market risk, proxied by increases in the VIX volatility index in the United States, had strong spillover effects on credit and liquidity risks during the course of the recent financial crisis (Mizen, 2008; Orlowski, 2008b). In essence, the volatility dynamics of equity markets are a good indication of investors' confidence in the country's financial stability and resiliency against external financial contagion. For this reason, equity market risk dynamics could serve as an important monitoring device for monetary policy makers.

Monitoring interest rate risk is equally crucial for monetary policy decision making, because its proliferation reduces the effectiveness of monetary policy instrumentalization. Central banks of the euro-candidates ought to consider a relative interest rate risk that can be captured by the volatility dynamics of short-term interest rates in their respective countries vis-à-vis the volatility of the corresponding interest rates in the eurozone. Such an approach helps to set a time path for the interest rate risk premium vis-à-vis the eurozone, which is important for the successful implementation of monetary policy during the course of convergence to the euro.

Exchange rate risk is the third market risk category. This risk is tied to the instability of a possible exchange rate target and to the unreliability of the exchange rate channel of monetary policy transmission. Needless to say, this channel serves as a focus of monetary policy implementation in the economies converging to a common currency. Elevated exchange rate risk at stressful market periods confuses asset valuation and credit pricing in the banking sector. It subsequently necessitates higher interest rates and tighter credit. Monetary authorities must react to jumps in exchange rate volatility as they distort the functioning of the exchange rate channel of policy transmission, which has been proven to be unstable in the euro-candidate countries (Golinelli and Rovelli, 2005; Orlowski, 2005, 2008a; Kočenda and Valachy, 2006; Kočenda *et al.*, 2006). We therefore estimate conditional volatility of exchange rate changes in response to key determinants of exchange rates, that is, the uncovered interest parity and the purchasing power parity, in our selected countries.

We also investigate the evolution of risks in the selected euro-candidate countries during the past decade, with special attention to the propagating of the 2007–2009 global financial crisis. In order to capture risk dynamics, we examine changes in the conditional volatility of major equity market indexes, relative short-term interest rates and daily changes in the euro value of local currencies. Our sample period starts January 3, 2000 and ends August 7, 2009, with some adjustments for different inception dates for the secondary market trading of long-term government bonds in individual countries. In order to investigate the conditional volatility dynamics we employ GARCH(p, q)-M-GED, the generalized autoregressive conditional heteroscedasticity with the in-mean

Table 2: Changes in 3-month market interest rates vis-à-vis the changes in Euribor 3-month rates and the log of the exchange rate against the euro. GARCH-M-GED estimation – equations 3 and 4. Daily series; sample period January 3, 2000 – August 7, 2009

Variables ⇓	Czech Republic	Poland	Hungary	Romania	Slovakia
Conditional mean equation (coefficient × 100)					
Constant term	−0.124***	−0.000***	0.000***	−38.801***	−28.041***
EURIBOR3M	0.000	0.000	0.000***	0.000***	−0.000
Log(Exchange rate)	0.000	0.000	−0.000	0.017***	0.000
Log(GARCH)	−0.000***	−0.000***	−0.000***	−11.468***	−3.972***
Conditional variance equation					
Constant	0.000***	0.006***	0.000***	0.002***	0.000***
ARCH(1)	0.537***	2.314***	0.780***	0.006***	0.012***
ARCH(2)	−0.280***	−1.309**	−0.480***	−0.002***	−0.008***
ARCH(3)	—	—	−0.179***	—	0.000***
GARCH(1)	0.520	0.789***	0.876***	0.412***	0.952***
GED parameter	0.266***	0.234***	0.155***	0.174***	0.380***
Diagnostic statistics					
Log likelihood	10,634.12	4,301.831	−5,779.824	5,501.916	−1,832.546
AIC	−8.490	−3.430	−6.208	−4.389	−4.962
SIC	−8.476	−3.409	−6.185	−4.369	−4.937
Durbin–Watson Stat	2.020	2.314	1.822	1.107	1.670

***denotes significance at 1%, **at 5% and *at 10%.
Notes: All variables are in first differences; *t*-statistics are in parentheses; AIC = Akaike information criterion, SIC = Schwartz information criterion.
Source: Authors' own estimation based on Datastream data

supports the claim that short-term interest rates of the euro-candidates are likely to jump significantly in times of financial distress, underscoring exceptional vulnerability of their banking sectors to external shocks. In addition, there is a significant risk discount in the cases of the Romanian and Slovak rates as implied by the negative log(GARCH) coefficients in the conditional mean equations. These reactions are likely related to the very high initial interest rate risk premia in these two countries as well as to changes in interbank borrowing from local rather than eurozone banks. At the same time, there is a very small interest rate risk discount detected for the Czech, Polish and Hungarian interbank rate series. The conditional volatility series of interbank rates is highly persistent for Polish and Hungarian interbank markets, as signified by high values of GARCH coefficients. Interbank rates remain vulnerable to ARCH-type shocks with non-uniform diffusion in the cases of the Czech, Polish and Hungarian rates.

The graphical displays (Figures 2(a)–(e)) of the GARCH conditional standard deviation series show large jumps in interest rate volatility for the Czech Republic, Hungary and Romania coinciding with the October 10, 2008 turbulence in global financial markets. Poland is a notable exception.

prices are not sticky, experiencing at times abrupt changes consistent with the prevalence of fat tails. We argue that high leptokurtosis, that is, extreme tail risks associated with abrupt price adjustments stem from asset-price volatility. Asset prices in euro-candidate countries are highly correlated with bank lending, which is strongly influenced by high foreign bank participation in domestic credit markets (Gabrisch, 2010). Substantial credit booms spurred by foreign banks in these countries can threaten the macroeconomic and financial stability of the region. It seems, therefore, necessary to enact regulations to control the excessive leverage of banks, particularly foreign-controlled ones, that has engendered pro-cyclical effects.

The third component is international collaboration. In hindsight, the extreme risks of financial variables arise from asset-price bubbles generated not only by domestic factors, but also transmitted through external spillovers. Owing to the international transmission of shocks, international coordination of these policies is crucial, particularly for the euro-candidate countries acting as a group pursuing the joint task of adopting the euro. This is a special requirement for euro-candidates because the engagement of international banks is relatively high in terms of equity and participation in domestic lending. International collaboration should not be limited to emergency situations only, such as the efforts of the Vienna Initiative launched in January 2009 in response to the recent crisis. It should start in seemingly tranquil times simultaneously in host and home countries of international banks. Macro- and micro-prudential regulation and agreements should be mutually coordinated in order to avert possible loopholes and asymmetric effects.

We further advocate that central banks in the euro-candidate countries should take over more responsibility for both monetary and regulatory policies in the future. This is due to pro-cyclical effects of simultaneous actions of banks, households, private companies and the government in both crisis and pre-crisis periods. Private sector expectations in anticipation of the euro adoption are likely to boost both private and public spending, and ultimately improve profitability of financial institutions. Central banks in these countries, as independent institutions, are certainly qualified to steer the smooth euro-convergence process effectively, but they need to account for possible outbreaks of extreme risks in financial markets.

A SUMMARY

Our study investigates extreme tail risks embedded in the behavior of key monetary and financial variables in four euro-candidate countries: the

Czech Republic, Hungary, Poland and Romania. We also include Slovakia, already a euro-member, for comparative purposes. We discuss implications of extreme risks for monetary policies in these countries and provide policy suggestions. These risks exist in every monetary economy. On practical grounds, they stem from leptokurtic distribution of financial variables.

Our empirical investigation of the equity market, interest rate and exchange rate risks reaffirms prevalence of significant tail risks in the examined countries, as implied by the leptokurtic data distribution in the conditional volatility series. We find that extreme tail risks associated with interbank rates are more pronounced than those of equity market indexes and exchange rates. Our tests also show that external contagion effects of the 2007–2009 global financial crisis were very strong, triggering excessive volatility in all financial markets of the euro-candidate countries. Evidently, these countries face a continuous challenge of enhancing financial stability and institutional resiliency against global financial contagion.

Monetary policies can help mitigate extreme tail risks in financial markets of the euro-candidates. In order to accomplish this task, monetary policies should aim at preventing anticipated outbreaks of volatility of key financial variables to counteract excessive upswings of credit cycles. Monetary policies following this concept should be reasonably restrictive and aim at preventing an excessive buildup of debt in the economy. However, they should become decisively expansionary at times of financial distress in order to increase the supply of loanable funds and sustain bank lending. Such flexible policy responses are possible when monetary policy conduct departs from rigid instrument rules and resorts to discretionary prevention of financial market distress. Monetary policies aimed at mitigating extreme tail risks ought to be comprehensive and supplemented with appropriate macro- and micro-prudential regulatory responses as they all comprise a financial stability policy framework. Moreover, monetary and regulatory policies ought to be mutually coordinated in order to eliminate asymmetric responses within a cohesive bloc of countries.

In essence, we advocate a new financial stability framework for the euro-candidates, which includes three basic synchronized components: monetary policy, (macro- and micro-) prudential stability policy and international synchronization.

REFERENCES

Ahrend, R. 2008: *Monetary ease – A factor behind financial crisis? Some evidence from OECD countries*. Economics E-Journal Discussion paper no. 2008-44.