abroad on the risk-adjusted movement in the spot exchange rate.

The corresponding policy instrument rule derived from (9) can be presented as

$$i^d_t - i^E_t = \frac{1}{1-\rho}\left(\hat{s}_{t+\tau,t} - s_t - \theta_t\right) - \frac{\rho}{1-\rho}\left(\Delta p^d_{t+\tau,t} - \Delta p^E_{t+\tau,t}\right) \tag{10}$$

It is, however, debatable how plausible or binding a possible application of the instrument rule prescribed by Eq. (10) might be for prospective euro entrants. This functional relationship suggests that there is a long-run interaction between the interest rate differential and the inflation forecast differential as well as the spot exchange rate forecast that includes the exchange rate risk premium. From the perspective of a converging economy, the exchange rate risk premium ought to be diminishing, which

[6] The Markov process applied in this case allows for distinguishing between the average drift and the average volatility of the exchange rate at a given time horizon (for the modeling procedure of diffusion approximation in the ARCH analytical framework see Gourieroux and Jasiak, 2001, pp. 257-8).

implies that the instrument rule has to be dynamic, or subject to continuous revisions. Moreover, in order to aid the monetary convergence process, the instrument rule prescribed by Eq. (10) has to become an integral part of a broad conduct of monetary policy, thus it needs to be fully consistent with the general targeting rule[7].

The implementation of the above instrument rule might be useful for an effective conduct of monetary policy based on RIFT. After all, the proposed RIFT framework boils down to minimizing the inflation forecast differential relative to the common inflation target, as well as minimizing the exchange rate risk premium $\theta_t$. As discussed in the previous section, these two policy objectives may at times become mutually exclusive. If this is the case while the policy-makers follow the proposed RIFT framework, priority would be assigned to the inflation target, however, at the cost of a higher currency risk premium (and, consequently, a higher interest rate risk premium).

In practical terms, realization of the target rule prescribed by Eq. (9) depends on the magnitude and the directional change of the exchange rate risk premium $\theta_t$. For a country converging to a common currency area, it is imperative that this premium shows a decisively declining tendency, which would reaffirm the convergence process actually taking place.

## IV. Exchange Rate Risk Premium – The Empirical Assessment

The empirical analysis in this paper is aimed at assessing the exchange rate risk premium in a policy scenario feasible for the candidates to the euro. Hence the model investigates the existing exchange rate risk in the converging economies. The empirical testing is based on the TARCH-M process which has two important extensions to the basic GARCH model. First, the augmented test allows for inclusion of the r-order asymmetric leverage (TARCH) effect that enables to distinguish between negative and positive shocks to volatility. Second, it includes the conditional variance in the mean equation (the M-extension) that enables to examine the process with a path dependent rather than a

[7] This suggestion is consistent with the observation made by Svensson (2003) who claims that devising an appropriate targeting rule is more useful for contemporary monetary policies that an explicit reliance on Taylor rules.

zero conditional mean. Therefore, it accounts for the risk premium in the mean equation that evaluates dynamic changes in the exchange rate as a function of inflation and interest rate differentials with built-in optimal lags.

Consistently, Eq. (11) is a basis for the empirical analysis of interactions between the movement in the nominal exchange rate as a function of the expected domestic inflation differential and the lagged interest rate differential relative to Germany as the largest economy in the euro area. The model is stated as

$$\Delta \log(s_t) = \beta_0 + \beta_p \left(p^d_{t+\tau,t} - p^E_{t+\tau,t}\right) + \beta_i \left(i^d_{t-\kappa} - i^E_{t-\kappa}\right) + \varepsilon_t \quad (11)$$

In essence, the model investigates changes in the (log of) nominal exchange rate stated in domestic currency values of one euro as a function of relative inflation expectations for $\tau$ -period ahead, and the nominal short-term interest rate differential lagged by an optimal response period $\kappa$. Changes in the log of $s_t$ are applied here as the levels and the logs of the analyzed exchange rates are all non-stationary thus they would not be suitable for application in the GARCH –M test. Dynamic movements in the log of all exchange rates display strong stationarity. Inflation differentials are forwarded by $\tau$ -periods as the foreign exchange markets are seemingly driven by inflation expectations. Adversely, interest rate differentials are lagged by the optimal response period as current period changes in the exchange rate are presumed to be influenced by the prior adjustments in domestic interest rates relative to those prevailing in the euro area.

To incorporate the impact of the prevalent currency risk on the nominal exchange rate movement, the basic model can be augmented by the exchange rate risk proxied by the log of the conditional variance, which implies an exponential rather than a quadratic effect of the observed volatility. In this sense, the augmented functional form of the model suggests that the changes in the current nominal exchange rate are responsive to the percentage changes in the currency risk. The augmented model becomes

$$\Delta \log(s_t) = \beta_0 + \beta_p \left(p^d_{t+\tau,t} - p^E_{t+\tau,t}\right) + \beta_i \left(i^d_{t-\kappa} - i^E_{t-\kappa}\right) + \beta_\theta \log\left(\sigma^2_t\right) + \varepsilon'_t \quad (12)$$

In order to capture the exact impact of the volatility of subcomponents, the conditional variance equation is designed as

$$\sigma_t^2 = \omega + \sum_{l=1}^{p} \beta_l \varepsilon'^2_{t-l} + \sum_{j=1}^{q} \beta_j \sigma^2_{t-j} + \sum_{k=1}^{r} \beta_k \varepsilon'^2_{t-k} \Gamma_{t-k} \tag{13}$$

In quintessence, Eqs. (12) and (13) are designed as a TARCH-M model composed of the mean equation containing the log of the conditional variance and the conditional variance equation formulated as a TARCH(p,q,r) process[8]. The inclusion of the conditional variance in the mean equation allows for admission of a discrete time analog in the investigated relationship. The variance equation consists of three subcomponents: the ARCH term in the order of 'p' represented by $\sum_{l=1}^{p} \beta_l \varepsilon'^2_{t-l}$, the q-order GARCH term $\sum_{j=1}^{q} \beta_j \sigma^2_{t-j}$, and the leverage asymmetric r-order TARCH term $\sum_{k=1}^{r} \beta_k \varepsilon'^2_{t-k} \Gamma_{t-k}$. The ARCH terms reflect the impact of 'news' or 'surprises' from the previous periods (up to the q-order) on the conditional variance. The GARCH terms explain the impact of the forecast variance from the previous periods on the current conditional variance, thus allows measuring the degree of persistency in volatility. The leverage effect is captured by the asymmetric TARCH term (to the k-order), in which $\Gamma_{t-k}$ are k-period dummy variables assuming the value of one for all the observed negative shocks $\left(\varepsilon'_{t-k} \langle 0\right)$ and zero for the positive ones. A negative value of the estimated leverage effect coefficient $\beta_k$ implies that negative news or innovations raise the subsequent volatility of the exchange rate more than the positive news. In addition, a positive value of this coefficient indicates an increase and a negative value a decrease in the subsequent exchange rate volatility attributable to asymmetric shocks.

Before estimating the TARCH series for the three examined NMS, it is helpful to analyze vector autoregressive (VAR) distribution of lagged adjustments between the spot

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[8] The threshold GARCH or TARCH model was introduced by Glosten, Jaganathan and Runkle (1993). The M-extension, that is, the inclusion of volatility or the risk premium in the conditional mean equation was first proposed by Engle, Lilien and Robbins (1987). A comprehensive overview of various ARCH-class models along with a synopsis of their applications and a summary of empirical results can be found in Poon and Granger (2003). The ARCH-class models originated from the seminal work of Robert Engle who gives their worthy noting synthesis in his Nobel Prize acceptance lecture (Engle, 2004). These econometric models have been applied for the purpose of evaluating various categories of financial risk in the NMS by Matoušek and Taci (2003); Orlowski (2003 and 2004b); and Valachy and Kočenda (2003).

exchange rate, as well as inflation and short-term interest rate (three-month T-Bill rates) differentials vis-à-vis Germany. The VAR analysis enables to identify the optimum lags between changes in inflation and exchange rates as the dual-target variables, and the short-term interest rates as the instrument variable. The results of the VAR estimation for Poland, Hungary and the Czech Republic based on a monthly data for the sample period January 1995 – June 2004 are presented in Table 1.

**Table 1:** Unrestricted VAR Estimates of Lagged Responses: Changes in Logs of Exchange Rates and Differentials in CPI-based Inflation and in 3-mo T-Bill Rates vis-à-vis Germany for Czech Republic, Poland and Hungary (January 1995-June 2004).

| **Impact** | **Czech Republic** | | | **Poland** | | | **Hungary** | | |
|---|---|---|---|---|---|---|---|---|---|
| **on ⇒ of ⇓** | **Δlog of spot ex.rate** | **Inflation diff.** | **Interest rate diff.** | **Δlog of spot ex.rate** | **Inflation diff.** | **Interest rate diff.** | **Δlog of spot ex.rate** | **Inflation diff.** | **Interest rate diff.** |
| **Δlog of spot exch. rate** | 2-mo 0.187 [1.61] | 1-mo 7.387 [1.41]<br><br>6-mo 13.223 [2.48] | 1-mo 9.037 [2.26]<br><br>2-mo 10.904 [2.68] | 1-mo 0.252 [2.18] | not detected for up to 8-mo | 5-mo -9.142 [-2.34] | 1-mo 0.293 [2.43]<br><br>8-mo -0.199 [-1.91] | 7-mo 9.274 [1.86] | 5-mo 26.502 [3.48]<br><br>6-mo -14.803 [-1.80] |
| **Inflation diff.** | 3-mo 0.009 [2.51]<br><br>4-mo -0.007 [-1.86] | 1-mo 1.031 [8.68] | 3-mo 0.382 [3.00]<br><br>8-mo -0.222 [-2.26] | 3-mo 0.011 [1.46] | 1-mo 1.202 [10.56] | 3-mo -0.692 [-2.66] | 1-mo 0.004 [1.56] | 1-mo 0.937 [8.71] | not detected for up to 8-mo |
| **Interest rate diff.** | 1-mo -0.005 [-1.52]<br><br>3-mo -0.006 [-1.52] | 3-mo -0.265 [-1.47]<br><br>6-mo 0.443 [2.70] | 1-mo 0.738 [6.54]<br><br>2-mo 0.392 [2.79]<br><br>4-mo -0.360 [-2.54] | Not detected for up to 8-mo | 1-mo -0.129 [-1.58]<br><br>2-mo 0.256 [1.98] | 1-mo 1.173 [9.95]<br><br>2-mo -0.326 [-1.75]<br><br>3-mo 0.414 [2.12] | 2-mo -0.006 [-2.38]<br><br>3-mo 0.005 [1.75] | 1-mo 0.218 [2.62]<br><br>8-mo 0.238 [3.07] | 1-mo 0.999 [8.09] |

Notes: The first line in each row states the number of months; the second line shows the VAR coefficient, and the third one shows t-statistics. Exchange rates are stated in domestic currency values of one euro and, prior to January 1999, of the Deutsche mark adjusted by its official fixed parity rate to the euro of 1.95583.

Source: Own computation based on the Bundesbank, CNB, NBP, NBH and IMF data.

The unrestricted VAR analysis of interactions between movements in the exchange rate and differentials in inflation and in short-term interest rates vis-à-vis Germany displays a variety of responses in the examined countries. Such diverse effects suggest that their monetary and financial systems are seemingly different in terms of both the systemic foundations and financial markets reactions to changes in key monetary variables.

As shown in Table 1, movements in nominal exchange rates are largely driven by their past changes with a two-month lag in the Czech Republic and only one-month in both Poland and Hungary. The latter effect may stem from the impact of the crawling devaluation system that was maintained in both countries for a large part of the sample period. There is also a slightly significant adverse effect with an eight-month lag in the case of Hungary. Rising inflation differentials contribute to some extent to currency depreciation with a three-month lag in the Czech Republic and Poland, while their impact is more instantaneous in Hungary. An increase in domestic interest rates relative to German rates contributes to currency appreciation with a one-month, and repeatedly, a three month-lag in the Czech Republic and a two-month lag in Hungary, while the results for Poland are inconclusive. Thereby, changes in the PLN value relative to the euro show a considerably weaker response to inflation and interest rate differentials than the relative changes in the currencies of the two remaining countries. This is not a surprise, since the NBP remains to be fervently committed to a fully flexible exchange rate system, while the CNB follows a managed float strategy and the NBH has applied an ERM II-shadowing regime since October 2001.

Equally diverse are influences on inflation differentials. Their specific characteristics shed light on the relative importance of the exchange rate, the credit, and the expectations channels of monetary policy transmission, as these channels reflect a lagged response of target implementation to changes in monetary policy instruments and other key policy variables. As shown in Table 1, inflation differentials are insulated from changes in the exchange rate in the case of Poland, proving an ambiguous role of the exchange rate channel there. The pro-inflationary effect of currency depreciation in the Czech Republic is relatively mild with a two-month lag, yet, it becomes very strong after six months. The same effect is pronounced in Hungary with a seven-month lag underpinning a relatively active role of the exchange rate channel, which is also confirmed by Golinelli and Rovelli (2002). There is at least one common link between all three countries; namely, they all show a high persistency of inflation differentials, which follow a significant one-period autoregressive movement. This proves a pronounced, almost instantaneous impact of indexation of wages and prices in all three NMS.

The impact of changes in monetary policy instrument on the policy target variable or, in other words, changes in interest rates on inflation can be detected with short three-month and one-month lags for Poland and the Czech Republic respectively. Thus evidently, an increase in interest rates has a short-term suppressing impact on inflation there. One may therefore conclude that the DIT regimes in both countries are quite successfully implemented. Nevertheless, there are also some adverse corrective effects with a two-month lag in Poland and a six-month lag in the Czech Republic. In contrast, the response of inflation to prior adjustments in interest rates in Hungary is quite superfluous as rising interest rate differentials seem to exacerbate inflation with one-, and repeatedly, eight-month lags there. Such an effect implies that the use of interest rates as an effective tool of monetary policy in Hungary is inefficient, and thus the application of Taylor rules is implausible[9]. Furthermore, it appears that in the case of Hungary an increase in interest rates magnifies inflation expectations, which may cast some doubts about the effectiveness or even the applicability of the DIT framework there.

The dissimilar interest rate responses to changes in exchange rate and inflation also demonstrate seemingly different reactions of policy-makers to changes in macroeconomic fundamentals. A striking effect is the lack of interest rate responses to changes in inflation in the case of Hungary, which is unusual for a DIT country. The absence of such responses engenders suspicion that the NBH monetary policy is still geared toward active steering of the exchange rate contrary to the officially declared commitment to inflation targeting. This argument is further underscored by the pronounced interest rate responses to changes in the exchange rate with a five-month lag, although a bit counteracted after six months. A similar reaction is detected for the Czech Republic, however, with a considerably shorter lag, which corresponds with the active management of the exchange rate admitted by the CNB (Tuma, 2003). In contrast to

[9] The Hungarian case seems to validate the criticism of the Taylor rules expressed by Svensson (2003).

these two euro candidates, Poland shows a somewhat perplexing significant response of higher interest rates to the PLN appreciation with a five-month lag. This might stem from the active management of capital inflows pursued by the NBP.

The lack of uniformity in interactions between different target and instrument variables in the three examined countries suggests that the sources and patterns of the exchange rate risk are seemingly diverse. This point is elucidated by the analysis of the functional relationship expressed by Eqs. (12) and (13) – the TARCH(p,q,r)-M test for the three NMS[10].

The estimation results for the Czech Republic are shown in Table 2. The first striking result is the highly significant estimated coefficient $\hat{\beta}_{\theta}$ of the log of the conditional variance in the mean equation, which implies that changes in exchange rate depend strongly on the prevalent exchange rate risk. Since the estimated value of the coefficient is positive, an increase in currency volatility contributes to the CKR depreciation in euro terms. Moreover, the high statistical significance of this relationship suggests that a containment of the exchange rate conditional volatility is essential for strengthening the Czech currency and, ultimately, for a successful convergence to the euro. In addition, one-period forwarded inflation expectations have a moderately significant impact on the exchange rate dynamics. The positive value of the $\hat{\beta}_{p}$ coefficient implies that a rise in inflation expectations translates to the CKR depreciation. Without doubt, this confirms a link between the price and the currency stability objectives.

The estimated variance equation shows that the exchange rate risk (as expressed by the log of the preceding period conditional variance) is highly persistent as proven by the statistically significant first-order GARCH term coefficient that is close to unity. In addition, the first-order and, even more significantly, the second-order ARCH terms are quite pronounced proving that unanticipated 'news' or 'surprises' about volatility tend to exacerbate the currency risk. Moreover, since the sum of the GARCH and ARCH terms

[10] The functional relationships reported in Table 2-4 have been carefully selected on the basis of minimum AIC and SIC values. In each of the three countries a normal (Gaussian) distribution of error terms is assumed, as the conducted normality tests for various functional forms have not shown any significant departures from this assumption. Moreover, tests assuming generalized error distribution (GED) and Student-t distributions have produced inferior, less conclusive outcomes.

is close to but still less than one, it can be argued that the Czech exchange rate risk is in fact converging to the steady-state albeit very slowly. The second-order asymmetric TARCH effects are also significant, although the estimated coefficient $\hat{\beta}_{k2}$ has a positive value, meaning that asymmetric shocks tend to bolster exchange rate volatility with a two-period lag.

**Table 2:** TARCH(2,1,2)-M estimation results of Eqs. (12) and (13) for Czech Republic (January 1995-June 2004).

| | Coefficient | Standard error | z-Statistics | Probability |
|---|---|---|---|---|
| *Mean Equation:* | | | | |
| $\hat{\beta}_0$ | 0.1333 | 0.0047 | 28.40 | 0.000 |
| $\hat{\beta}_p$ for t+1 | 0.0010 | 0.0053 | 1.82 | 0.069 |
| $\hat{\beta}_i$ for t-1 | -0.0006 | 0.0057 | -1.08 | 0.282 |
| $\hat{\beta}_\theta$ | 0.0154 | 0.0005 | 29.30 | 0.000 |
| *Variance Equation:* | | | | |
| $\hat{\omega}$ | 0.0001 | 0.0001 | 2.13 | 0.033 |
| $\hat{\beta}_{l1}$ ($1^{st}$ order ARCH) | 0.0920 | 0.0324 | 2.84 | 0.005 |
| $\hat{\beta}_{l2}$ ($2^{nd}$ order ARCH) | -0.1409 | 0.0320 | -4.41 | 0.000 |
| $\hat{\beta}_{j1}$ ($1^{st}$ order GARCH) | 0.8939 | 0.0382 | 23.39 | 0.000 |
| $\hat{\beta}_{k1}$ ($1^{st}$ order TARCH) | -0.0085 | 0.0210 | -0.41 | 0.684 |
| $\hat{\beta}_{k2}$ ($2^{nd}$ order TARCH) | 0.1937 | 0.0540 | 3.58 | 0.000 |
| $R^2$=0.195, Log Likelihood=323.62, DW=2.00, AIC= -5.755, SIC= -5.508 | | | | |

Notes: DW is Durbin Watson statistics, AIC is Akaike Information Criterion, SIC is Schwartz Information Criterion. The data generating process (DGP) assumptions are: normal (Gaussian) distribution, log of the squared one-period lagged variance is the M component in the mean equation, and TARCH(2,1,2).

Source: Own computation based on the Bundesbank, CNB and IMF data.

In sum, a stable path of the CKR exchange rate strongly depends on the ability of the Czech monetary authorities to reduce the exchange rate risk premium. Therefore, this exercise proves that the ability to contain the exchange rate risk plays a pivotal role in a successful pursuit of monetary convergence to the euro area and, henceforth, diminishing the exchange rate risk shall become an integral part of the convergence strategy.

The TARCH-M analysis for Poland summarized in Table 3 yields similar exchange rate risk characteristics to those detected in the Czech case. Most importantly, the risk coefficient in the mean equation has a comparable impact on the exchange rate movement; namely, a possible propagation of currency risk is decisively translated into PLN depreciation and, vice versa, a declining risk into its appreciation. But unlike in the

**Table 3:** TARCH(2,1,2)-M estimation results of Eqs. (12) and (13) for Poland (January 1995-June 2004).

| | Coefficient | Standard error | z-Statistics | Probability |
|---|---|---|---|---|
| *Mean Equation:* | | | | |
| $\hat{\beta}_0$ | 0.1183 | 0.0524 | 2.25 | 0.024 |
| $\hat{\beta}_p$ for t+1 | 0.0007 | 0.0005 | 1.50 | 0.133 |
| $\hat{\beta}_i$ for t-1 | -0.0013 | 0.0005 | -2.68 | 0.007 |
| $\hat{\beta}_\theta$ | 0.0134 | 0.0067 | 2.01 | 0.044 |
| *Variance Equation:* | | | | |
| $\hat{\omega}$ | 0.0002 | 0.0001 | 2.70 | 0.068 |
| $\hat{\beta}_{l1}$ ($1^{st}$ order ARCH) | 0.1169 | 0.1184 | 0.99 | 0.324 |
| $\hat{\beta}_{l2}$ ($2^{nd}$ order ARCH) | -0.1974 | 0.0879 | -2.25 | 0.025 |
| $\hat{\beta}_{j1}$ ($1^{st}$ order GARCH) | 0.5599 | 0.1672 | 3.35 | 0.001 |
| $\hat{\beta}_{k1}$ ($1^{st}$ order TARCH) | -0.1213 | 0.1372 | -0.88 | 0.377 |
| $\hat{\beta}_{k2}$ ($2^{nd}$ order TARCH) | 0.2679 | 0.1520 | 1.76 | 0.078 |
| $R^2$=0.099, Log Likelihood=268.32, DW=1.63, AIC= -4.697, SIC= -4.451 | | | | |

Notes: DW is Durbin Watson statistics, AIC is Akaike Information Criterion, SIC is Schwartz Information Criterion. DGP assumptions are: normal (Gaussian) distribution, log of the squared one-period lagged variance is the M component in the mean equation, and TARCH(2,1,2).

Source: Own computation based on the Bundesbank, NBP and IMF data.

Czech case, the exchange rate movement in Poland is influenced by the preceding period adjustment in the interest rate differential vis-à-vis Germany, the increase of which quickly translates into the PLN appreciation. The conditional variance in the Polish case is also relatively persistent as suggested by the significant first-order GARCH coefficient. Yet, it displays a lower degree of persistency as its estimated value is considerably less than one. In addition, changes in the PLN value of the euro are significantly affected by the second-order ARCH and TARCH terms. The negative coefficient of the second-order ARCH term implies a suppressing effect of the past, unexpected shocks to the exchange rate, which may very likely stem from deliberate corrections of these shocks conducted by the NBP. The second-order TARCH coefficient is positive (similarly to the Czech case) but it is only bordering on statistical significance.

The observed proximity of exchange rate reactions to the currency risk in the Czech Republic and Poland is not surprising since both countries follow a similar DIT framework with relatively flexible exchange rates. Nevertheless, the Czech exchange rate movements appear to be more driven by inflation expectations than the Polish ones, while the Polish currency reactions to the previous period changes in the interest rate differential are a bit more pronounced. In both cases, the exchange rate risk appears to be declining, or moving to a steady-state, as implied by the sum of ARCH and GARCH terms not exceeding unity.

Seemingly different features of the exchange rate risk are observed in the case of Hungary, as shown in Table 4. The mean equation implies that the changes in the Hungarian forint (HUF) relative to euro are driven significantly by each of the dependent variables. The cumulative exchange rate risk further contributes to the HUF depreciation, as do inflation expectations for one-period ahead, while rising interest rate differentials two periods before translate into the HUF appreciation[11]. The conditional variance reacts strongly and swiftly to the unexpected shocks from the previous period. These shocks tend to exacerbate the exchange rate volatility quite ostensibly, as proven by the high value of the estimated ARCH coefficient. At the same time, the variance persistency (GARCH effects) has not been found in the case of Hungary in any of the various tested

[11] A one-period lagged interest rate differential is surprisingly insignificant in the case of Hungary during the examined sample period.

functional forms. The strong ARCH effect along with the absence of GARCH may be associated with the prolonged application of the crawling devaluation system by the NBH during a large part of the examined period. The pronounced asymmetric leverage (TARCH) effect is noteworthy in the Hungarian case. It has a negative coefficient proving that the NBH has reacted swiftly to one-sided shocks to currency volatility and that these reactions have effectively trimmed down the volatility. In quintessence, the test appears to indicate that the NBH demonstrates a stronger commitment to managing the exchange rate risk than both the CNB and the NBP do.

**Table 4:** TARCH(1,0,1)-M estimation results of Eqs. (12) and (13) for Hungary (based on January 1995-June 2004).

| | Coefficient | Standard error | z-Statistics | Probability |
|---|---|---|---|---|
| *Mean Equation:* | | | | |
| $\hat{\beta}_0$ | 0.1330 | 0.0450 | 2.96 | 0.003 |
| $\hat{\beta}_p$ for t+1 | 0.0025 | 0.0007 | 3.59 | 0.000 |
| $\hat{\beta}_i$ for t-2 | -0.0020 | 0.0008 | -2.47 | 0.013 |
| $\hat{\beta}_\theta$ | 0.0151 | 0.0051 | 2.95 | 0.003 |
| *Variance Equation:* | | | | |
| $\hat{\omega}$ | 0.0002 | 0.0001 | 11.71 | 0.000 |
| $\hat{\beta}_{l1}$ ($1^{st}$ order ARCH) | 0.6822 | 0.2309 | 2.95 | 0.031 |
| $\hat{\beta}_{k1}$ ($1^{st}$ order TARCH) | -0.7773 | 0.2433 | -3.20 | 0.001 |
| $R^2$=0.352, Log Likelihood=321.90, DW=2.05, AIC= -5.726, SIC= -5.554 | | | | |

Notes: DW is Durbin Watson statistics, AIC is Akaike Information Criterion, SIC is Schwartz Information Criterion. DGP assumptions are: normal (Gaussian) distribution, log of the squared one-period lagged variance is the M component in the mean equation, and TARCH(1,0,1).

Source: Own computation based on the Bundesbank, NBH and IMF data.

In addition to the general findings encapsulated in Tables 2-4, the time-varying path of the conditional standard deviation associated with the TARCH-M tests provides a number of insights about the actual reactions of the exchange rate risk to various systemic and external shocks. The dynamic changes in the conditional exchange rate risk in the Czech Republic, as proxied by the conditional standard deviation, are shown in Figure 1.

**Figure 1: TARCH Conditional SD for Czech R.**

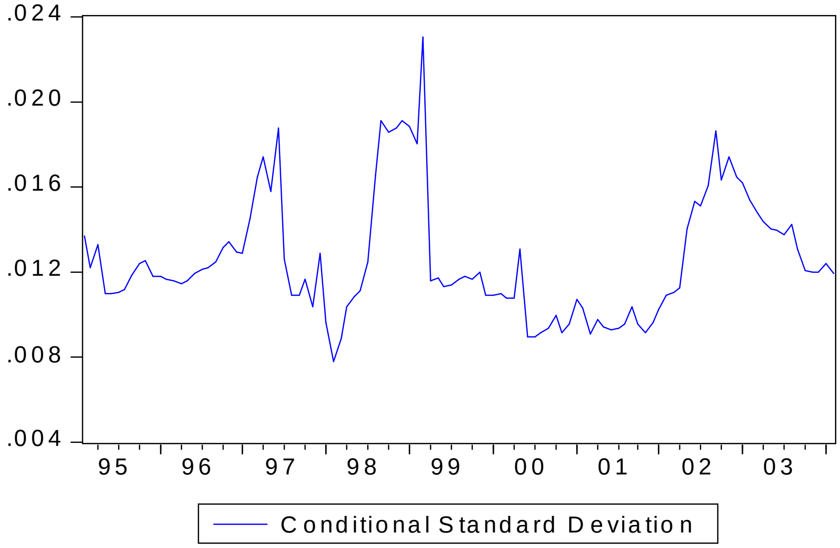



**Figure 2: TARCH Conditional SD for Poland**

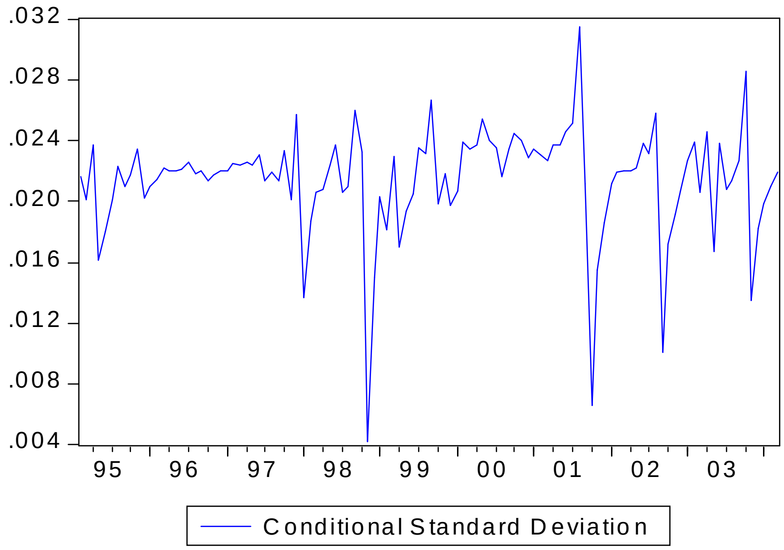
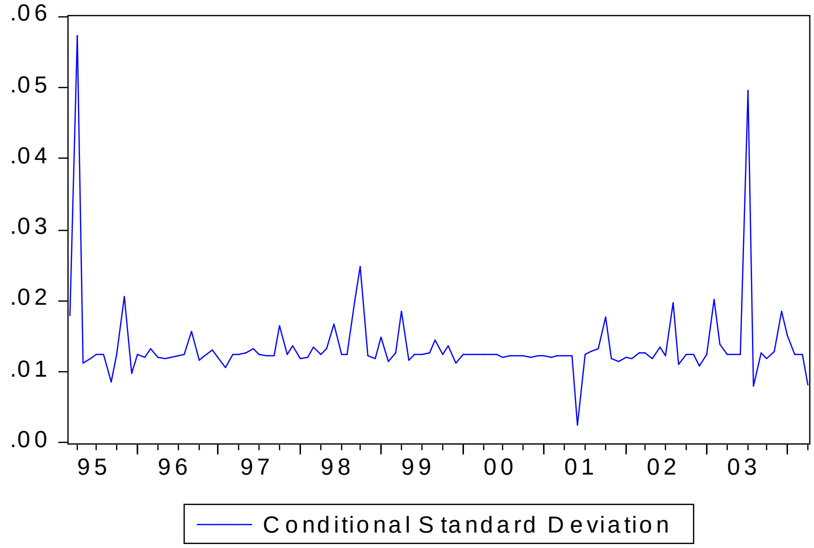


**Figure 3: TARCH Conditional SD for Hungary**




There is a clear propagation of currency risk in mid-1997 at the time of the Asian financial crisis that had strong contagion effects on the CKR (Linne, 1999; Gelos and Sahay, 2001). These pressures appear to dissipate in the first half of 1998, which means, with the inception of the DIT policy. Yet, they build up again in the second half of that year as well as in 1999, which can be associated with strong contagion and spillover effects from the Russian financial crisis of August/September 1998. There is a new wave of pressures on the CKR at the end of 2002 and through 2003, very likely associated with a significant deterioration of the Czech fiscal discipline at that time.

The time distribution of the conditional standard deviation for Poland (Figure 2) sheds light on a number of factors contributing to the PLN exchange rate jitters. Poland's currency sailed through the Asian financial crisis without major turbulences, as empirically proven by Gelos and Sahay (2001). The first significant increase in the exchange rate volatility followed by a deep correction can be observed around the time of the Russian financial crisis. The volatility shock of September 1998 can be undoubtedly attributed to the official strategy of 'de-coupling' the Polish financial markets and institutions from the Russian problems (Orlowski, 2001a). The monetary authorities of Poland presented a compelling evidence of immunity to possible contagion effects from the Russian crisis, by emphasizing a better institutional advancement of its financial system and higher quality of assets held by the country's financial institutions. Furthermore, the NBP cut its benchmark interest rates (contrary to NBH hiking them) in an effort to send a signal to financial markets about the resilience of Poland's monetary system to external crises. The further propagation of the exchange rate risk that can be seen in Figure 2 has had a different origin. Poland's exchange rate has a history of reacting to mixed messages about the authorities' ability to maintain fiscal discipline. For instance, the Finance Ministry warning on July 11, 2001 about a possible increase in borrowing in the Eurobond market in case of the Parliament's failure to approve the proposed parsimonious budget triggered speculative pressures on the PLN. Similar episodes also took place in July 2002 and September 2003. In hindsight, the analysis underscores the importance of imposing fiscal discipline as one condition for reducing the exchange rate risk.

The Hungarian exchange rate volatility (Figure 3) is influenced by a seemingly different set of factors. The first significant jump in the exchange rate risk coincides with the 9.0 percent devaluation of the HUF against the basket of currencies on March 13, 1995. The volatility spike was quickly contained mainly by the introduction of the crawling devaluation system three days later. In addition, some pressures on the exchange rate risk can be seen at the time of the Russian financial crisis. In contrast, the volatility fell sharply as a result of the DIT introduction and the simultaneous widening of the currency intervention band from +/-2.25 to +/-15.0 percent around the reference rate enacted on May 4, 2001. However, the GARCH standard deviation series indicate highly unstable exchange rate volatility even during the DIT regime. Just like in the cases of Poland and the Czech Republic, the exchange rate risk was exacerbated by increasingly gloomy outlook for fiscal discipline. Nevertheless, the significant jump in volatility in mid-2003 coincides with the reassessment (devaluation) of the HUF reference against the euro (from 276.1 to 282.36) on June 4, 2003, a puzzling move considering the strength of the HUF of about 12 percent at that time relative to the initial reference rate. Moreover, the numerical average value of the GARCH conditional standard deviation is considerably higher in Hungary than in the remaining two countries. This suggests that the active management of the exchange rate in Hungary does not contribute to effective reduction of the exchange rate risk. On the contrary, it seems that a less engaged, more flexible approach to the exchange rate as the one demonstrated by the CNB and the NBP can be viewed as a superior strategy for containing the exchange rate risk.

A worthy noting conclusion from this exercise is that the risk elasticity coefficients of the domestic currency movements (depreciations) in the euro terms (the estimated $\hat{\beta}_{\theta}$ coefficients) are almost identical in all three countries. They are all statistically significant. The Czech risk factor is prevalent in the determination of the CKR exchange rate changes, while the interest parity and inflation differentials come forth as significant in Hungary and, to some extent, in Poland. The uniform sensitivity of domestic currency to risk may very likely stem from the treatment of the three NMS by foreign exchange market participants as a homogeneous bloc in terms of country risk assessment. Yet, the variance equations imply that the analyzed systems are heterogeneous. In brief, the Czech exchange rate volatility is dominated by the GARCH (persistency) effect, so is the Polish one, although to a lesser degree. In contrast, Hungary's currency volatility is predominantly driven by the 'news' (ARCH-effects) and the asymmetric (TARCH) shocks. Therefore, the policy approach to smoothing the exchange rate patterns cannot be uniform within this heterogeneous group of the euro candidates.

## V. Summary and Analytical Extension

This study has investigated the exchange rate risk in the NMS that are actively pursuing convergence to the euro. Consistently with the major precepts of monetary convergence to a common currency area, the exchange rate risk is defined here as the excess exchange rate volatility above the level associated with unbiased uncovered interest and purchasing power parity conditions. Specifically, exchange rate volatility becomes very pronounced in the presence of expectations of growing budget deficits and government borrowing needs, wage and price rigidities, or other symptoms of vulnerability to large, unstable capital flows. Such defined exchange rate risk has been assessed for Poland, Hungary and the Czech Republic by employing the TARCH-M model, which is in essence the standard GARCH with the variance included in the mean equation, amplified by the impact of asymmetric shocks to volatility. The log of the conditional variance in the mean equation, as a proxy of the exchange rate risk, appears to be quite pronounced in all three countries, proving that the problem of excessive exchange rate has yet to be resolved. Therefore, this study argues that the ability to mitigate the exchange rate risk premium ought to be considered as an important criterion for assessing the currency stability and thus for evaluating an effective convergence to the euro. It further suggests that the best way to mitigate such a risk is to adopt a monetary policy framework based on *relative inflation forecast targeting*, or RIFT.

The empirical tests also show that the sources and the persistency of exchange rate risk in these countries are not isomorphic but stem from underlying significant systemic differences among the examined NMS. Thus the prescription for dealing with the persistency and asymmetry of the observed shocks ought to be different for each country. Nevertheless, in spite of the explicit disparity, there is a common reason underlying propagation of the exchange rate risk in these countries, namely, the questionable outlook for fiscal discipline. By all means, monetary policy alone cannot mitigate the exchange rate risk. The outlook for disciplined fiscal policy plays a pivotal role in containing exchange rate risk premia, particularly in the DIT countries[12].

Moreover, additional technical concerns are likely to emerge once the euro candidate countries enter the ERM II arrangement devised as the mandatory interim policy regime. A new policy challenge stemming from the required (soft) peg to the euro will be achieving currency stability or, in other words, containing excessive exchange rate risk premia, while at the same time allowing enough flexibility to control financial stability. It appears that the ERM II might be able to deliver both attributes if a broad (+/-15%) rather than a narrow (+/-2.5%) tolerance band around a central parity rate is officially applied (Kenen and Meade, 2003). In any case, it is imperative that the conditions of the ERM II participation are carefully determined. Critically important are the timing of the ERM II entry and the determination of the reference exchange rate,

[12] This point is convincingly argued by Favero and Giavazzi (2004) who investigate propagation of exchange rate risk under the DIT policy in Brazil. In the presence of the country's perpetual large budget deficit, a response of domestic currency depreciation to international financial shocks is larger than it would be if the fiscal discipline were maintained. The depreciation is further triggered by the country's large exposure to short-term debt denominated in foreign currency. Even though the foreign currency debt and the scope of fiscal disorder in the euro candidate countries are less serious than in Brazil, they cannot afford to ignore the warnings expressed by Favero and Giavazzi.

which should correspond closely with a dynamic equilibrium exchange rate. For instance, it would be a strategic policy error to enter the ERM II at a time of an external financial crisis or unfavorable risk structure (the pecking order) of capital inflows, that is, a prevalence of short-term over long-term capital inflows. Such financial market jitters would entail multiple exchange rate equilibria, thus increase a risk of misalignment between the officially adopted reference rate and the equilibrium rate.

Thus a correct specification of the ERM II reference rate is crucial. Its determination should be preferably left to financial markets and not to arbitrary judgment of policy-makers. A properly determined reference rate - the one that is in equilibrium with macroeconomic fundamentals and market expectations - seems more critical for guaranteeing exchange rate stability than the width of the intervention band. The band itself is aimed at providing an effective cushion against unexpected currency shocks, such as contagion effects from external financial crises. But a properly determined reference rate provides a direct link to macroeconomic fundamentals. If the reference rate is too weak relative to the equilibrium rate, the room for additional depreciation will be reduced. A weak reference rate will also call for additional foreign exchange market intervention to support the national currency. Adversely, a if the reference rate is too strong, particularly in the presence of appreciation shocks, intervention aimed at weakening of the currency will be necessary. In any case, misspecification of the reference rate can bring about high fiscal costs of interventions. It may also exacerbate the exchange rate risk premium as the candidate's ability to maintain currency volatility within the prescribed fluctuations band will be hindered.

In hindsight, regardless of the specific mode of monetary convergence to the euro chosen by individual candidate countries, their ability to mitigate exchange rate risk ought to be viewed as an important criterion for assessing preparedness to enter the ERM II and later to adopt the euro.

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