Interest-Rate Volatility in the Baltics: Issues of Measurement and International Contagion

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Abstract
Prior to their entry into the Eurozone, the Baltic countries of Estonia, Latvia, and Lithuania faced a major financial crisis that was brought about by events abroad. This financial risk led to instability in the real economy as well. This study uses monthly data to first model interest-rate volatility as a measure of financial instability before using our preferred volatility measure to test for international spillovers among interest-rate and output fluctuations. Vector Autoregressive (VAR) and Multivariate GARCH methods show that spillovers are more common among Baltic neighbors, particularly involving Latvia, than within individual countries. When European neighbors are added to a multivariate model, Russia's impact is shown to be larger than that of Germany.

Keywords: Interest Rate Volatility, Baltics, Contagion, Vector Autoregression, GARCH.

Introduction

With their recent entry into the Eurozone, the Baltic countries of Estonia, Latvia, and Lithuania have continued their impressive path toward reintegration into Western Europe. At the same time, however, the benefits gained by joining the monetary union must be balanced by certain economic costs. In particular, the use of monetary policy—already restricted by the Baltics' pre-Euro currency-board fixed exchange-rate regimes—will be further constrained, and the three small open economies might be opened to increased financial instability. Without the use of interest rates as a stabilizing tool, such economies might experience larger macroeconomic fluctuations.

With a combined population of less than seven million, the three Baltic countries have an economic importance that far outweighs their size. All three successfully maintained Euro pegs (under the Exchange-Rate Mechanism, or ERM-II) as a prerequisite for joining the common currency, but there were sacrifices involved. Latvia, in particular, chose to maintain its peg during the 2008 Global Financial Crisis and achieve internal balance through a contractionary "internal devaluation" that resulted in output declines and higher unemployment. This policy was much discussed in the United States during debates of austerity versus activist policy. Having met the criteria and joined the Eurozone in 2014 (three years after Estonia and one year before Lithuania), Latvia is now considered to be a macroeconomic "success story."

This study examines how macroeconomic fluctuations are measured and transmitted in and among the three Baltic countries. We begin by calculating volatility using two standard time-series methods and comparing our measures. Then, using Vector Autoregressive (VAR) methodologies, we examine linkages among interest-rate volatility, as well as with output volatility, at three levels. At the first level, we see no within-country spillovers between interest rates and output. At the second level, within the Baltics, there are more connections—particularly involving Latvia. Finally, when large neighbors are considered, Russia plays a much large role than does Germany.

Studies that focus purely on the Baltics are rare in the literature. Many analyses of interest-rate volatility tend to focus on large economies, or emerging markets such as those in Latin America. In general, volatility is often measured using the Autoregressive Heteroskedasticity (ARCH) approach introduced by Engle (1982) and expanded into its Generalized form by Bollerslev (1986). This method calculates the error term of an estimation as a time-varying fuction of past errors. Edwards (1998) uses GARCH approaches on nominal interest rates in Mexico, Argentina and Chile, finding evidence of spillovers. Edwards and Susmel (2003) focus on emerging markets as well. Laopodis (2000, 2001, 2002) finds evidence spillovers among long-run interest rates in the European Monetary System.

Studies of Central Europe and the Baltics often explore interconnections using a variety of methods. Papadamou and Oikonomou (2007) use VAR methods to examine spillovers among interest-rate spreads and the real economy, in eight countries (including the Baltics). They highlight monetary channels as significant transmission mechanisms for Estonia and Latvia. While they do not focus on volatility, Choudhry and Wallace (2008) use cointegration approaches to test for interest-rate convergence for the Baltic countries. Papadamou (2009) applies a GARCH model to examine connections between yield spreads—but not the interest rate—and industrial production in the four Visegrad countries (the Czech Republic, Hungary, Poland, and Slovakia). While they do not include the Baltics, they do find evidence of interconnections between interest rates and output in the region.

Two recent papers focus on these two variables, separately, in Central and Eastern Europe. Hegerty (2011) uses a variety of GARCH methods to model volatility and applies mainly univariate approaches to address spillovers among nominal interest rates in a set of ten transition economies. While foreign interest-rate variability is included as an additional variable in each univariate specification, output is not included, however. Hegerty (2012) does focus only on output variability—but not interest rates—in nine CEE economies (including Latvia and Lithuania, but not Estonia). Both studies find evidence of spillovers, but not between the two variables together.

This study looks for such transmission using time-series methods. It proceeds as follows. Section II outlines the empirical methodology. Section III discusses the results. Section IV concludes.

Methodology

This study uses monthly data from the International Financial Statistics (IFS) of the International Monetary Fund. The sample period begins in 1998, but our time-series methods result in a loss of 12 observations, so our analysis begins in October 1999. Because Euro accession means that countries no longer have a national policy interest rate, we end our sample in January 2014 (Latvia's entry into the Eurozone).

We use nominal money-market rates for Latvia and Lithuania; because Estonia had joined the Euro during our study period we use the deposit rate in that case. We also use monthly series of industrial production to proxy GDP; these are deseasonalized using the Census-X12 procedure. In addition, we use time series of German industrial production and Eurozone money market rates, as well as both series for Russia. We then take natural logs of all series (except Euro interest rates, which briefly took on negative values during the recent crisis) and difference these log series. We thus analyze interest rates (levels and log changes) and output (log changes) for five countries: The three Baltic nations and two European neighbors.

We begin by confirming that our series are stationary using the Phillips-Perron (1998) test. Since we reject the null of nonstationarity (where the series mean rises or falls over time) for all differenced series below, we proceed with the first-differenced series. Next, we generate two different measures of time-varying volatility. As is described in detail by Bahmani-Oskooee and Hegerty (2012), there are a number of competing measures and none has become "standard" in the literature. Since each of our time series has only about 170 observations, we do not apply any univariate GARCH methods (which require hundreds of observations). Instead, we choose other variance-based procedures.
In the first, we generate moving standard deviations over rolling 12-month windows:

$$RVOL = \sqrt{\frac{\left(\sum_{j=1}^{12} \Delta \ln r_{t+1-j} - \Delta \ln r_{r-j}\right)^2}{11}} \quad \text{(1a).}$$

In the second, we estimate a rolling AR(1) equation for each series over 12-month windows:

$$\Delta \ln r_{i,t} = c + \rho \Delta \ln r_{i,t-1} + \varepsilon_t \quad \text{(1b)}$$

and use the regression standard errors as a measure of variance. We generate a total of 20 volatility series: Two measures for five countries, for both interest rates and output. While we briefly discuss the first method, we use the second for the bulk of our empirical analysis.

Once we have described the time-series properties of our variance series, we proceed to test for international spillovers using a number of time-series econometric techniques. First, we conduct bivariate Granger causality tests for the interest-rate and output volatility series for each of the three Baltic countries separately. This shows whether the addition of a variable to a time-series regression adds to its explanatory power; if so, we can say that the new variable "Granger causes" the original variable. Rejecting the null hypothesis of no causality suggests that output volatility affects interest-rate volatility, or vice-versa. The lag length of each vector is chosen by minimizing the Schwarz goodness-of-fit criterion.

We then use this test's multivariate extension on larger vectors that include interest-rate and output volatility for Estonia, Latvia, and Lithuania, as well as for a European partner (eight variables in total). Two separate vectors are estimated, one with Germany and one with Russia. This will allow us not only to see whether interest-rate volatility in one country affects the same variability in a neighboring country, but also to test for connections between interest rates and output.

We also generate Impulse-Response Functions, which plot the time path of the response of one variable after a shock to another. We choose the Generalized VAR methodology of Pesaran and Shin (1998) over the more traditional, "orthogonal" model of Sims (1980) because Generalized IRFs are insensitive to the ordering of the variables in the VAR and do not affect one another endogenously. If the time path of the response is more than two standard errors from zero, we can say that the response to the shock is significant. While there are eight variables in each VAR, we will focus only on Baltic responses to German or Russian shocks.

Finally, following Laopodis (2000, 2001, 2002) or Hegerty (2011), we conduct a Multivariate GARCH analysis of interest rates and output growth in four countries simultaneously, Our mean equation is an AR(1), as in Equation 2(a), while our variance series is a GARCH(1,1) as in Equation (2b). Each error term is therefore affected by the other countries' lagged error terms, and likewise, the variance series are influenced the same way as well. Finally, we calculate constant conditional correlations between the variances of each pair of variables, as in Equation (2c).

$$\Delta \ln r_{i,t} = c + \rho_i \Delta \ln r_{i,t-1} + \varepsilon_t \quad \text{for all i} \qquad (2a)$$

$$\ln \sigma_{i,t}^2 = \alpha_{i,0} + \sum_{j=1}^{8} \left(\alpha_{i,j} \phi_i \varepsilon_{i,t-1}^2 + \beta_{i,j} \ln \sigma_{j,t-1}^2 \right) \quad \text{for all i, j} \qquad (2b)$$

$$\sigma_{i,j,t} = \gamma_{i,j} \sigma_{i,t} \sigma_{j,t} \qquad \text{for all i, j; i} \neq \text{j} \qquad (2c).$$

This approach will give us a more advanced way of looking for volatility spillovers from country to country, and between the financial sector and the real economy. Our findings are presented below.

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Results

Figure 1 (in appendix) shows our three (untransformed) interest-rate series. Estonia's lending rate is by definition higher than Latvia's and Lithuania's money market rates, but volatility (which will be generated using changes logs, which remove level effects) is present for all. In particular, Latvia experiences a "spike" during the crisis period in 2009.

Figure 2 depicts the growth rate (log changes) in the Baltic countries' indices of industrial production. Period of high growth (the mid 2000s) are followed by sharp declines a few years later, but it is clear that there is volatility throughout the sample period. Our goal is to test empirically whether these fluctuations are related to one another.

Our Phillips-Perron stationarity test results are provided in Table 1 (in the Appendix). While some interest rates are stationary in levels, not all are. All series are stationary in log differences, however, so this transformation is used throughout the study. Since industrial production is already depicted in log changes, it is stationary for all countries and no test results are provided.

Next, we generate our two separate volatility series for each country. The Baltic series are shown in Figure 3. The two measures clearly capture the same events—stability in the middle of the sample, but higher variability earlier and later—and each country's pair exhibits a high degree of comovement. Based on past studies, we choose the AR(1) error method for all subsequent analysis. Figure 3 also shows the relevant variance series for the three Baltic nations' growth rates of industrial production.

We next test for spillovers. We begin with our bivariate Granger causality tests, which look for within-country connections between interest rates and output, and are depicted in Table 2. Here, perhaps surprisingly, we see no significant spillovers for any of the three countries. All test statistics have p-values above the critical value required to reject the null hypothesis of no significant impact.

Our multivariate Granger causality/block exogeneity tests, provided in Table 3, show more evidence of contagion, particularly within the Baltic. Some effects form interesting pairs. Estonian output affects Latvian interest rates, and Estonian interest rates affect Latvian output, at a 5% significance level. In addition, Latvian interest-rate volatility spills over to Lithuanian output volatility, and Lithuanian interest-rate volatility spills over to Latvian output volatility. This is particularly true in the specification that includes Russian variables, but clearly Latvia is both an important source of, and recipient of, volatility spillovers. While Germany (and the EU) appear to have no effects on the Baltics, Russian interest-rate volatility spills over to Lithuanian output volatility, and Estonian output is affected by Russian output.

The relative influence of Russia as compared to Germany is confirmed by the IRFs in Figure 4. No German IRF is significant, but Russia's impact on Estonia and Lithuania is depicted as a short-run positive increase that decays after a few months. This suggests that recent events in Russia, including Western sanctions and oil-price declines, have the potential to spread westward and affect the Baltic region.

Finally, our Multivariate GARCH results are provided in Table 4. While the mean equation estimates, ARCH coefficients, and GARCH coefficients are all provided, here we focus on the GARCH coefficients (volatility spillovers), and mainly on the conditional correlations. We see evidence of transmission in many cases, both within-country and between countries. This evidence is somewhat stronger than was the case when VAR methods were used.

When we examine the GARCH coefficients, we see that German interest rates spill over to the Baltics much more than does German output. Latvia appears to be most affected by its Baltic neighbors; all of its output coefficients and all but one of its interest-rate coefficients are significant. Lithuania is somewhat less affected, followed by Estonia. The conditional correlations show Latvia's variables to be closely tied to its neighbors; four of the six possible pairs have significant coefficients. Again, only one German pair—German output and Estonian output—have a significant correlation.

Many results are similar when we consider the Russian specification, except that the within-Baltic effects appear to be somewhat weaker. Latvia's links, particularly when we consider the conditional correlations, are still strong, and Russia's impact is much stronger than was the case for Germany. Russian interest-rate risk is tied to Estonian output volatility, and Russian output volatility is significantly correlated with variance in all three Baltic countries' output series. We again conclude, therefore, that within the Baltic, Latvia's economy is closely tied to its neighbors, and that Russia serves as a significant source of shocks to the region.

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Conclusion

The Global Financial crisis that began in 2008 show how international events could easily spread to the Baltic countries of Estonia, Latvia, and Lithuania. Through policy choices partially related to the regions' currency pegs to the Euro, financial volatility translated to sharp swings in output. While these policies were successful and all three countries joined the Euro within a few years, the loss of an independent monetary policy introduces additional channels of macroeconomic volatility transmission.

This study uses time-series econometric methods to investigate the transmission of interest-rate volatility, as well as output volatility, within the region. This is done at three levels: within-country, within the Baltic region, and within Europe. We first use a pair of statistical methods to measure interest-rate volatility, and thus financial risk, from 1999 to 2014. Moving standard deviation and AR(1) errors both produce similar series, while we do not use GARCH techniques due to our fairly short sample size. Using the AR(1) measure, the then use a set of Vector Autoregressive (VAR) methods to examine spillovers among interest-rate variability and output variability for the three Baltic countries, as well as Germany and Russia.

Bivariate Granger causality tests show no spillovers between each country's interest-rate and output volatility series separately, but the multivariate version of the test (including both volatility series for four countries, together) show international spillovers. In particular, Latvia serves both as a source of and as a recipient of spillovers. International spillovers originating in Russia are much stronger than those that emanate from Germany; this is confirmed via our Generalized Impulse-Response Functions. Performing a Multivariate GARCH analysis in an eigh-variable system confirms these findings.

These results should help make the case to policymakers that Euro membership, which further ties the Baltic region to the German-dominated bloc, might not completely insulate the Baltic region from international macroeconomic spillovers. Events in Russia - both economic as well as political - have great potential to destabilize the region. Both the financial sector, proxied by interest-rate volatility, and the real economy are vulnerable. At the same time, the individual Baltic countries form an integrated economic space, so policymakers must also be wary of shocks originating in the economies of their smaller neighbors.

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Appendixes

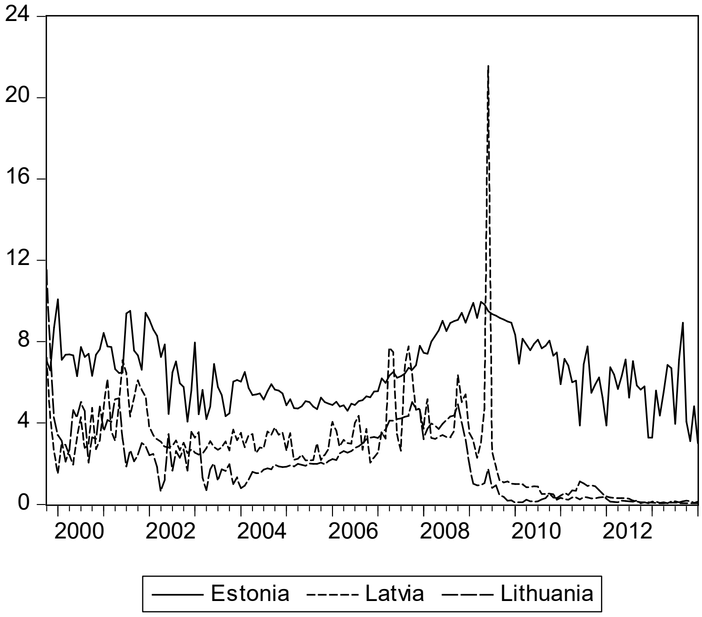

Fig. 1. Monthly Nominal Interest Rates, 1999-2014.

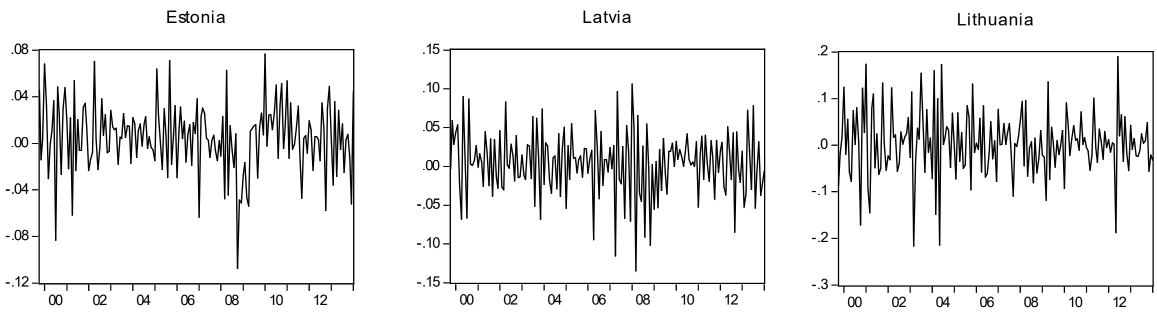

Fig. 2. Monthly Industrial Production Growth Rates, 1999-2014.

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Table 1: Phillips-Perron Stationarity Test Results (p-values in parentheses).

Log interest rates	Levels	1st Differences
Estonia	-4.988 (0.000)	-26.497 (0.000)
Latvia	-0.438 (0.899)	-17.030 (0.000)
Lithuania	-1.737 (0.411)	-15.406 (0.000)
EU	-1.046 (0.736)	-6.594 (0.000)
Germany	-4.307 (0.001)	-16.200 (0.000)

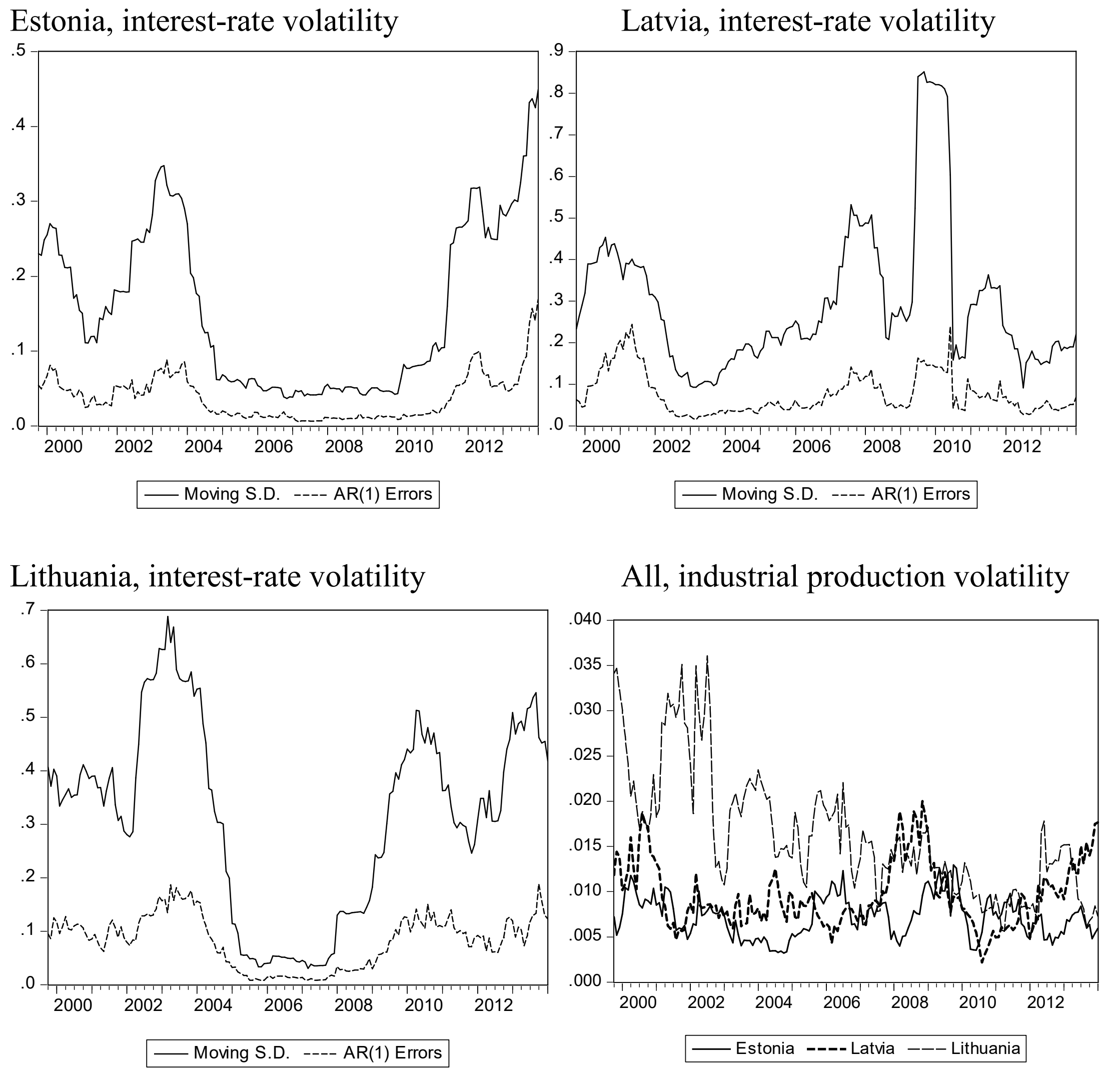

Fig. 3. Baltic Volatility Series, 1999-2014.

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Table 2. Bivariate Granger Causality Test Results (p-values in parentheses).

	Estonia	Latvia	Lithuania
YVOL→RVOL	0.017 (0.896)	2.637 (0.268)	0.006 (0.940)
RVOL→YVOL	2.404 (0.121)	2.975 (0.226)	0.233 (0.629)

Table 3. Multivariate Granger Causality Test Results (p-values in parentheses).

Panel A: Including Germany						
Excluded	Estonia, RVOL	Estonia, YVOL	Latvia, RVOL	Latvia, YVOL	Lithuania, RVOL	Lithuania, YVOL
Estonia, RVOL		0.796 (0.372)	0.928 (0.335)	4.631 (0.031)	0.153 (0.695)	1.350 (0.245)
Estonia, YVOL	0.470 (0.493)		5.555 (0.018)	0.001 (0.974)	1.393 (0.238)	0.141 (0.707)
Latvia, RVOL	0.304 (0.581)	0.094 (0.759)		0.013 (0.909)	0.108 (0.742)	2.616 (0.106)
Latvia, YVOL	0.767 (0.381)	0.117 (0.732)	0.793 (0.373)		0.008 (0.930)	0.935 (0.334)
Lithuania, RVOL	2.811 (0.094)	0.789 (0.374)	0.362 (0.548)	2.760 (0.097)		0.683 (0.409)
Lithuania, YVOL	3.780 (0.052)	0.129 (0.719)	0.398 (0.528)	0.573 (0.449)	0.093 (0.761)	
EU, RVOL	1.272 (0.259)	2.635 (0.105)	1.179 (0.278)	0.098 (0.755)	0.357 (0.550)	0.182 (0.670)
Germany, YVOL	0.037 (0.847)	0.075 (0.785)	2.221 (0.136)	1.482 (0.224)	0.024 (0.876)	0.018 (0.893)
All	8.879 (0.262)	7.573 (0.372)	13.438 (0.062)	9.326 (0.230)	3.569 (0.828)	3.831 (0.799)
Panel B: Including Russia						
Excluded	Estonia, RVOL	Estonia, YVOL	Latvia, RVOL	Latvia, YVOL	Lithuania, RVOL	Lithuania, YVOL
Estonia, RVOL		1.290 (0.256)	0.108 (0.742)	6.283 (0.012)	0.000 (0.992)	3.209 (0.073)
Estonia, YVOL	0.261 (0.609)		4.518 (0.034)	0.128 (0.720)	1.838 (0.175)	0.002 (0.962)
Latvia, RVOL	0.853 (0.356)	0.023 (0.880)		0.064 (0.801)	0.265 (0.607)	4.569 (0.033)
Latvia, YVOL	0.940 (0.332)	0.929 (0.335)	0.692 (0.406)		0.058 (0.810)	0.622 (0.430)
Lithuania, RVOL	2.118 (0.146)	0.818 (0.366)	0.242 (0.623)	3.977 (0.046)		0.509 (0.476)
Lithuania, YVOL	0.084 (0.772)	0.091 (0.763)	2.283 (0.131)	0.282 (0.596)	2.420 (0.120)	
Russia, RVOL	1.636 (0.201)	3.303 (0.069)	0.849 (0.357)	0.222 (0.638)	2.946 (0.086)	7.865 (0.005)
Russia, YVOL	1.991 (0.158)	14.324 (0.000)	1.616 (0.204)	0.338 (0.561)	0.249 (0.618)	0.524 (0.469)
All	11.548 (0.117)	19.804 (0.006)	13.957 (0.052)	8.222 (0.313)	6.660 (0.465)	13.223 (0.067)

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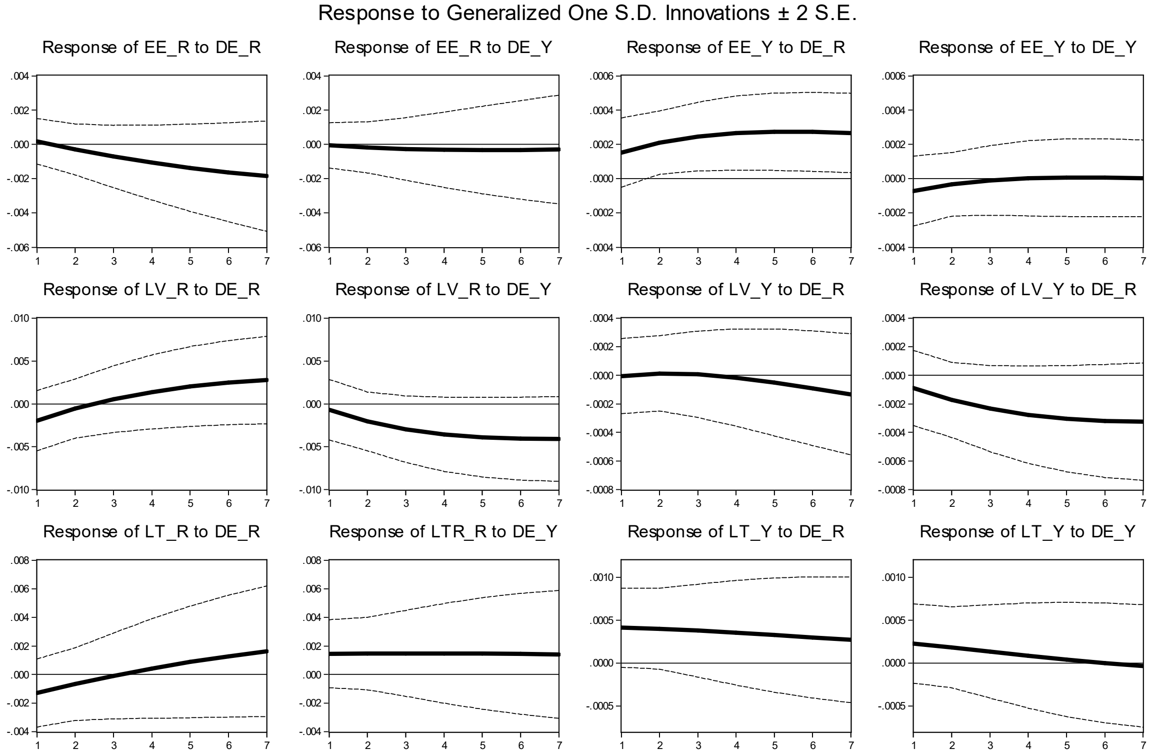
Volatility series, calculated as AR(1) standard errors, Russian specification



Volatility series, calculated as AR(1) standard errors, German specification

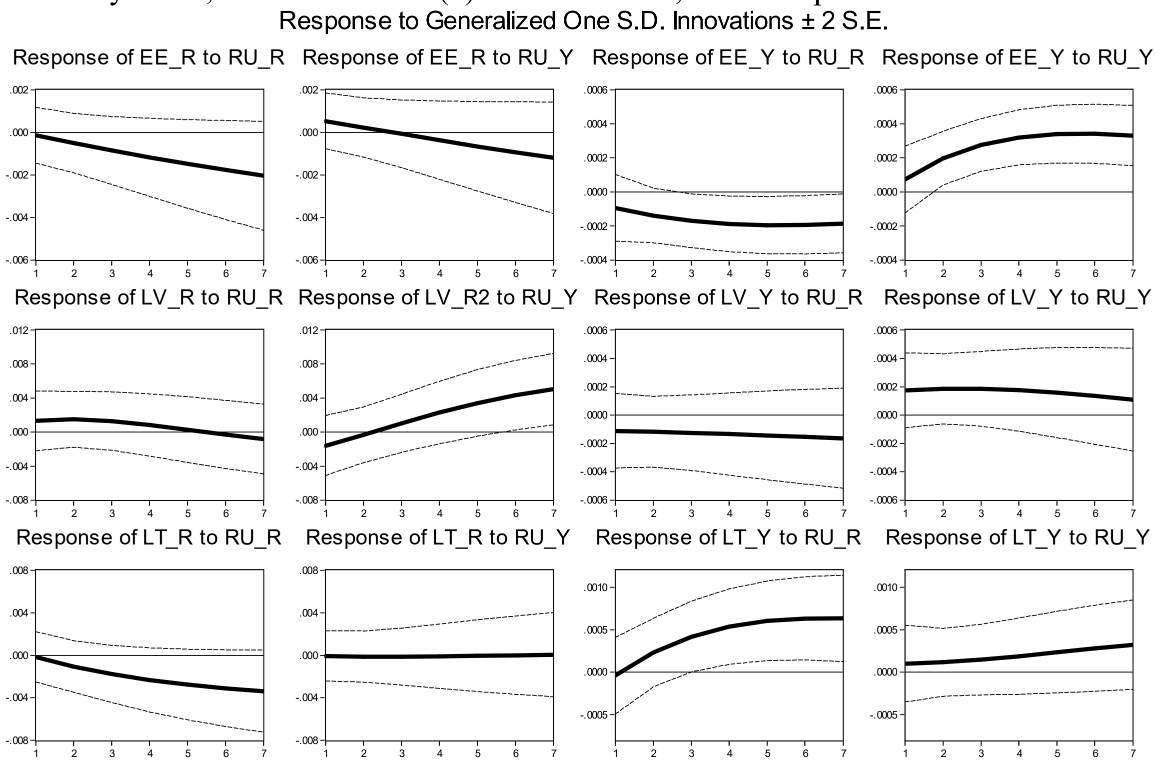


Fig. 4. Generalized Impulse-Response Functions (With ±2 Standard Error Bands).

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Table 4. Multivariate GARCH Test Results (p-values in parentheses).

German Specification

Mean Equation						
C	0.004 (0.446)	0.006 (0.001)	-0.019 (0.185)	0.004 (0.026)	0.031 (0.001)	0.002 (0.417)
AR(1)	-0.300 (0.000)	-0.235 (0.000)	-0.153 (0.038)	-0.437 (0.000)	-0.067 (0.406)	-0.369 (0.000)
GARCH Equation						
Constant						
EE_R	0.000 (0.200)	0.000 (0.701)	0.000 (0.750)	0.000 (0.592)	0.000 (0.560)	0.000 (0.517)
EE_Y	0.000 (0.273)	0.000 (0.030)	0.000 (0.458)	0.000 (0.546)	0.000 (0.420)	0.000 (0.541)
LV_R	0.000 (0.823)	0.000 (0.416)	0.023 (0.001)	0.000 (0.934)	0.001 (0.423)	0.000 (0.998)
LV_Y	0.000 (0.587)	0.000 (0.397)	0.000 (0.810)	0.000 (0.001)	0.000 (0.216)	0.000 (0.594)
LT_R	0.000 (0.673)	0.000 (0.384)	0.002 (0.313)	0.000 (0.255)	0.001 (0.037)	0.000 (0.577)
LT_Y	0.000 (0.895)	0.000 (0.675)	0.000 (0.725)	0.000 (0.049)	0.000 (0.235)	0.001 (0.170)
EU_R	0.000 (0.712)	0.000 (0.306)	-0.001 (0.632)	0.000 (0.303)	0.000 (0.985)	0.000 (0.901)
DE_Y	0.000 (0.438)	0.000 (0.274)	0.000 (0.537)	0.000 (0.883)	0.000 (0.689)	0.000 (0.469)
ARCH						
EE_R	0.235 (0.000)	0.012 (0.835)	0.308 (0.000)	0.108 (0.030)	0.015 (0.880)	0.021 (0.726)
EE_Y	-0.012 (0.802)	0.046 (0.07)	0.072 (0.158)	0.100 (0.001)	0.101 (0.139)	0.082 (0.127)
LV_R	0.316 (0.000)	0.040 (0.466)	0.433 (0.000)	0.194 (0.001)	0.430 (0.000)	0.280 (0.001)
LV_Y	0.112 (0.062)	0.124 (0.000)	0.131 (0.014)	0.098 (0.045)	0.135 (0.125)	0.054 (0.384)
LT_R	-0.014 (0.852)	0.100 (0.089)	0.405 (0.000)	0.087 (0.312)	0.364 (0.000)	0.040 (0.549)
LT_Y	0.008 (0.893)	0.067 (0.123)	0.276 (0.000)	0.039 (0.413)	0.039 (0.562)	0.133 (0.017)
EU_R	0.168 (0.023)	0.005 (0.82)	0.175 (0.000)	0.040 (0.372)	0.102 (0.172)	0.012 (0.782)
DE_Y	0.219 (0.007)	0.130 (0.010)	0.386 (0.000)	0.158 (0.003)	0.360 (0.000)	0.070 (0.367)
GARCH						
EE_R	0.798 (0.000)	0.772 (0.176)	0.426 (0.029)	0.753 (0.000)	0.677 (0.192)	0.732 (0.039)
EE_Y	0.917 (0.000)	0.838 (0.000)	0.653 (0.001)	0.775 (0.000)	0.693 (0.000)	0.775 (0.000)
LV_R	0.360 (0.103)	0.540 (0.096)	0.411 (0.000)	0.446 (0.000)	0.295 (0.046)	0.305 (0.349)
LV_Y	0.698 (0.000)	0.657 (0.000)	0.502 (0.001)	0.669 (0.000)	0.604 (0.000)	0.765 (0.029)
LT_R	0.699 (0.302)	0.522 (0.17)	0.271 (0.053)	0.564 (0.006)	0.731 (0.000)	0.635 (0.243)
LT_Y	0.714 (0.740)	0.521 (0.036)	0.284 (0.348)	0.722 (0.000)	0.665 (0.002)	0.612 (0.001)
EU_R	0.691 (0.000)	0.775 (0.000)	0.463 (0.013)	0.813 (0.000)	0.737 (0.000)	0.576 (0.301)
DE_Y	0.093 (0.724)	0.416 (0.128)	0.280 (0.106)	0.108 (0.709)	0.136 (0.462)	0.287 (0.616)

Constant Conditional Correlations

	EE_Y	LV_R	LV_Y	LT_R	LT_Y	EU_R	DE_Y
EE_R	-0.063 (0.400)	-0.014 (0.819)	-0.138 (0.039)	-0.08 (0.288)	-0.036 (0.571)	0.039 (0.512)	0.033 (0.704)
EE_Y		0.081 (0.414)	0.176 (0.032)	0.103 (0.314)	0.093 (0.208)	0.222 (0.123)	0.212 (0.009)
LV_R			-0.043 (0.64)	0.155 (0.025)	-0.015 (0.837)	-0.110 (0.340)	-0.054 (0.448)
LV_Y				-0.055 (0.559)	0.249 (0.001)	-0.007 (0.915)	0.042 (0.608)
LT_R					-0.063 (0.371)	0.027 (0.720)	0.093 (0.280)
LT_Y						0.029 (0.665)	-0.098 (0.156)
EU_R							0.076 (0.402)

AIC = -17.813

Hegerty S. 2015. Interest-Rate Volatility in the Baltics: Issues of Measurement and International Contagion. *Eastern European Business and Economics Journal* **1**(1): 12-27.

Russian Specification

	EE_R	EE_Y	LV_R	LV_Y	LT_R	LT_Y
Mean Equation						
C	0.007 (0.285)	0.006 (0.002)	-0.024 (0.233)	0.004 (0.075)	0.024 (0.047)	0.003 (0.25)
AR(1)	-0.295 (0.000)	-0.127 (0.001)	-0.137 (0.149)	-0.368 (0.000)	-0.075 (0.387)	-0.395 (0.000)
GARCH Equation						
C						
EE_R	0.000 (0.276)	0.000 (0.899)	0.001 (0.827)	0.000 (0.961)	0.000 (0.739)	0.000 (0.999)
EE_Y	0.000 (0.576)	0.000 (0.192)	0.000 (0.840)	0.000 (0.938)	0.000 (0.863)	0.000 (0.904)
LV_R	0.001 (0.483)	0.000 (0.722)	0.025 (0.002)	0.000 (0.896)	0.002 (0.755)	0.000 (0.968)
LV_Y	0.000 (0.773)	0.000 (0.637)	0.000 (0.941)	0.000 (0.044)	0.000 (0.905)	0.000 (0.775)
LT_R	-0.001 (0.327)	0.000 (0.327)	0.002 (0.515)	0.000 (0.700)	0.001 (0.182)	0.000 (0.811)
LT_Y	0.000 (0.952)	0.000 (0.560)	0.000 (0.654)	0.000 (0.196)	0.000 (0.276)	0.001 (0.122)
RU_R	0.000 (0.941)	0.000 (0.490)	-0.001 (0.476)	0.000 (0.715)	0.001 (0.687)	0.000 (0.173)
RU_Y	0.000 (0.099)	0.000 (0.251)	0.000 (0.707)	0.000 (0.039)	0.000 (0.687)	0.000 (0.121)
ARCH						
EE_R	0.260 (0.000)	0.063 (0.881)	0.337 (0.406)	0.113 (0.738)	0.146 (0.673)	0.049 (0.855)
EE_Y	-0.019 (0.714)	0.064 (0.108)	0.132 (0.595)	0.108 (0.562)	0.122 (0.68)	0.088 (0.738)
LV_R	0.368 (0.000)	0.141 (0.169)	0.447 (0.016)	0.167 (0.599)	0.410 (0.199)	0.306 (0.198)
LV_Y	0.097 (0.032)	0.12 (0.083)	0.167 (0.525)	0.107 (0.458)	0.166 (0.563)	0.067 (0.661)
LT_R	0.130 (0.310)	0.138 (0.060)	0.389 (0.018)	0.185 (0.163)	0.395 (0.001)	0.139 (0.724)
LT_Y	0.009 (0.910)	0.079 (0.109)	0.308 (0.001)	0.060 (0.078)	0.134 (0.109)	0.135 (0.035)
RU_R	0.123 (0.082)	0.067 (0.097)	0.149 (0.149)	0.086 (0.148)	0.136 (0.436)	0.048 (0.472)
RU_Y	0.235 (0.017)	0.18 (0.077)	0.500 (0.331)	0.305 (0.180)	0.408 (0.192)	0.296 (0.001)
GARCH	EE_R	EE_Y	LV_R	LV_Y	LT_R	LT_Y
EE_R	0.801 (0.000)	0.77 (0.629)	0.453 (0.422)	0.728 (0.397)	0.621 (0.542)	0.747 (0.623)
EE_Y	0.879 (0.000)	0.848 (0.000)	0.594 (0.457)	0.789 (0.001)	0.718 (0.273)	0.732 (0.471)
LV_R	0.412 (0.042)	0.530 (0.137)	0.404 (0.008)	0.462 (0.557)	0.436 (0.389)	0.356 (0.418)
LV_Y	0.757 (0.000)	0.632 (0.004)	0.463 (0.341)	0.691 (0.000)	0.558 (0.623)	0.722 (0.271)
LT_R	0.602 (0.125)	0.567 (0.052)	0.386 (0.095)	0.596 (0.002)	0.742 (0.000)	0.638 (0.560)
LT_Y	0.730 (0.769)	0.654 (0.006)	0.380 (0.087)	0.700 (0.000)	0.687 (0.000)	0.612 (0.000)
RU_R	0.793 (0.000)	0.864 (0.000)	0.537 (0.050)	0.705 (0.003)	0.726 (0.011)	0.704 (0.000)
RU_Y	0.511 (0.003)	0.465 (0.017)	0.370 (0.208)	0.484 (0.000)	0.000 (0.032)	0.439 (0.006)

Constant Conditional Correlations	EE_Y	LV_R	LV_Y	LT_R	LT_Y	RU_R	RU_Y
EE_R	-0.062 (0.409)	-0.015 (0.813)	-0.129 (0.060)	-0.081 (0.284)	-0.032 (0.609)	0.052 (0.465)	-0.077 (0.298)
EE_Y		0.082 (0.401)	0.173 (0.034)	0.102 (0.318)	0.092 (0.215)	-0.177 (0.011)	0.253 (0.003)
LV_R			-0.044 (0.638)	0.157 (0.023)	-0.015 (0.839)	-0.083 (0.247)	-0.115 (0.131)
LV_Y				-0.057 (0.555)	0.243 (0.001)	-0.070 (0.37)	0.418 (0.000)
LT_R					-0.059 (0.401)	0.009 (0.927)	-0.054 (0.575)
LT_Y						-0.157 (0.038)	0.180 (0.006)
RU_R							-0.024 (0.780)

AIC = -15.482