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The VARying Effect of Foreign Shocks in Central and Eastern Europe

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Abstract

This paper investigates the impact of international shocks – interest rate, commodity price and industrial production shocks – on key macroeconomic variables in ten Central and Eastern European (CEE) countries by using near-VAR models and monthly data from the early 1990s to 2009. In contrast to previous work, the empirical analysis takes explicit account of the possibility of (multiple) structural breaks in the underlying time series. We establish strong evidence of structural breaks, particularly along the years 2007 and 2008, suggesting the very relevant impact of the recent global crisis on CEE economies. Moreover, our results suggest that the way how countries react to world commodity price shocks is related to the underlying economic structure and the credibility of the monetary policy. We also find that some countries like Slovakia and Slovenia – already euro area members – react stronger to foreign industrial production shocks than other countries and that the responses to such shocks are strongly correlated for selected CEE countries. Nevertheless, our results also shed light on substantial differences in responses to foreign interest rate shocks that originate from the US or the euro area.

Keywords: monetary policy; foreign shocks; multiple structural breaks; near-VAR model; CEE economies.

JEL: E43, E50, E52, C22, O52

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1. Introduction

Macroeconomic effects of monetary policy shocks in transition economies have long been at the centre of policy debate in Central and Eastern European (CEE) countries. The literature, however, does not provide consensus on the sign and size of responses to monetary policy shocks in CEE countries.[1] Results even appear occasionally inconsistent for the same country. For instance, a permanent or a temporary fall/rise in the CPI inflation rate can be observed after a monetary policy contraction for a specific country. Similarly, output may rise, fall or exhibit a humped shape in the aftermath of a monetary policy shock. Therefore, the puzzle is not the usual price or exchange rate puzzle so often analysed in the literature, but rather the large divergence of the results. Elbourne and de Haan (2004) highlight that the main sources of cross-study heterogeneity in results are the following: a) the use of different time periods; b) the different schemes applied to identify monetary policy shocks; and c) the utilization of diverse sets of variables.[2] We would add to this list a fourth item: d) the failure to take account of structural breaks in the underlying time series.

The impact of shocks different from monetary policy shocks in CEE countries has received comparatively less attention (see Frenkel and Nickel, 2005). Nevertheless, the question of how CEE economies respond to foreign commodity and industrial production shocks is of utmost importance when considering that CEE countries are required to adopt the euro in the future. This means that CEE economies have to absorb foreign shocks without relying on independent monetary and exchange rate policies. Furthermore, the more the responses to foreign shocks are correlated, the easier it is to conduct a common monetary policy.[3]

The contribution of this paper to the existing literature is twofold. First, we consider in our model the possibility of (multiple) structural breaks in selected macroeconomic variables. These structural breaks could be potentially related to factors like the strong restructuring process during the transition period, domestic and international financial crisis occurred in the past or more recently, among others. Second, we analyze, in addition to monetary policy shocks, the role of other foreign shocks (commodity price shocks and

[1] See, *e.g.*, Ganev *et al.*, 2002; Maliszewski, 2002; Bitans *et al.*, 2003; Arnoštova and Hurník, 2004;; Jarocinski, 2005; Darvas, 2006; Égert *et al.*, 2007; among others. See also Égert and MacDonald (2009) for a survey.

[2] Héricourt (2006) also argues that it does matter whether one employs industrial production or GDP figures for output.

[3] See Orlowski (2004, 2008) for analyses related to the design of an appropriate policy framework in select CEE countries for a successful future convergence to the euro.

industrial production shocks coming from both the euro area and the US) that may hit these economies, and we examine the degree of response heterogeneity to the shocks.

The paper is structured as follows. Section 2 describes the methodology and data. Section 3 sketches out the expected effects of the foreign shocks on selected macroeconomic variables, and subsequently presents the estimation results. Section 4 presents the degree of response heterogeneity to the shocks studied. Section 5 finally summarises and draws policy conclusions.

2. Econometric Methodology and Data Issues

2.1. Detecting Multiple Structural Breaks

Structural breaks in key macroeconomic variables have important implications for macro-econometric modeling. This is very likely to be a serious issue in countries that have undergone economic restructuring. Thus, we first analyze the existence of (multiple) structural breaks in the variables used for this study in order to incorporate such possible breaks in our model.

The literature provides several techniques for testing and locating structural breaks in the intercept and trend (see, *e.g.*, Bai and Perron, 1998, 2003a, 2003b, 2006), but only few are able to consider breaks in the variance (see Inclán and Tiao, 1994, McConnell and Pérez-Quirós, 2000, Wang and Zivot, 2000, and Herrera and Pesavento, 2005). The possibility of the existence of several breaks in the time series considered leads us not to perform the McConnell and Pérez-Quirós (2000) methodology, which has been developed to detect only the existence of one break in volatility. Furthermore, the possible existence of breaks in intercept/trend and variance at the same time leads us not to use the Inclán and Tiao (1994) or Herrera and Pesavento (2005) methodologies. Therefore, the methodology that allows us to detect multiple structural breaks in the intercept, trend and variance at the same time is that developed by Wang and Zivot (2000). Therefore, we apply this latter methodology to detect the number of breaks and to identify break dates. Once we identify the dating of breaks, we construct structural change dummies for each variable.

Wang and Zivot (2000) consider a segmented deterministically trending and heteroskedastic autoregressive model

$$y_t = a_t + b_t t + \sum_{i=1}^{p} \varphi_i y_{t-i} + s_t u_t, \qquad (1)$$

for $t = 1,2,\ldots,T$ where $u_t|\Omega_t \sim iidN(0,1)$ and Ω_t denotes the information set at time *t*. They assume that parameters a_t, b_t and s_t are subject to $m<T$ structural changes, *m* initially known, with break dates $k_1, k_2, \ldots, k_m$, $1 < k_1 < k_2 < \ldots < k_m \leq T$, so that the observations can be separated into *m*+1 regimes. Let $k = (k_1, k_2, \ldots, k_m)$ denote the vector of break dates. For each regime i $(i = 1,2,\ldots,m+1)$, the parameters a_t, b_t and s_t are given by: $a_t = \alpha_i$, $b_t = \beta_i$, $s_t = \sigma_i \geq 0$ for $k_{i-1} \leq t < k_i$ with $k_0 = 1$ and $k_{m+1} = T+1$.

Let I_A denote an indicator variable such that I_A is equal to one if the event *A* is true and zero otherwise. Then (1) can be rewritten as

$$y_t = \sum_{i=1}^{m+1} I_{\{k_{i-1} \leq t < k_i\}} (\alpha_i + \beta_i t) + \sum_{i=1}^{p} \phi_i y_{t-i} + s_t u_t \tag{2}$$

Given the assumption of normality of the errors u_t, Wang and Zivot (2000) obtain the likelihood function of (2). The estimation of the model is possible by using the Gibbs sampler. Wang and Zivot (2000) determine the number of breaks and the form of the breaks on the basis of the Bayesian Information Criterion (BIC).[4]

2.2. Near-VAR Model

CEE countries are small open economies for which foreign shocks can be very important. For this reason, we use four variables for the domestic sector (Y_t) and three variables for the foreign sector (X_t^*), and we assume that there is no feedback from variables of the CEE countries to the foreign variables.[5] Specifically, we consider the following *pth*-order near-VAR model for each country under study:[6]

$$\begin{bmatrix} Y_t \\ X_t^* \end{bmatrix} = \begin{bmatrix} \lambda_0^1 \\ \lambda_0^2 \end{bmatrix} + \begin{bmatrix} \lambda_{11} & \lambda_{12} \\ 0 & \lambda_{22} \end{bmatrix} \begin{bmatrix} D_t \\ D_t^* \end{bmatrix} + \sum_{j=1}^{p} \begin{bmatrix} \Phi_j^{11} & \Phi_j^{12} \\ 0 & \Phi_j^{22} \end{bmatrix} \begin{bmatrix} Y_{t-j} \\ X_{t-j}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{bmatrix}, \tag{3}$$

where Y_t denotes the vector of country-specific variables; $X_t^* = (P_t^W, X_t)'$ is a vector of foreign variables, with P_t^W being a world commodity price index and X_t a vector that contains other foreign variables; D_t is the vector of corresponding structural change dummies for domestic variables under consideration; D_t^* is the vector of corresponding

[4] The reader is referred to Wang and Zivot (2000) for further discussion of this methodology.
[5] This is a reasonable assumption due to CEE countries are small open economies.
[6] Notice that λ_{22} and Φ_j^{22} are taken to be diagonal.

structural change dummies for foreign variables under consideration;[7] and $\varepsilon_t = (\varepsilon_{1t} \quad \varepsilon_{2t})'$ is the error term.[8]

The vector of domestic variables used here includes the industrial production index (*ip*), the consumer price index (*cpi*), a nominal short-term interest rate (*sr*), and the real effective exchange rate (*reer*): $Y_t = (ip_t, cpi_t, sr_t, reer_t)'$.

Two different specifications for X_t are considered:

1. $X_t = (ip_t^{EA}, sr_t^{EA})'$: Euro area industrial production index and euro area nominal short-term interest rate, respectively.
2. $X_t = (ip_t^{US}, sr_t^{US})'$: US industrial production index and US nominal short-term interest rate, respectively.

All variables but interest rates are seasonally adjusted and expressed in logs. In this paper we do not perform an explicit analysis of the long-run behavior of the economy. By doing the analysis in levels we allow for implicit cointegrating relationships in the data, and still have consistent estimates of the parameters. For further discussion about this issue, see, *e.g.,* Sims *et al.* (1990), Hamilton (1994), and Ramaswamy and Sløk (1998).

We estimate the near-VAR model by maximum likelihood, with the optimal lag length determined by Akaike Information Criterion. Furthermore, shocks are identified through a standard Choleski decomposition with the variables ordered as in Y_t and X_t^*.[9] The underlying assumption is that domestic monetary policy shocks have no contemporaneous impact on output and prices[10] but may affect the effective exchange rate immediately. However, the monetary policy does not respond to contemporaneous changes in the effective exchange rate.[11]

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[7] D_t and D_t^* are step dummies.

[8] We are considering the fact that the effects of foreign shocks would depend on the exchange rate regime by including in D_t the breaks detected in real exchange rates that are explicitly related to changes in exchange rate regime.

[9] Notice that domestic variables do not have any contemporaneous impact on foreign variables, and each variable in X_t^* is excluded from having any contemporaneous impact on the other variables contained in X_t^*.

[10] The argument is that information about prices and output is only available with a lag, since they are not observable within a month.

[11] We also consider an alternative identification scheme that allows for real exchange rates contemporaneous respond to interest rate shocks. The results – which we do not report here due to space constraints – do not differ substantially from the baseline results.

2.3. Elasticities

To quantify the effects of the corresponding shock across countries, we construct three summary measures of impact: a) the maximum elasticity recorded between 1 and 12 months after the shock;[12] b) the average elasticity recorded between 1 and 12 months after the shock (so that single "peaks" have less influence on the impact measure); and c) the elasticity to the corresponding shock after 12 months.

3. Empirical Results

The empirical results are obtained using data from Datastream and the International Financial Statistics of the International Monetary Fund.[13] Data Appendix provides details on data. We use monthly data and choose the sample period to maximize its length.

3.1. Structural Breaks

The results from the Wang and Zivot (2000) test (see Table 1) reveal that most of the variables considered indeed exhibit often more than one break between the early 1990s and 2008/2009.[14] Structural breaks detected can be related to: (a) international financial crises, like the Russian one; (b) domestic financial crisis, such as the Czech koruna crisis in 1997; (c) domestic macroeconomic adjustments, like the one in Hungary in 1995; (d) changes in the nominal exchange rate regime;[15] and (e) the recent global financial crisis. It is worth noting that we have found strong evidence of structural breaks along the years 2007 and 2008 suggesting the very relevant impact of the recent global crisis on CEE economies.

We exploit these breaks to estimate the reaction of domestic industrial production, prices, short-term interest rate, and real effective exchange rate to foreign shocks.

Before looking at the empirical results, it is useful to summarize the expected impact of the shocks studied on the domestic variables.

3.2. Expected Effects of Foreign Shocks

A positive commodity price shock, *i.e.*, an increase in world commodity prices (see Table 2, Panel A): One may think of a positive spillover effect on industrial production in the case of

[12] This maximum elasticity is defined as the smallest variable change registered between 1 and 12 months after the corresponding shock when the expected effect is negative, and it is defined as the largest variable change registered between 1 and 12 months after the shock when the expected effect is positive.
[13] The proxy used for the Latvian industrial production comes from Central Statistical Bureau of Latvia.
[14] We specify a criterion that if two or more breaks are obtained within a very short interval of six months, the set of such breaks is considered as one single break with the interim period being a period of adjustment.
[15] For a further interpretation of located structural breaks see Égert *et al.* (2006).

commodity producing and exporting countries, since higher commodity prices could trigger an increase in the production of commodities. While some of the countries in our sample have substantial agricultural output, none of them have substantial mineral or oil sectors and, consequently, they are net importers of these products. When industrial output relies heavily on commodity inputs, there can be a loss of competitiveness due to higher input prices. Obviously, inflation is expected to increase in the aftermath of commodity price increases as a consequence of an increase in oil prices, in food prices or in the price of diverse goods that contain different minerals. When inflation rises, domestic monetary policy may want to react by increasing interest rates to prevent second and third round effects, and to avoid that these price shocks are incorporated into inflation expectations. Finally, short-term interest rate hikes may lead to an appreciation of the exchange rate. However, in the medium/long term the exchange rate may depreciate to counteract the loss of external competitiveness.

A positive foreign interest rate shock, *i.e.*, a rise in the foreign interest rate (see Table 2, Panel B): To the extent that higher interest rates curb domestic demand and, thus, imports in the foreign country, industrial production may contract due to the contraction of exports. As a result of falling demand, domestic prices may also decrease. The effect on domestic interest rates is ambiguous. Interest rates can either decrease (in an inflation targeting framework if inflation falls) or rise (in the case of exchange rate targeting). Whereas a fall in prices triggered by monetary tightening could lead to a depreciation of the real exchange rate, a rise in interest rates could entail a nominal appreciation in the short run (due to capital inflows) and a nominal depreciation in the long run (as a higher interest rate indicates future nominal depreciations). Which effect overweighs the other becomes then an empirical matter.

A positive foreign shock hitting industrial production (see Table 2, Panel C): Generally, shocks to industrial production are considered as supply-side shocks. However, in the context of the CEE countries, positive shocks to the industrial production of trade partners can also be considered as a demand shock if the trade partner uses inputs coming from CEE countries. Therefore, from the domestic country's perspective, such a shock would boost domestic industrial production to the extent that foreign industrial production uses imported intermediate goods. The impact on inflation is ambiguous and, consequently, the impact on domestic interest rates is also uncertain. Finally, the real effective exchange rate would appreciate because of the improvement in the trade balance.

3.3. Estimated Effects of Foreign Shocks

Let us now turn to the estimation results. Table 3 quantifies the effects of the domestic variables to positive commodity price, foreign interest rate and foreign industrial production shocks for each transition economy,[16] by using the three above-mentioned summary measures of impact (*i.e.*, the maximum elasticity, the average elasticity and the "after" elasticity).[17]

We observe that the impact of *a positive commodity price shock* on industrial production is mixed (Table 3, Panel A). First, whereas industrial production falls after the shock in Lithuania, output increases in the remaining countries. Second, the responses of domestic prices to such a shock are as expected, *i.e.*, prices increase in all countries but Romania. Moreover, price responses generally appear to be of higher magnitude in less developed country – a consequence of the higher shares of energy and foodstuff in their inflation basket. Third, the response of interest rate to the shock is also mixed. We find a positive response in four out of ten countries – a natural outcome of inflation targeting countries eager to prevent second and third round effects, and to avoid the incorporation of such effects into inflationary expectations. This holds true, in particular, for the Czech Republic. However, results are somewhat puzzling for the rest of countries where interest rates decrease. Finally, the outcome for the real exchange rate is in line with expectations, *i.e.*, real exchange rate appreciates in some cases and it depreciates in others.

The response of industrial production to *a positive euro area interest rate shock* (Table 3, Panel B) is negative in all countries except for Czech Republic and Slovenia, and it is very small in magnitude in all cases. The expected reduction in prices occurs in almost all the countries considered. The effects on the other two variables (interest rate and real effective exchange rate) are mixed, with cases where these variables rise and others in which the variables decline. In addition, when we look at US interest rate shocks we obtain similar results (Table 3, Panel C), with Estonia and Hungary showing the main differences.

Let us finally consider the effect of *foreign industrial production shocks* on the domestic variables of the ten CEE countries (Table 3, Panels D and E). The results indicate that industrial production significantly rises everywhere after a positive foreign shock in the same variable. This is in line with expectations. Nonetheless, we find that the reaction to the same shock will be larger if the shock comes from the US than if it comes from the euro area.

[16] An Appendix with all the impulse response functions, along with 95% confidence intervals, for the countries under study is available from the authors upon request.

[17] It should be noted that some results are not statistically significant at the 5% critical level. Nevertheless, although the impulse responses are not statistically significant, the estimations are still economically significant (regarding the signs of effects), and numerically and qualitatively plausible.

The three exceptions to this are Romania, Slovakia and Slovenia, where euro area shocks have larger effects. As expected, results for prices and interest rate vary across countries. Finally, the real exchange rate appreciates after a positive industrial production shock, as it is predicted by the Theory, in six out of ten countries when the shock comes from the euro area, and in seven out of ten countries when the shock comes from US.

4. Similarities and Differences of Reactions to the shocks - Policy Implications for Euro Area Enlargement

The literature on optimal currency areas deals extensively with the question of when countries should form a currency union. The issues raised are a) the extent to which countries' business cycles are synchronised; b) whether countries are hit by asymmetric shocks; and c) how countries in a currency union react to a symmetric shock hitting the whole currency area. These issues emerge because divergence in business cycles, asymmetric shocks and asymmetric responses to shocks imply that the lack of a country-specific exchange rate and monetary policy prohibits the ability to adequately respond to shocks. Indeed, asymmetric shocks can amplify boom and bust cycles, increase macroeconomic volatility and inflict lasting damage on long-term growth.

Against this background, the literature argues that factor (labour and capital) mobility, labour market flexibility, trade openness and similar economic structures help accommodate asymmetric shocks and generate similar responses to symmetric shocks. A relatively recent argument, which elaborates further on similar economic structures, says that intra-industry trade is a key determinant of business cycle harmonisation (Frankel and Rose, 1998). The higher the share of openness and the more important the share of intra-industry trade in total trade flows, the stronger the synchronisation of business cycles because a slowdown or acceleration in a given sector will equally affect both countries. Also, Frankel and Rose (1998) argue that intra-industry trade would secure endogenously business cycle synchronisation. Business cycles may be less correlated today, but if the share of intra-industry trade in total trade is high enough, business cycles will become synchronised in the future.[18]

In this section we perform an additional analysis to develop a more clear impression of the similarities and differences between the dynamic responses of CEE countries to foreign shocks. To do so, we compute the correlation coefficients between the impulse response

[18] See Fidrmuc and Korhonen (2006) for a recent survey on how synchronised CEE countries are with respect to the euro area.

functions of individual countries for each shock under consideration and for all domestic variables (see Table 4).[19] This approach helps reduce the wealth of country-specific empirical results presented in earlier parts of the paper.

Table 4, Panel A, presents the cross-country correlation coefficients of impulse response functions to a positive commodity price shock. This Table reveals that there is a high similarity (positive correlations coefficients and greater than 0.75) in the response of prices for all countries (except for Czech Republic and Romania, where the opposite occurs). In addition, the interest rate responses are very similar between some pairs of countries (Bulgaria and Estonia, Bulgaria and Slovakia, Czech Republic and Estonia, Czech Republic and Slovakia, Hungary and Poland, Hungary and Romania, Latvia and Lithuania, Latvia and Slovenia, Lithuania and Slovenia). Furthermore, there are no clear similarities in the industrial production responses. Finally, the response of the real effective exchange rate is similar for Bulgaria and Slovakia, Latvia and Lithuania, Slovakia and Slovenia, among others.

Results from Table 4, Panels B and C, show the absence of remarkable similarities in the response of domestic variables among CEE economies after a positive foreign interest rate shock.

Finally, results from Table 4, Panels D and E, indicate that we can distinguish three groups of countries depending on their output responses to a positive euro area industrial production shock: a) Estonia, Hungary, Poland, Romania and Slovakia, with similar responses; b) Latvia and Lithuania, whose responses are alike; and c) Bulgaria, Czech Republic and Slovenia, which do not present similarities in their responses to any other transition economy. Regarding the responses of prices, Czech Republic, Estonia, Latvia, Lithuania, Romania, Slovakia and Slovenia behave in a similar way (correlation larger than 0.90). In addition, relevant similarities are not found either in the responses of interest rates or in those of real effective exchange rates following a positive euro area supply side shock. When the shock comes from United States (see Table 4, Panel E), the response of prices is similar: 1) for Bulgaria, Estonia and Hungary; 2) for Czech Republic, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.

[19] This approach has already been used in the literature (see, *e.g.*, Dedola and Lippi 2005; among others).

5. Concluding Remarks

This paper provides new empirical evidence on the impact of foreign shocks in ten CEE countries on the basis of near-VAR models that consider the structural breaks found in the selected macroeconomic series. This econometric specification allows us to disentangle appropriately the effects of world commodity price shocks, foreign monetary policy shocks and shocks in foreign industrial production. Our results show that the impact of commodity price shocks could be dampened by credible monetary policy and a household consumption structure more oriented towards services rather than to basic necessities (food and energy). Our results also imply that countercyclical fiscal policies could counteract negative foreign demand shocks that happened during the 2008/2009 crisis and that forced some countries to carry out fiscal consolidation instead of boosting domestic demand.

Our results clearly indicate that a positive commodity price shock gives rise to higher inflation rates. This finding has two implications. First, this result is more pronounced for countries at a lower stage of development. This is a mechanical response due to the fact that poorer countries have a higher weight on commodity-related items (energy, food) in the CPI basket as poorer households consume relatively more commodity-related items than richer households. This means that economic structure matters in the response to a symmetric shock. Different economic structures can generate asymmetric responses to symmetric shocks. The second implication is that the response to the commodity shock is less pronounced for inflation targeting countries such as the Czech Republic. This means that a credible monetary policy and well-anchored inflation expectations dampens second- and third-round effects of such a shock.

Our results also indicate that a positive shock to euro area industrial production generates a positive response in domestic industrial production. This indicates strong trade links of CEE countries to the euro area. In particular, Slovakia and Slovenia - that joined the euro area in recent years - react particularly strongly to euro area industrial production shocks (and less so to a similar shock coming from the US), indicating that their production structures are well integrated with that of the euro area. Furthermore, we also show that a positive foreign industrial production shock generates comparable responses in output and prices for some CEE countries. Such a synchronisation in the response to industrial production shocks is, without any doubt, encouraging for the suitability of those CEE countries to adopt the euro at a later stage.

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Data Appendix

Table A.1. Periods and Data Sources

Country	Sample period	Industrial production	Prices	Interest rate	Real effective exchange rate
Bulgaria	2000:1-2009:3	Datastream	CPI IFS	Interbank rate IFS	Based on CPI IFS
Czech Rep.	1993:1-2009:7	Datastream	CPI IFS	Money market rate IFS	Based on CPI Datastream
Estonia	1994:1-2008:12	Datastream	CPI Datastream	Deposit rate IFS	Based on CPI IFS
Hungary	1989:1-2009:7	Datastream	CPI Datastream	Treasury bill rate Datastream	Based on CPI Datastream
Latvia	1994:1-2008:12	Industrial Sales Central Statistical Bureau of Latvia	CPI Datastream	Money market rate IFS	Based on CPI Datastream
Lithuania	1994:1-2008:12	Datastream	CPI Datastream	Money market rate Datastream	Based on CPI Datastream
Poland	1991:1-2009:7	Datastream	CPI Datastream	Money market rate Datastream	Based on CPI Datastream
Romania	1995:1-2009:7	Datastream	CPI Datastream	Money market rate Datastream	Based on CPI Datastream
Slovakia	1993:1-2008:11	Datastream	CPI Datastream	Money market rate Datastream	Based on CPI Datastream
Slovenia	1994:1-2008:12	Datastream	CPI Datastream	Money market rate Datastream	Based on CPI Datastream

Notes: (a) IFS: International Financial Statistics of the IMF. (b) United States industrial production and short-term interest rate are from IFS. Euro area industrial production and short-term interest rate are authors' calculations based on weights from Fagan *et. al* (2005) and data from IFS. (c) Commodity prices are from the Commodity Research Bureau. (d) Non-seasonally adjusted series have been seasonally adjusted using the TRAMO-SEAT program.

Table 1. Multiple Structural Breaks, Wang and Zivot (2000)

	Number of Breaks	Dates
Bulgaria 2000:1-2009:3		
bg_ip	2	2002:4, 2007:9
bg_cpi	1	2007:6
bg_sr	2	2005:3, 2008:12
bg_reer	0	-
Czech Republic 1993:1-2009:7		
cz_ip	3	1998:9, 2003:11, 2008:10
cz_cpi	4	1997:6, 1998:9, 2001:4, 2007:10
cz_sr	4	1997:4, 1999:1, 2001:8, 2008:6
cz_reer	2	1996:6, 2007:10
Estonia 1994:1-2008:12		
es_ip	3	1996:6, 1998:7, 2002:12
es_cpi	3	1997:3, 2003:3, 2008:11
es_sr	4	1997:7, 1999:3, 2003:7, 2005:11
es_reer	2	1999:1, 2007:9
Hungary 1989:1-2009:7		
hu_ip	2	1997:2, 2008:2
hu_cpi	2	1995:2, 2006:9
hu_sr	2	1996:5, 2008:10
hu_reer	3	1995:5, 2000:4, 2008:6
Latvia 1994:1-2008:12		
lat_ip	3	1998:6, 1999:7, 2007:11
lat_cpi	3	1995:6, 2003:9, 2007:6
lat_sr	3	1996:12, 2001:12, 2007:3
lat_reer	2	1998:8, 2002:3
Lithuania 1994:1-2008:12		
lit_ip	2	1997:1, 1998:12
lit_cpi	3	1996:3, 2002:2, 2007:7
lit_sr	3	1994:11, 1999:12, 2004:1
lit_reer	2	1998:8, 2005:1
Poland 1991:1-2009:7		
po_ip	3	1998:9, 2005:8, 2008:1
po_cpi	2	1993:9, 2001:5
po_sr	2	1994:5, 2002:3
po_reer	3	2000:11, 2004:4, 2008:8
Romania 1995:1-2009:7		
ro_ip	2	1997:12, 2006:11
ro_cpi	3	1997:3, 1999:2, 2007:8
ro_sr	3	2000:10, 2003:8, 2005:1
ro_reer	1	1998:3
Slovakia 1993:1-2008:11		
sk_ip	2	2002:4, 2004.1
sk_cpi	2	1998:12, 2004:1
sk_sr	1	1998:10
sk_reer	1	1998:8
Slovenia 1994:1-2009:7		
sv_ip	2	2001:8, 2008:10
sv_cpi	1	1999:6
sv_sr	2	1996:9, 2004:3
sv_reer	1	1998:8
United States/Euro area 1989:1-2009:7		
Com	2	1996:9, 2008:1
us_ip	3	2000:11, 2001:11, 2008:8
us_sr	3	1992:7, 2000:12, 2007:7
ea_ip	1	2008:5
ea_sr	3	1995:3, 2002:9, 2008:6

Note. ip: industrial production, cpi: consumer price index, com: commodity, sr: short-term interest rate, reer: real effective exchange rate.

Table 2. Theoretical Effects of Foreign Shocks

Panel A	
Effect of a positive commodity price shock on:	
Industrial production	-
Consumer price index	+
Domestic interest rate	+
Real effective exchange rate	+ or -
Panel B	
Effect of a positive foreign interest rate shock on:	
Industrial production	-
Consumer price index	-
Domestic interest rate	+ or -
Real effective exchange rate	+ or -
Panel C	
Effect of a positive foreign industrial production shock on:	
Industrial production	+
Consumer price index	+ or -
Domestic interest rate	+ or -
Real effective exchange rate	-

Table 3. Elasticity of domestic variables to foreign shocks

		Panel A			*Panel B*			*Panel C*			*Panel D*			*Panel E*		
		Positive commodity price shock			*EA positive interest rate (100 basis points)*			*US positive interest rate (100 basis points)*			*EA positive industrial production shock*			*US positive industrial production shock*		
		Max. 1:12	*Aver. 1:12*	*After 12*	*Max. 1:12*	*Aver. 1:12*	*After 12*	*Max. 1:12*	*Aver. 1:12*	*After 12*	*Max. 1:12*	*Aver. 1:12*	*After 12*	*Max. 1:12*	*Aver. 1:12*	*After 12*
Domestic Output	Bulgaria	0.51*	0.41*	0.51*	-0.06*	-0.04*	-0.06*	-0.02	-0.01	-0.02	0.49*	0.30	0.22	0.53	0.19	0.04
	Czech Rep.	0.18	0.12	0.08	0.05*	0.04*	0.05*	0.08*	0.06*	0.08*	0.51*	0.00	-0.04	-0.93	-0.46	-0.85
	Estonia	0.43*	0.26*	0.43*	-0.01	0.00	-0.01	0.01	0.01	0.01	1.32*	0.86*	1.32*	1.43*	1.04*	1.40*
	Hungary	0.19	0.15	0.19	-0.04*	-0.03*	-0.04	0.05*	0.03	0.01	1.47*	0.98*	1.47*	2.25*	1.13*	2.07*
	Latvia	0.05	0.04	0.04	-0.05*	-0.04*	-0.05*	-0.02	-0.02	-0.02*	2.11*	1.77*	1.84*	2.05*	1.80*	2.00*
	Lithuania	-0.01	0.00	-0.01	-0.07*	-0.06*	-0.06*	-0.07*	-0.06*	-0.06*	2.51*	2.20*	2.36*	2.51*	1.97*	2.25*
	Poland	0.42*	0.34*	0.39*	-0.02	-0.01	-0.02	-0.01	0.01	-0.01	0.77*	0.58*	0.77*	1.63*	1.13*	1.63*
	Romania	0.20	0.09	-0.06	-0.03	-0.01	-0.03	0.05*	0.04*	0.02	0.90*	0.56*	0.90*	0.77*	0.31*	0.70*
	Slovakia	0.71*	0.47*	0.71*	-0.03*	0.00	0.01	-0.01	0.01	0.02	0.84*	0.59*	0.84*	0.10	-0.02	0.08
	Slovenia	0.05	0.04	0.04	0.02*	0.01	0.01	0.03*	0.02*	0.02*	0.80*	0.68*	0.70*	0.60*	0.47*	0.58*
Domestic Prices	Bulgaria	0.30	0.13	0.30	0.02	0.01	0.00	0.01	0.00	0.01	-0.73	-0.37	-0.73	-1.36*	-0.69*	-1.36*
	Czech Rep.	0.00	0.00	0.00	-0.01	0.00	-0.01	0.00	0.00	0.00	0.25*	0.11*	0.25*	0.45*	0.18*	0.45*
	Estonia	0.09	0.04	0.09	-0.03	-0.02*	-0.03	0.02	0.00	0.02	0.83*	0.43*	0.83*	0.19	0.13	0.09
	Hungary	0.02	0.01	0.02	0.02*	0.02*	0.02	0.02	0.01	0.02	-0.20	-0.14	-0.20	-0.68*	-0.33*	-0.68*
	Latvia	0.10	0.05	0.10	-0.01	0.00	-0.01	0.00	0.00	0.00	0.60*	0.33*	0.60*	0.05	0.03	0.05
	Lithuania	0.16	0.08	0.16	-0.02*	-0.01*	-0.02*	-0.02	-0.01	-0.02	0.57*	0.29*	0.57*	0.36	0.17	0.36
	Poland	0.04	0.01	0.04	0.00	0.00	0.00	-0.01	0.00	-0.01	-0.05	-0.04	-0.04	0.50	0.25	0.50
	Romania	-0.85*	-0.34*	-0.85*	-0.14*	-0.06*	-0.14*	-0.05	-0.01	-0.05	3.04*	1.50*	3.04*	3.39*	1.60*	3.39*
	Slovakia	0.02	0.01	0.02	-0.01*	-0.01*	-0.01*	0.00	0.00	0.00	0.67*	0.37*	0.67*	0.35	0.10	0.35
	Slovenia	0.10	0.05	0.10	-0.02	-0.01	-0.02	-0.02*	-0.01*	-0.02*	0.48*	0.27*	0.48*	0.42*	0.20*	0.42*
Domestic Interes Rate (basis points)	Bulgaria	2.25	1.42	2.25	1.17*	0.57*	1.15*	0.80	-0.01	0.80	3.46	1.84	1.99	-10.84	-5.00	-10.84
	Czech Rep.	13.20*	9.20*	12.5*	1.39*	0.94*	0.95*	0.88	0.29	-0.12	-31.04*	-22.66*	-23.36*	-22.11	-3.96	8.49
	Estonia	12.99*	7.29*	11.67*	2.85*	2.18*	2.26*	-0.52	-0.04	0.27	-49.65*	-38.80*	-42.82*	-1.91	2.87	-0.89
	Hungary	-6.18	-3.38	-0.35	-5.31*	-2.94*	-5.31*	5.01*	2.57	5.01*	50.52	31.61	50.52	-120.91*	-69.35*	-120.91*
	Latvia	-8.72	-5.65	-8.72	1.95	1.61	1.94	1.04	0.84	0.90	18.14	8.78	2.67	8.11	-1.25	-4.71
	Lithuania	-17.88	-5.71	-17.88	0.60	-0.21	0.60	-5.62*	-4.37	-4.11	105.35	79.20	84.61	212.72	103.81	212.72
	Poland	-11.63	-5.80	-0.33	0.89	0.07	0.89	5.58*	4.15*	5.19*	26.77	14.85	21.77	-60.52*	-43.30	-34.08
	Romania	-79.00	-40.10	-40.46	-14.5*	-6.26	-1.28	-17.36	-7.19	2.25	-82.98	14.94	-82.98	271.95*	124.43	25.96
	Slovakia	5.26	3.18	5.26	-0.34	-0.25	-0.27	0.20	0.15	0.11	7.18	4.80	6.45	7.71	4.98	7.58
	Slovenia	-8.72	-5.65	-8.72	-1.81*	-0.98	-0.29	-3.72*	-2.41*	-2.00	-10.77	-4.45	-10.77	58.34	42.04	49.06
Real Effective Exchange Rate	Bulgaria	0.28*	0.18*	0.28*	-0.04	-0.02	-0.01	0.00	0.00	0.00	-0.11	0.06	-0.11	-0.56	-0.24	-0.56
	Czech Rep.	-0.14*	-0.11*	-0.12	0.03*	0.02*	0.03*	0.07*	0.05*	0.07*	-0.41	-0.21	-0.40	-1.25*	-0.86*	-1.25*
	Estonia	0.13	0.06	0.13	-0.01	0.00	-0.01	0.02	0.01	-0.01	-0.37*	-0.28	-0.27	0.53	0.30	0.13
	Hungary	0.26*	0.17*	0.26*	0.04*	0.03*	0.04*	-0.03*	-0.02*	-0.03*	-1.11*	-0.82*	-1.09*	-0.79*	-0.56*	-0.75*
	Latvia	0.04	0.01	0.04	0.01	0.00	0.00	0.00	0.00	0.00	-0.41*	-0.32*	-0.28	-0.25	-0.22	-0.24
	Lithuania	-0.07	-0.05	-0.03	0.00	0.00	0.00	-0.02*	-0.01	-0.01	0.19	0.05	0.19	0.68*	0.46*	0.38*
	Poland	-0.24*	-0.16	-0.11	0.04*	0.03*	0.04*	0.06*	0.03*	0.06*	0.26	0.16	0.22	-0.70	-0.51	-0.42
	Romania	0.59*	0.29	0.58*	0.07*	0.05*	0.05*	0.12*	0.08*	0.09	-1.07*	-0.76*	-0.85*	-1.41*	-1.01*	-1.16*
	Slovakia	0.33*	0.11	0.33*	0.01	0.01	0.01	0.03	0.01	0.03	0.53	0.22	0.53	-0.44	-0.36	-0.31
	Slovenia	0.04	0.01	0.04	-0.02	-0.01	-0.02	-0.01	0.00	-0.01	0.18	0.08	0.18	0.25	0.16	0.25

Note. The maximum elasticity (*Max.*) is the biggest (positive elasticity) or smallest (negative elasticity) percentage of a change recorded between 1 and 12 months after one unit increase in the corresponding foreign shock. The average elasticity (*Aver.*) is recorded between 1 to 12 months after one unit increase in the corresponding foreign shock. The "after" elasticity (*After*) is the percentage of a variable change registered 12 months after one unit increase in the corresponding foreign shock. One asterisk means a p-value less than 5%.

Table 4. Cross-country correlation coefficients of impulse response functions to foreign shock

Panel A: Cross-country correlation coefficients of impulse response functions to a positive commodity shock

	Bulgaria				Czech R.				Estonia				Hungary				Latvia				Lithuania				Poland				Romania				Slovakia				Slovenia			
	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer
Bulgaria	1.00	1.00	1.00	1.00	-0.24	-0.87	0.74	-0.76	0.90	0.98	0.91	0.89	0.47	0.88	0.58	0.74	-0.03	0.97	-0.72	0.88	0.19	0.99	-0.62	0.75	0.64	0.99	0.71	0.62	-0.51	-0.99	0.25	0.29	0.81	0.96	0.91	0.91	-0.03	0.97	-0.72	0.88
Czech R.	-0.24	-0.87	0.74	-0.76	1.00	1.00	1.00	1.00	-0.55	-0.89	0.90	-0.68	0.59	-0.94	-0.08	-0.79	0.93	-0.93	-0.11	-0.54	-0.78	-0.88	0.04	-0.31	0.55	-0.88	0.27	-0.02	0.94	0.89	-0.44	-0.32	-0.71	-0.96	0.87	-0.55	0.93	-0.93	-0.11	-0.54
Estonia	0.90	0.98	0.91	0.89	-0.55	-0.89	0.90	-0.68	1.00	1.00	1.00	1.00	0.29	0.94	0.32	0.91	-0.29	0.99	-0.44	0.63	0.31	0.98	-0.33	0.47	0.38	0.98	0.61	0.57	-0.76	-0.97	-0.12	0.65	0.92	0.96	0.92	0.69	-0.29	0.99	-0.44	0.63
Hungary	0.47	0.88	0.58	0.74	0.59	-0.94	-0.08	-0.79	0.29	0.94	0.32	0.91	1.00	1.00	1.00	1.00	0.82	0.97	-0.92	0.36	-0.74	0.90	-0.98	0.13	0.93	0.89	0.82	0.19	0.37	-0.88	0.87	0.80	-0.05	0.94	0.34	0.42	0.82	0.97	-0.92	0.36
Latvia	-0.03	0.97	-0.72	0.88	0.93	-0.93	-0.11	-0.54	-0.29	0.99	-0.44	0.63	0.82	0.97	-0.92	0.36	1.00	1.00	1.00	1.00	-0.90	0.98	0.98	0.96	0.73	0.97	-0.68	0.75	0.82	-0.97	-0.80	-0.16	-0.56	0.98	-0.46	0.99	0.99	0.99	0.99	0.99
Lithuania	0.19	0.99	-0.62	0.75	-0.78	-0.88	0.04	-0.31	0.31	0.98	-0.33	0.47	-0.74	0.90	-0.98	0.13	-0.90	0.98	0.98	0.96	1.00	1.00	1.00	1.00	-0.54	0.99	-0.73	0.83	-0.78	-0.99	-0.88	-0.32	0.62	0.96	-0.36	0.95	-0.90	0.98	0.98	0.96
Poland	0.64	0.99	0.71	0.62	0.55	-0.88	0.27	-0.02	0.38	0.98	0.61	0.57	0.93	0.89	0.82	0.19	0.73	0.97	-0.68	0.75	-0.54	0.99	-0.73	0.83	1.00	1.00	1.00	1.00	0.29	-0.99	0.49	0.00	0.13	0.97	0.64	0.78	0.73	0.97	-0.68	0.75
Romania	-0.51	-0.99	0.25	0.29	0.94	0.89	-0.44	-0.32	-0.76	-0.97	-0.12	0.65	0.37	-0.88	0.87	0.80	0.82	-0.97	-0.80	-0.16	-0.78	-0.99	-0.88	-0.32	0.29	-0.99	0.49	0.00	1.00	1.00	1.00	1.00	-0.88	-0.97	-0.03	-0.08	0.82	-0.97	-0.80	-0.16
Slovakia	0.81	0.96	0.91	0.91	-0.71	-0.96	0.87	-0.55	0.92	0.96	0.92	0.69	-0.05	0.94	0.34	0.42	-0.56	0.98	-0.46	0.99	0.62	0.96	-0.36	0.95	0.13	0.97	0.64	0.78	-0.88	-0.97	-0.03	-0.08	1.00	1.00	1.00	1.00	-0.56	0.98	-0.46	0.99
Slovenia	-0.03	0.97	-0.72	0.88	0.93	-0.93	-0.11	-0.54	-0.29	0.99	-0.44	0.63	0.82	0.97	-0.92	0.36	0.99	0.99	0.99	0.99	-0.90	0.98	0.98	0.96	0.73	0.97	-0.68	0.75	0.82	-0.97	-0.80	-0.16	-0.56	0.98	-0.46	0.99	1.00	1.00	1.00	1.00

Panel B: Cross-country correlation coefficients of impulse response functions to a positive euro area interest rate shock

	Bulgaria				Czech R.				Estonia				Hungary				Latvia				Lithuania				Poland				Romania				Slovakia				Slovenia			
	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer
Bulgaria	1.00	1.00	1.00	1.00	-0.58	0.71	0.48	-0.38	0.29	0.59	0.41	-0.35	0.52	-0.53	-0.30	-0.53	0.61	0.89	0.64	-0.60	0.60	0.91	-0.10	-0.44	0.61	0.95	0.59	-0.29	0.37	0.93	-0.06	-0.60	-0.41	0.35	-0.49	-0.47	-0.40	0.47	0.34	-0.28
Czech R.	-0.58	0.71	0.48	-0.38	1.00	1.00	1.00	1.00	0.40	0.91	0.92	0.26	-0.91	-0.87	0.45	0.82	-0.89	0.89	0.54	0.62	-0.68	0.90	-0.76	0.58	-0.05	0.59	-0.16	0.56	0.23	0.90	-0.88	0.89	0.51	0.83	-0.98	0.98	0.45	0.83	-0.64	-0.35
Estonia	0.29	0.59	0.41	-0.35	0.40	0.91	0.92	0.26	1.00	1.00	1.00	1.00	-0.59	-0.99	0.31	-0.05	-0.21	0.88	0.71	0.89	-0.08	0.84	-0.65	0.91	0.88	0.46	-0.14	-0.57	0.98	0.83	-0.80	0.52	-0.38	0.93	-0.94	0.14	0.54	0.98	-0.67	0.78
Hungary	0.52	-0.53	-0.30	-0.53	-0.91	-0.87	0.45	0.82	-0.59	-0.99	0.31	-0.05	1.00	1.00	1.00	1.00	0.67	-0.84	-0.43	0.38	0.44	-0.79	-0.90	0.30	-0.22	-0.39	-0.87	0.84	-0.47	-0.77	-0.73	0.80	-0.29	-0.95	-0.49	0.89	-0.54	-0.99	-0.75	-0.50
Latvia	0.61	0.89	0.64	-0.60	-0.89	0.89	0.54	0.62	-0.21	0.88	0.71	0.89	0.67	-0.84	-0.43	0.38	1.00	1.00	1.00	1.00	0.93	0.99	0.03	0.97	0.25	0.82	0.47	-0.15	-0.03	0.99	-0.18	0.84	-0.42	0.68	-0.53	0.54	-0.50	0.80	-0.07	0.50
Lithuania	0.60	0.91	-0.10	-0.44	-0.68	0.90	-0.76	0.58	-0.08	0.84	-0.65	0.91	0.44	-0.79	-0.90	0.30	0.93	0.99	0.03	0.97	1.00	1.00	1.00	1.00	0.30	0.86	0.65	-0.24	0.05	0.99	0.88	0.80	-0.17	0.63	0.81	0.46	-0.62	0.74	0.76	0.49
Poland	0.61	0.95	0.59	-0.29	-0.05	0.59	-0.16	0.56	0.88	0.46	-0.14	-0.57	-0.22	-0.39	-0.87	0.84	0.25	0.82	0.47	-0.15	0.30	0.86	0.65	-0.24	1.00	1.00	1.00	1.00	0.95	0.87	0.48	0.38	-0.63	0.16	0.19	0.68	0.32	0.33	0.73	-0.82
Romania	0.37	0.93	-0.06	-0.60	0.23	0.90	-0.88	0.89	0.98	0.83	-0.80	0.52	-0.47	-0.77	-0.73	0.80	-0.03	0.99	-0.18	0.84	0.05	0.99	0.88	0.80	0.95	0.87	0.48	0.38	1.00	1.00	1.00	1.00	-0.54	0.62	0.87	0.86	0.54	0.72	0.87	-0.04
Slovakia	-0.41	0.35	-0.49	-0.47	0.51	0.83	-0.98	0.98	-0.38	0.93	-0.94	0.14	-0.29	-0.95	-0.49	0.89	-0.42	0.68	-0.53	0.54	-0.17	0.63	0.81	0.46	-0.63	0.16	0.19	0.68	-0.54	0.62	0.87	0.86	1.00	1.00	1.00	1.00	-0.47	0.96	0.64	-0.42
Slovenia	-0.40	0.47	0.34	-0.28	0.45	0.83	-0.64	-0.35	0.54	0.98	-0.67	0.78	-0.54	-0.99	-0.75	-0.50	-0.50	0.80	-0.07	0.50	-0.62	0.74	0.76	0.49	0.32	0.33	0.73	-0.82	0.54	0.72	0.87	-0.04	-0.47	0.96	0.64	-0.42	1.00	1.00	1.00	1.00

Panel C: Cross-country correlation coefficients of impulse response functions to a positive United States interest rate shock

	Bulgaria				Czech R.				Estonia				Hungary				Latvia				Lithuania				Poland				Romania				Slovakia				Slovenia			
	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer
Bulgaria	1.00	1.00	1.00	1.00	-0.13	0.46	-0.91	0.50	0.67	-0.53	0.04	-0.12	0.82	-0.63	0.90	-0.31	-0.32	-0.37	-0.26	-0.58	-0.57	-0.60	0.48	-0.56	0.82	0.38	0.04	0.20	0.84	0.14	0.89	0.60	-0.65	0.00	-0.65	-0.68	0.44	-0.82	0.55	0.52
Czech R.	-0.13	0.46	-0.91	0.50	1.00	1.00	1.00	1.00	0.60	-0.99	0.30	-0.66	0.31	-0.97	-0.87	-0.93	-0.66	-0.98	0.60	-0.95	-0.63	0.40	-0.76	-0.37	-0.35	0.99	0.34	0.89	0.28	0.93	-0.99	0.89	0.65	0.86	0.87	0.09	0.70	-0.46	-0.81	-0.10
Estonia	0.67	-0.53	0.04	-0.12	0.60	-0.99	0.30	-0.66	1.00	1.00	1.00	1.00	0.90	0.99	-0.27	0.86	-0.66	0.97	0.77	0.77	-0.90	-0.31	-0.82	-0.44	0.37	-0.98	0.78	-0.86	0.86	-0.91	-0.32	-0.48	-0.07	-0.81	0.58	-0.38	0.83	0.54	-0.61	0.68
Hungary	0.82	-0.63	0.90	-0.31	0.31	-0.97	-0.87	-0.93	0.90	0.99	-0.27	0.86	1.00	1.00	1.00	1.00	-0.67	0.95	-0.33	0.92	-0.88	-0.19	0.63	0.03	0.72	-0.95	-0.03	-0.95	0.97	-0.83	0.84	-0.73	-0.44	-0.75	-0.66	-0.33	0.83	0.56	0.54	0.44
Latvia	-0.32	-0.37	-0.26	-0.58	-0.66	-0.98	0.60	-0.95	-0.66	0.97	0.77	0.77	-0.67	0.95	-0.33	0.92	1.00	1.00	1.00	1.00	0.91	-0.49	-0.92	0.20	-0.37	-0.99	0.93	-0.91	-0.74	-0.93	-0.65	-0.90	-0.15	-0.91	0.90	0.04	-0.94	0.31	-0.88	0.14
Lithuania	-0.57	-0.60	0.48	-0.56	-0.63	0.40	-0.76	-0.37	-0.90	-0.31	-0.82	-0.44	-0.88	-0.19	0.63	0.03	0.91	-0.49	-0.92	0.20	1.00	1.00	1.00	1.00	-0.47	0.47	-0.78	0.02	-0.91	0.65	0.78	-0.49	0.00	0.75	-0.93	0.45	-0.97	0.50	0.89	-0.78
Poland	0.82	0.38	0.04	0.20	-0.35	0.99	0.34	0.89	0.37	-0.98	0.78	-0.86	0.72	-0.95	-0.03	-0.95	-0.37	-0.99	0.93	-0.91	-0.47	0.47	-0.78	0.02	1.00	1.00	1.00	1.00	0.75	0.96	-0.40	0.79	-0.80	0.89	0.72	0.29	0.41	-0.41	-0.79	-0.42
Romania	0.84	0.14	0.89	0.60	0.28	0.93	-0.99	0.89	0.86	-0.91	-0.32	-0.48	0.97	-0.83	0.84	-0.73	-0.74	-0.93	-0.65	-0.90	-0.91	0.65	0.78	-0.49	0.75	0.96	-0.40	0.79	1.00	1.00	1.00	1.00	-0.38	0.91	-0.90	-0.28	0.83	-0.28	0.85	0.21
Slovakia	-0.65	0.00	-0.65	-0.68	0.65	0.86	0.87	0.09	-0.07	-0.81	0.58	-0.38	-0.44	-0.75	-0.66	-0.33	-0.15	-0.91	0.90	0.04	0.00	0.75	-0.93	0.45	-0.80	0.89	0.72	0.29	-0.38	0.91	-0.90	-0.28	1.00	1.00	1.00	1.00	0.02	0.02	-0.93	-0.84
Slovenia	0.44	-0.82	0.55	0.52	0.70	-0.46	-0.81	-0.10	0.83	0.54	-0.61	0.68	0.83	0.56	0.54	0.44	-0.94	0.31	-0.88	0.14	-0.97	0.50	0.89	-0.78	0.41	-0.41	-0.79	-0.42	0.83	-0.28	0.85	0.21	0.02	0.02	-0.93	-0.84	1.00	1.00	1.00	1.00

Note. Light grey cells mean a positive correlation coefficient larger than 0.75. Dark grey cells mean a negative correlation coefficient larger than -0.75.

Table 4. Cross-country correlation coefficients of impulse response functions to foreign shock (*Cont.*)

Panel D: Cross-country correlation coefficients of impulse response functions to a positive euro area industrial production shock

	Bulgaria				Czech R.				Estonia				Hungary				Latvia				Lithuania				Poland				Romania				Slovakia				Slovenia			
	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer
Bulgaria	**1.00**	**1.00**	**1.00**	**1.00**	-0.40	-0.94	-0.44	-0.41	-0.73	-0.92	-0.30	-0.87	-0.30	0.38	-0.03	0.18	0.87	-0.93	0.41	-0.92	0.64	-0.90	0.34	-0.96	-0.30	-0.61	0.32	-0.57	-0.83	-0.97	0.19	-0.73	-0.50	-0.94	0.25	-0.90	0.46	-0.97	0.12	-0.28
Czech R.	-0.40	-0.94	-0.44	-0.41	**1.00**	**1.00**	**1.00**	**1.00**	0.22	0.99	0.96	0.68	-0.19	-0.56	-0.01	0.67	-0.46	0.99	-0.44	0.63	-0.28	0.99	-0.68	0.29	-0.11	0.54	0.13	0.14	0.34	0.99	-0.49	0.82	0.06	0.99	-0.76	0.06	-0.02	0.99	0.05	-0.75
Estonia	-0.73	-0.92	-0.30	-0.87	0.22	0.99	0.96	0.68	**1.00**	**1.00**	**1.00**	**1.00**	0.81	-0.65	-0.10	0.27	-0.33	0.99	-0.36	0.98	0.04	0.99	-0.67	0.85	0.84	0.44	0.11	0.49	0.98	0.99	-0.41	0.95	0.94	0.99	-0.80	0.71	0.18	0.99	0.23	-0.12
Hungary	-0.30	0.38	-0.03	0.18	-0.19	-0.56	-0.01	0.67	0.81	-0.65	-0.10	0.27	**1.00**	**1.00**	**1.00**	**1.00**	0.19	-0.65	-0.84	0.21	0.46	-0.67	-0.57	-0.25	0.97	0.37	0.86	-0.29	0.68	-0.54	-0.85	0.51	0.94	-0.64	-0.27	-0.44	0.40	-0.57	-0.80	-0.86
Latvia	0.87	-0.93	0.41	-0.92	-0.46	0.99	-0.44	0.63	-0.33	0.99	-0.36	0.98	0.19	-0.65	-0.84	0.21	**1.00**	**1.00**	**1.00**	**1.00**	0.91	0.99	0.85	0.89	0.21	0.43	-0.68	0.51	-0.48	0.99	0.93	0.93	-0.03	0.99	0.62	0.76	0.73	0.99	0.59	-0.04
Lithuania	0.64	-0.90	0.34	-0.96	-0.28	0.99	-0.68	0.29	0.04	0.99	-0.67	0.85	0.46	-0.67	-0.57	-0.25	0.91	0.99	0.85	0.89	**1.00**	**1.00**	**1.00**	**1.00**	0.51	0.42	-0.58	0.70	-0.11	0.98	0.87	0.69	0.31	0.99	0.93	0.97	0.92	0.98	0.21	0.36
Poland	-0.30	-0.61	0.32	-0.57	-0.11	0.54	0.13	0.14	0.84	0.44	0.11	0.49	0.97	0.37	0.86	-0.29	0.21	0.43	-0.68	0.51	0.51	0.42	-0.58	0.70	**1.00**	**1.00**	**1.00**	**1.00**	0.72	0.53	-0.83	0.42	0.96	0.44	-0.40	0.73	0.50	0.49	-0.62	0.19
Romania	-0.83	-0.97	0.19	-0.73	0.34	0.99	-0.49	0.82	0.98	0.99	-0.41	0.95	0.68	-0.54	-0.85	0.51	-0.48	0.99	0.93	0.93	-0.11	0.98	0.87	0.69	0.72	0.53	-0.83	0.42	**1.00**	**1.00**	**1.00**	**1.00**	0.86	0.99	0.68	0.51	0.08	0.99	0.64	-0.37
Slovakia	-0.50	-0.94	0.25	-0.90	0.06	0.99	-0.76	0.06	0.94	0.99	-0.80	0.71	0.94	-0.64	-0.27	-0.44	-0.03	0.99	0.62	0.76	0.31	0.99	0.93	0.97	0.96	0.44	-0.40	0.73	0.86	0.99	0.68	0.51	**1.00**	**1.00**	**1.00**	**1.00**	0.34	0.99	-0.10	0.56
Slovenia	0.46	-0.97	0.12	-0.28	-0.02	0.99	0.05	-0.75	0.18	0.99	0.23	-0.12	0.40	-0.57	-0.80	-0.86	0.73	0.99	0.59	-0.04	0.92	0.98	0.21	0.36	0.50	0.49	-0.62	0.19	0.08	0.99	0.64	-0.37	0.34	0.99	-0.10	0.56	**1.00**	**1.00**	**1.00**	**1.00**

Panel E: Cross-country correlation coefficients of impulse response functions to a positive United States industrial production shock

	Bulgaria				Czech R.				Estonia				Hungary				Latvia				Lithuania				Poland				Romania				Slovakia				Slovenia			
	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer	ip	cpi	sr	reer
Bulgaria	**1.00**	**1.00**	**1.00**	**1.00**	0.78	-0.99	-0.86	-0.08	-0.52	0.83	0.61	0.89	-0.92	0.98	0.80	0.80	0.23	-0.98	0.84	-0.39	-0.21	-0.99	-0.88	0.03	-0.33	-0.99	-0.14	-0.79	-0.91	-0.99	0.37	-0.53	-0.77	-0.99	-0.56	-0.81	0.43	-0.98	0.22	0.00
Czech R.	0.78	-0.99	-0.86	-0.08	**1.00**	**1.00**	**1.00**	**1.00**	-0.86	-0.86	-0.65	-0.01	-0.95	-0.98	-0.88	0.31	-0.15	0.98	-0.90	0.73	-0.45	0.99	0.69	-0.08	-0.72	0.99	0.57	0.46	-0.96	0.99	-0.74	0.78	-0.86	0.99	0.13	0.28	0.05	0.98	-0.67	-0.98
Estonia	-0.52	0.83	0.61	0.89	-0.86	-0.86	-0.65	-0.01	**1.00**	**1.00**	**1.00**	**1.00**	0.79	0.84	0.45	0.60	0.59	-0.80	0.56	-0.57	0.75	-0.85	-0.53	0.40	0.91	-0.84	-0.30	-0.87	0.78	-0.84	0.30	-0.57	0.74	-0.86	-0.35	-0.94	0.37	-0.81	0.26	-0.07
Hungary	-0.92	0.98	0.80	0.80	-0.95	-0.98	-0.88	0.31	0.79	0.84	0.45	0.60	**1.00**	**1.00**	**1.00**	**1.00**	0.05	-0.96	0.93	0.11	0.42	-0.98	-0.52	-0.43	0.61	-0.98	-0.34	-0.29	0.99	-0.95	0.79	0.03	0.87	-0.95	0.00	-0.38	-0.18	-0.92	0.60	-0.37
Latvia	0.23	-0.98	0.84	-0.39	-0.15	0.98	-0.90	0.73	0.59	-0.80	0.56	-0.57	0.05	-0.96	0.93	0.11	**1.00**	**1.00**	**1.00**	**1.00**	0.82	0.97	-0.50	-0.55	0.66	0.98	-0.31	0.82	0.02	0.97	0.70	0.88	0.04	0.96	-0.08	0.76	0.80	0.96	0.56	-0.67
Lithuania	-0.21	-0.99	-0.88	0.03	-0.45	0.99	0.69	-0.08	0.75	-0.85	-0.53	0.40	0.42	-0.98	-0.52	-0.43	0.82	0.97	-0.50	-0.55	**1.00**	**1.00**	**1.00**	**1.00**	0.79	0.99	0.12	-0.52	0.39	0.97	-0.12	-0.46	0.52	0.97	0.74	-0.51	0.70	0.95	-0.01	0.04
Poland	-0.33	-0.99	-0.14	-0.79	-0.72	0.99	0.57	0.46	0.91	-0.84	-0.30	-0.87	0.61	-0.98	-0.34	-0.29	0.66	0.98	-0.31	0.82	0.79	0.99	0.12	-0.52	**1.00**	**1.00**	**1.00**	**1.00**	0.61	0.99	-0.74	0.88	0.69	0.99	-0.43	0.95	0.63	0.98	-0.88	-0.36
Romania	-0.91	-0.99	0.37	-0.53	-0.96	0.99	-0.74	0.78	0.78	-0.84	0.30	-0.57	0.99	-0.95	0.79	0.03	0.02	0.97	0.70	0.88	0.39	0.97	-0.12	-0.46	0.61	0.99	-0.74	0.88	**1.00**	**1.00**	**1.00**	**1.00**	0.88	0.99	0.53	0.76	-0.20	0.99	0.95	-0.73
Slovakia	-0.77	-0.99	-0.56	-0.81	-0.86	0.99	0.13	0.28	0.74	-0.86	-0.35	-0.94	0.87	-0.95	0.00	-0.38	0.04	0.96	-0.08	0.76	0.52	0.97	0.74	-0.51	0.69	0.99	-0.43	0.95	0.88	0.99	0.53	0.76	**1.00**	**1.00**	**1.00**	**1.00**	0.08	0.99	0.62	-0.20
Slovenia	0.43	-0.98	0.22	0.00	0.05	0.98	-0.67	-0.98	0.37	-0.81	0.26	-0.07	-0.18	-0.92	0.60	-0.37	0.80	0.96	0.56	-0.67	0.70	0.95	-0.01	0.04	0.63	0.98	-0.88	-0.36	-0.20	0.99	0.95	-0.73	0.08	0.99	0.62	-0.20	**1.00**	**1.00**	**1.00**	**1.00**

Note. Light grey cells mean a positive correlation coefficient larger than 0.75. Dark grey cells mean a negative correlation coefficient larger than -0.75.

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