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The OeNB's quarterly *Focus on European Economic Integration (FEEI)* presents peer-reviewed studies on macro-financial and monetary integration in Central, Eastern and Southeastern Europe (CESEE) as well as related country analyses and statistics. This publication reflects a strategic research priority of the OeNB.

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Call for Entries
Olga Radzyner Award 2011 for Scientific Work on European Economic Integration

The Oesterreichische Nationalbank (OeNB) has established an award to commemorate Olga Radzyner, former Head of the OeNB's Foreign Research Division, who died in a tragic accident in August 1999. The award is bestowed on young economists for excellent research on topics of European economic integration and is conferred annually. In 2011, four applicants are eligible to receive a single payment of EUR 3,000 each from an annual total of EUR 12,000.

Submitted papers should cover European economic integration issues and be in English or German. They should not exceed 30 pages and should preferably be in the form of a working paper or scientific article. Authors shall submit their work before their 35th birthday and shall be citizens of any of the following countries: Albania, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, FYR Macedonia, Hungary, Kosovo, Latvia, Lithuania, Moldova, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia or Ukraine. Previous winners of the Olga Radzyner Award, ESCB central bank employees as well as current and former OeNB staff are not eligible. In case of co-authored work, each of the co-authors has to fulfill all the entry criteria.

Authors shall send their submissions by postal mail – with the envelope marked "Olga Radzyner Award" – to the Oesterreichische Nationalbank, Foreign Research Division, Otto-Wagner-Platz 3, PO Box 61, 1011 Vienna, Austria. Entries for the 2011 award should arrive at the OeNB by October 10, 2011, at the latest.

For more information, please see *www.oenb.at* or contact Ms. Eva Gehringer-Wasserbauer in the OeNB's Foreign Research Division either by e-mail (*eva.gehringer-wasserbauer@oenb.at*) or by phone (+43-1-40420-5205).

Visiting Research Program

The Oesterreichische Nationalbank (OeNB) invites applications from external researchers for participation in a Visiting Research Program established by the OeNB's Economic Analysis and Research Department. The purpose of this program is to enhance cooperation with

- members of academic and research institutions (preferably post-doc), and with
- central bank researchers[1]

who work in the fields of macroeconomics, international economics or financial economics and/or with a regional focus on Central, Eastern and Southeastern Europe.

The OeNB offers a stimulating and professional research environment in close proximity to the policymaking process. Visiting researchers are expected to collaborate with the OeNB's research staff on a prespecified topic and to participate actively in the department's internal seminars and other research activities. They are provided with accommodation on demand and have, as a rule, access to the department's data and computer resources and to research assistance. Their research output will be published in one of the department's publication outlets or as an OeNB Working Paper. Research visits should ideally last between 3 and 6 months, but timing is flexible.

Applications (in English) should include

- a curriculum vitae,
- a research proposal that motivates and clearly describes the envisaged research project,
- an indication of the period envisaged for the research stay, and
- information on previous scientific work.

Applications for the year 2012 should be e-mailed to

Eva.Gehringer-Wasserbauer@oenb.at

by November 1, 2011.

Applicants will be notified in the first week of December of the jury's decision. The next round of applications will close on May 1, 2012.

[1] *Other than those eligible for the External Work Experience program established within the ESCB.*

Studies

The Transmission of Euro Area Monetary Shocks to the Czech Republic, Poland and Hungary: Evidence from a FAVAR Model

Konstantins Benkovskis,
Andrejs Bessonovs,
Martin Feldkircher,
Julia Wörz[1,2]

We analyze the effects of euro area monetary policy on three Central and Eastern European non-euro area EU countries: the Czech Republic, Poland and Hungary. We employ an open economy version of the factor-augmented vector autoregression model (FAVAR) to estimate the cross-border effects of a contractionary monetary policy of the ECB. We find significant and sizeable effects of euro area monetary policy in these small and highly open economies, with economic activity variables being primarily affected through the impact of increased interest rates and reduced foreign demand – thus leading to a contraction of GDP – and exchange rate effects being important for price reactions.

JEL classification: C32, E31, E32, E40, F42
Keywords: FAVAR, monetary policy shocks, international transmission, euro area, Central and Eastern Europe

1 Introduction

The euro area accounts for more than 16% of world GDP at purchasing power parities and for 75% of EU GDP. With the exception of the U.K., all non-euro area EU members are small in comparison to the euro area as a whole. Representing 3% of total EU GDP in 2009, Poland is the second largest non-euro area EU country. Taking into account the importance of trade and financial linkages between non-euro area EU countries and the euro area, the monetary policy of the euro area is likely to have sizable effects on the small and open non-euro area EU countries. Although there is an abundant literature on monetary policy spillovers for countries within the sphere of influence of the U.S.A., there has been little empirical research on the transmission of monetary policy from the euro area to other EU members. One obvious explanation relates to the fact that the euro area was created only a relatively short time ago. The effects of monetary policy are usually studied within the framework of time series models and therefore require long time series. Clearly, the first studies based on observed data for the euro area were devoted to analyzing the workings of monetary policy within the euro area itself, taking into account the particular feature of different economies sharing a common monetary policy (see for example Peersman and Smets, 2001, and Peersman, 2004). Those studies that look in particular at the Central and Eastern European (CEE) EU member countries mostly focus on domestic monetary policy transmission channels in the context of these countries' transition from centrally planned to market economies (see for example Elbourne and de Haan, 2006, and Golinelli and Rovelli, 2005).

We aim to fill the gap of research on monetary policy spillovers in the European context by putting the focus explicitly on the effects of euro area monetary

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[2] *This paper was written during Konstantins Benkovskis' research stay at the OeNB's Foreign Research Division under the ESCB External Work Experience program. The authors would like to thank Peter Backé, Markus Eller, Jarko Fidrmuc, Doris Ritzberger-Grünwald (all OeNB), two anonymous referees and participants of the 2011 Annual Meeting of the Austrian Economic Association in Graz and of an internal seminar at the OeNB for their valuable comments.*

policy on three small and highly open EU member countries with flexible exchange rates: the Czech Republic, Poland, and Hungary.[3] Shedding some light on the impact of the ECB's decisions on these countries is of utmost importance, not only in view of future euro adoption in the region, but also in light of the recent unconventional monetary policy measures taken by the ECB to overcome the financial and economic crisis.

The existing literature on cross-border effects of monetary policy is vast, but inconclusive to date. The transmission of a monetary shock from a foreign country to the domestic economy can occur through different channels: The change in the foreign country's interest rate has an indirect effect on a small country, since the large foreign country can influence the global interest rate. An additional, direct interest rate effect can occur via domestic borrowing in foreign currencies, which may be of particular relevance in Central and Eastern European countries (CEECs). In general, the interest rate effects will be positively correlated between the two countries. Further, changes in foreign demand trigger an output response in the same direction in both countries. Another effect works through exchange rate movements, which cause effects on foreign and domestic output with opposing signs. Transmission can also occur through financial markets, as monetary growth abroad can trigger capital flows with an ambiguous net effect on the domestic liquidity situation. We apply a factor-augmented vector autoregression model (FAVAR), which seems highly appropriate in this context as it takes into account the largest possible amount of data series which may influence an economy's reaction to a monetary policy shock. This method has been developed first by Bernanke, Boivin and Eliasz (2005) to study the domestic effects of U.S. monetary policy. It was extended to the open economy case by Boivin and Giannoni (2008) and Mumtaz and Surico (2009), thus allowing the incorporation of international monetary policy transmission.

We find sizable effects of euro area monetary policy on the Czech Republic, Poland and Hungary overall. An unexpected increase in the euro area interest rate results in a contraction of all three economies, leading us to conclude that the foreign demand and interest rate effects (the latter being reinforced through foreign currency loans in these countries) dominate the reaction of real economic activity variables, while the exchange rate effect is important for price reactions, leading to higher export and import deflators. The reaction is strongest in Hungary, followed by the Czech Republic, and considerably smaller in Poland, the largest of the three economies.

The paper proceeds as follows: In section 2 we explain the various transmission channels and review the relevant literature. Section 3 describes the FAVAR model and applies it to the open economy. The database and the results of the factor analysis are given in section 4. Section 5 describes the effects of a contractionary monetary policy in the euro area and in each of the three countries, and section 6 concludes.

[3] *Our sample was determined by data considerations. Since we need roughly 200 time series over the whole observation period, we restrict the analysis to these three countries. We also focus on countries with a flexible exchange rate regime. The form of monetary policy transmission and hence the interpretation of the results for EU members which have pegged their currency to the euro is quite distinct and would go beyond the scope of this study.*

2 Cross-Border Effects of Monetary Policy

Open economy models do not offer a clear prediction about the effect of foreign monetary policy on domestic economic activity and prices. On the one hand, a restrictive monetary policy shock abroad will decrease foreign activity and, as a result, lower the demand for domestic products. This limits domestic output as do higher world interest rates and higher interest rates on foreign currency borrowing. On the other hand, according to the standard Mundell-Fleming framework, monetary restriction abroad will lead to a depreciation of the domestic currency under a floating exchange rate regime and will redirect demand from foreign goods toward domestic products. Thus, monetary policy affects foreign countries through a positive foreign demand and interest rate effect and a negative exchange rate effect with an ambiguous net outcome. The sign and the size of cross-border monetary policy transmission depend on many factors, such as country size, openness to international trade, the monetary policy regime and in particular the flexibility of the exchange rate, structural issues such as different degrees of wage and price stickiness, and the like.

In the particular case of Central, Eastern and Southeastern European countries, yet another factor comes into play: Loans in foreign currency are of great importance in these countries (Beckmann, Scheiber and Stix, 2011; Fidrmuc, Hake and Stix 2011), especially in Hungary and, to a lesser extent, in Poland. As a result, euro area monetary policy has an additional direct effect on these countries through a traditional interest rate channel.

During the last decade many empirical studies focused on the question of the cross-border effects of monetary policy, primarily studying the effect of U.S. monetary policy on other countries. Perhaps the most popular method of investigating the outcome of a foreign monetary policy shock is the structural VAR (SVAR) approach. Kozluk and Mehrotra (2009) broadly classify such papers into two categories. Papers from the first category estimate a VAR model for a large foreign economy augmented by some external variables for the domestic economy (Kim, 2001; Mackowiak, 2006), while papers from the second category estimate the model for a small domestic economy augmented by foreign variables (Kim and Roubini, 2000; Sousa and Zaghini, 2008; Kozluk and Mehrotra, 2009). However, there are papers which are difficult to classify into any of the above-mentioned groups as the set of domestic and foreign variables is about equal in size (Mojon and Peersman, 2003; Canova, 2005; Miniane and Rogers, 2007; Mumtaz and Surico, 2009). Some of these papers follow Cushman and Zha (1997) and apply the block-recursive structure of the two-country model, which assumes a unidirectional effect from the large economy to the small one. A recent theoretical contribution is given by Boivin, Giannoni and Mojon (2009), who aim to shed light on the evolution of the transmission mechanism by setting up a stylized two-country model. The calibrated model compares monetary transmission in the pre-EMU and the EMU periods. The model predicts significant benefits for a country joining a monetary union. In particular, a foreign interest hike results in a more contained domestic (short- and long-term) interest rate increase, boding well for consumption and thereby stabilizing output.

Several papers report a positive effect from foreign monetary expansion on activity in the domestic country, although in some cases the effect of the depreciating foreign currency outweighs the positive spillover effects. Kim and Roubini

(2000) find significant effects of U.S. monetary policy shocks on output levels of non-U.S. G7 economies. The output response is mixed. In the comparatively small G7 economy Canada, where the interest rate reacts strongly to the U.S. rate, output falls significantly in response to a U.S. rate increase. In large economies like Japan and Germany, the exchange rate depreciates more, and the output response to a higher Federal Funds Rate is positive. In Kim (2001) an expansionary monetary policy shock in the U.S.A. is shown to increase real GDP in the remaining G7 countries, with changes in the trade balance seeming to be too small to explain this boom. He concludes that the increase in world aggregated demand triggered by the lower world real interest rate is the important channel in the transmission. Schmidt (2006) offers an alternative explanation for these positive effects of U.S. monetary expansion, namely the asymmetry in the price-setting behavior of firms which arises as a result of dollar pricing in international exports. Canova (2005) finds that U.S. monetary policy shocks have important effects on Latin America, with U.S. contractionary monetary disturbance boosting domestic production with a time lag due to increased capital inflows.

Mackowiak (2006) finds that an expansionary monetary policy in Japan increases real output in Japan and depreciates the yen against the U.S. dollar. As the expansionary monetary policy causes a decrease in Japanese net exports and increases net exports of Japan's neighbors in the short run, positive spillover effects dominate. Similar findings for China are reported in Kozluk and Mehrotra (2009): A monetary expansion in China leads to an increase in real GDP (temporary) and the price level (permanent) in a number of economies in East and Southeast Asia, most notably in Hong Kong and the Philippines.

Mumtaz and Surico (2009) use the more sophisticated FAVAR approach for a panel comprising 17 industrial countries to investigate the international transmission mechanism. They conclude that an expansionary shock to monetary policy in the foreign block causes the nominal exchange rate of the pound sterling to appreciate. The growth rate of GDP and consumption increase temporarily but significantly, CPI and GDP deflator inflation reach their maximum values in the third year after the shock.

While the literature on the international transmission of monetary policy is abundant, there is – to our knowledge – very little research that looks into the specific effects of euro area monetary policy on non-euro area Eastern European EU members. Peersman (2004) looks at the effects of ECB monetary policy on individual euro area members, finding largely similar effects in individual member countries. In an earlier study, Peersman and Smets (2001) focus on euro area-wide effects of the common euro area monetary policy based on a synthetic sample from 1980 to 1998. They find stable effects comparable to those for the U.S.A. Another strand of the literature with a European focus analyzes the effects of monetary policy during the transition of Eastern Europe. Golinelli and Rovelli (2005) show that even though monetary policy followed different paths in the Czech Republic, Poland and Hungary, it was successful in achieving disinflation. Elbourne and de Haan (2006) look at the link between financial structures and monetary policy, finding little evidence for such a link.

Jiménez-Rodriguez, Morales-Zumaquero and Égert (2010) specifically look at the impact of international monetary shocks on Central, Eastern and Southeastern Europe. Using a rather long sample period, starting in the early 1990s, and a near-VAR analysis, they find evidence for structural breaks, including the global

crisis. They further find a weak but contractionary response of industrial production to a positive euro area interest rate shock (with the exception of the Czech Republic and Slovenia) and a fall in prices in almost all countries reviewed, while the effects on interest rates and effective exchange rates are mixed across countries.

3 Description of the Methodology

3.1 The Main Idea of a FAVAR Model

A vast body of monetary research has been devoted to uncovering monetary policy effects on macroeconomic variables. A conventional tool to explore and account for these effects is a vector autoregression model (VAR). Yet, standard VAR models can capture only a small number of variables, since a larger number leads to a substantial loss of degree of freedom. This is an especially severe limitation for CEECs, for which typically relatively short data series are available. However, according to Bernanke, Boivin and Eliasz (2005), two potential problems arise from such a small set of variables: First, the small number of variables is unlikely to span the dataset that central banks use to make their policy decisions. As a result, the measurement of policy shocks in this way is likely to be affected by an omitted-variable bias. Second, using standard VAR analysis, we can observe impulse responses only for variables that are included in the given framework, and a large number of economic variables that we are interested in are left out.

Bernanke, Boivin and Eliasz (2005) propose the solution to these problems by using the VAR analysis for a small number of unobservable factors which are extracted from a large dataset and represent different dimensions of the set of explanatory variables (factor-augmented vector autoregression, FAVAR). These latent factors account for the common dynamics of hundreds of macroeconomic variables and summarize the bulk of information about the whole economy in a small number of factors. Impulse responses of key macroeconomic variables are then constructed using the impulse responses of factors and corresponding factor loadings.

The main idea of FAVAR is to consider the joint dynamics of latent factors that span most of the economic variables and the observable monetary policy variables that have comprehensive effects throughout the economy. The joint dynamics of factors is assumed to be defined by a structural VAR as

$$\Phi_0 \begin{bmatrix} F_t \\ R_t \end{bmatrix} = \Phi(L) \begin{bmatrix} F_{t-1} \\ R_{t-1} \end{bmatrix} + \varepsilon_t \qquad (1)$$

where R_t is a $(M \times 1)$ vector of observable policy variables that affect the economy, F_t is a $(K \times 1)$ vector of unobservable factors excluding the above-mentioned policy variables, $\Phi(L)$ is a lag polynomial of finite order p, and ε_t is a vector of shocks assumed to be iid with mean zero and covariance matrices Q. The monetary policy shock is identified using a Cholesky identification scheme assuming that the monetary policy variable has only a lagged impact on unobservable factors.

The vector F_t is unobservable, and equation (1) cannot be estimated directly, although the information on latent factors could be extracted from a large set of observable economic variables. It is assumed that the $(N \times 1)$ vector X_t consisting of macroeconomic time series can be represented as a linear combination of the latent factors and the observable policy variables so that

$$X_t = \Lambda^F F_t + \Lambda^R R_t + e_t \tag{2}$$

where Λ^F and Λ^R are factor-loading matrices with $(N \times K)$ and $(N \times M)$ elements respectively, residuals e_t are allowed to be serially and weakly correlated across indicators. The number of unobservable factors and policy variables is much smaller than the number of macroeconomic time series $(N>>K+M)$.

3.2 FAVAR Analysis for a Small and Open Economy

As we are interested in the transmission of euro area monetary policy to the Czech Republic, Hungary and Poland, we need to extend the general FAVAR model to the case of two countries. We follow the approach of Boivin and Giannoni (2008) and assume that in each country, the state of the economy can be summarized by a vector of common factors. Since we are interested in the international policy spillover effect, we further restrict the analysis to the case where only the vector of foreign common factors contains a monetary policy variable. In this paper we estimate a model containing one large foreign and one small domestic economy, assuming that the CEEC of interest is the small economy, while the euro area is the large economy.

These assumptions seem to be well justified. Poland, by far the largest of the three economies, accounted for 3.5% of euro area GDP in 2010, according to Eurostat data based on exchange rates; this ratio increased recently due to Poland's outstanding economic performance compared to that of other EU members during the economic crisis. The GDP of the Czech Republic represents 1.5% of euro area GDP, while the figure for Hungary is 1%. Further, a clear asymmetry is reflected in trade relations. The euro area represents the most important trading partner for all three countries. Euro area imports ranged between 54% of total imports in Hungary and 60% in the Czech Republic in 2010. This share has fallen somewhat after a sharp upward spike in the accession year 2004, when euro area imports accounted for 70% of total Czech imports. On the export side, the euro area is even more important, with the respective trade shares coming to 56% for Hungary and Poland and to 66% for the Czech Republic. In contrast, euro area exports to these three countries have been rising steadily and accounted for 5.6% of total exports in 2010. The importance of these three countries for the euro area is identical on the import side.

Both small and large economies can be described by the respective vector of common factors $Z_t=[\hat{F}_t]'$ and $Z^*_t=[\hat{F}^*_t \; R^*_t]'$, where the large foreign economy (i.e. the euro area) is denoted by *. Unobservable factors $\hat{F}_t$ and $\hat{F}^*_t$ are separately extracted from a large set of macroeconomic variables X_t and X^*_t accordingly, using the algorithm fully described in the appendix[4] to this paper. In this asymmetric case, where we are interested in foreign monetary policy shocks only, this is reduced to the extraction of factors by principal components for the small economy.[5]

[4] *The appendix is available online only (see www.oenb.at).*

[5] *Since we are not interested in the effects of domestic monetary policy – a strand of the literature that has been extensively researched – there is no need to include separate domestic policy rates in the model (on the contrary, the strong correlation of the Czech domestic interest rate with the EURIBOR might introduce additional noise in the estimation). To corroborate this point, the share of interest rate variance explained by the first three common factors is rather low in all three countries under consideration (40.8% for the Czech Republic, 9.3% for Hungary, 34.3% for Poland). We take this as an indication that the influence of domestic interest rates is small for the purpose of our analysis.*

We follow the approach introduced by Cushman and Zha (1997) and subsequently used by Mojon and Peersman (2003) and Canova (2005) and assume a unidirectional causality from the large economy to the small one. In other words, we impose zero restrictions on some FAVAR coefficients in order to identify the inability of a small open economy to influence economic developments in a large foreign economy:

$$\begin{bmatrix} Z_t^* \\ Z_t \end{bmatrix} = \begin{bmatrix} \phi_{1,1}(L) & 0 \\ \phi_{1,2}(L) & \phi_{2,2}(L) \end{bmatrix} \begin{bmatrix} Z_{t-1}^* \\ Z_{t-1} \end{bmatrix} + u_t \tag{3}$$

The lag polynomials $\varphi_{1,1}(L)$ and $\varphi_{1,2}(L)$ show the impact of the large economy on itself and on the small economy respectively. Lag polynomial $\varphi_{1,2}(L)$ is of major interest to us as it identifies the transmission of a monetary shock in the euro area to CEECs. In our FAVAR model we assume that $\varphi_{2,1}(L)$ is equal to zero, so there is no effect from CEECs on the euro area at any lags. The null hypothesis that lagged values of CEECs have zero coefficients in the euro area block is not rejected for any of the three CEECs in our analysis.

In this paper, we use an identification scheme which is very similar to the standard Cholesky decomposition (a recursive identification scheme was also used by Bernanke, Boivin and Eliasz, 2005, and Blaes, 2009). The variables are ordered as follows: $(F_t^*, R_t^*, F_t)'$. Thus, the euro area's factors contemporaneously determine the movements in the CEECs' factors but not vice versa. The order of variables also assumes that monetary policy variables react contemporaneously to factor movements but not otherwise. The additional restriction we implement concerns the impact of the large country's monetary policy shock on the small economy. In the Cholesky decomposition we already assumed that the large country's interest rate does not affect unobservable factors of the large country, which is a quite traditional and realistic assumption, as real activity variables and prices have a lot of inertia and react to monetary policy with a lag. Consequently, we also assume that it has no influence on the small economy's latent factors. Hence, we end up with the following over-identified restriction scheme:

$$\begin{bmatrix} 1 & 0 & 0 \\ -\alpha_{R^*,F^*} & 1 & 0 \\ -\alpha_{F,F^*} & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{F^*} \\ u_t^{R^*} \\ u_t^{F} \end{bmatrix} = \begin{bmatrix} \gamma_{F^*} & 0 & 0 \\ 0 & \gamma_{R^*} & 0 \\ 0 & 0 & \gamma_F \end{bmatrix} \begin{bmatrix} \varepsilon_t^{F^*} \\ \varepsilon_t^{R^*} \\ \varepsilon_t^{F} \end{bmatrix} \tag{4}$$

The order of unobservable factors coincides with their order in the principal component extraction, which may be subject to criticism, as these factors have no economic interpretation. However, the first factor is usually associated with economic activity, which is largely predetermined in the current period. Also, we experiment with changing the order of unobservable common components in the Cholesky decomposition, which, however, does not affect our results significantly.

4 Database and Extracted Factors

4.1 Data Description

As regards the observable monetary policy instrument variable, changes in the 3-month EURIBOR are used as a reference rate for the European money market response to the ECB's monetary policy change. Although the money market rate is not set by the ECB (unlike the main refinancing rate or the rate on the marginal lending facility), the EURIBOR is an even better indicator of the euro area monetary policy in the current circumstances. During the recent financial turmoil, the ECB along with other central banks used non-standard measures to provide additional liquidity to the market. An excellent description of these measures and their effects can be found in Lenza, Pill and Reichlin (2010), who argue that the non-standard measures have resulted in a significant increase in the monetary base, which, however, has not translated into an increase in broad money. The main effect on the real economy was the one passed on through interest rates. Lenza, Pill and Reichlin (2010) stress three channels of transmission via interest rates. First, non-standard measures may influence the level of very short-term interest rates. Second, non-standard measures may affect the spreads in the money market (e.g. 3-month EURIBOR and 3-month overnight interest swap). Third, non-standard measures may manage expectations and affect the slope of the money market yield curve. To sum up, the 3-month EURIBOR rate contains both standard and non-standard measures and can be used as a good indicator of the ECB's monetary policy.

In order to determine common unobservable components for the euro area, the Czech Republic, Hungary and Poland in the FAVAR model, we use an unbalanced panel of data that comprises about 170 to 200 time series for each economy. We collect a rather broad set of macroeconomic variables consisting of national accounts' data on volumes, prices and employment, consumer and producer prices, hard data on industry, trade, exports and imports, financial data and soft data on consumer and business confidence.[6] When constructing the database we aim to keep a reasonable balance between real activity, price, external trade and financial indicators. The composition of indicators is almost identical for all countries and the euro area. More information on the dataset is given in the online appendix.

We use quarterly data for the period from the second quarter of 1999 to the third quarter of 2010 (46 observations). The sources of our data are Eurostat and IMF databases. The choice of the beginning of the sample was driven by two factors. First, the beginning of 1999 was the date of the euro introduction and marks the creation of the euro area. Second, and even more importantly, statistical data for the Czech Republic, Hungary and Poland are rather scarce for prior periods.

Where seasonally-adjusted data were not available from the statistical database, we use the standard X12 adjustment procedure (except for interest rates and exchange rates). All variables are transformed in logs with the exception of interest rates, confidence indicators and fiscal variables. These latter variables are measured in percent to GDP. Non-stationary variables are differentiated to obtain stationary

[6] *Our data set contains traditional activity and price variables. Due to data limitations (especially for Hungary and Poland), we put less emphasis on labor market variables than Bernanke, Boivin and Eliasz (2005) but include soft data on economic sentiment.*

time series. Several outliers are removed from the data. For example, for all three CEECs, external trade data are removed for the second quarter of 2004 because the statistical methodology changed due to these countries' accession to the EU. Observations for the first quarter of 2001 are removed from several national accounts variables in the euro area due to the inclusion of Greece in this quarter. As long as the number of missing observations does not exceed 4 for one variable, we fill the gap using a usual Expectation Maximization (EM) algorithm (see Stock and Watson, 2002b).

The size of the dataset is an important issue. As was argued by Boivin and Ng (2006), the use of more series can actually lead to less useful results, as some important factors may be dominant in the large database. Also, this problem tends to arise when the idiosyncratic errors are cross-correlated. However, our results appear to be quite robust to the size of the database. Therefore we keep this set of variables, which allows us to calculate impulse response functions for a large number of macroeconomic variables.

4.2 Unobservable Factors

First, we need to determine the number of unobservable factors for each region. According to the traditional Bai/Ng criteria (Bai and Ng, 2002), the number of unobservable factors is 3 for the euro area and Poland, and 4 for the Czech Republic and Hungary. However, we should take into account that these criteria perform badly when the number of observations is small. Moreover, as pointed out by Bernanke, Boivin and Eliasz (2005), Bai/Ng criteria do not address the question of how many factors should be included in the VAR. We experiment with different numbers of latent factors and find that FAVAR results are qualitatively unchanged as long as the number of factors for all regions is not smaller than 2. Taking into account the very short sample period, a smaller number of unobservable factors is preferable. In addition, this also narrows the confidence bands of impulse responses. In contrast, a larger number of factors maximizes the fraction of variance explained by common factors and therefore also improves the validity of impulse responses. In order to keep a good balance between a small number of variables in the VAR and a high fraction of common variance we extract 3 unobservable factors for each country or region following the methodology described in section 3.2. These factors are depicted in chart 1.

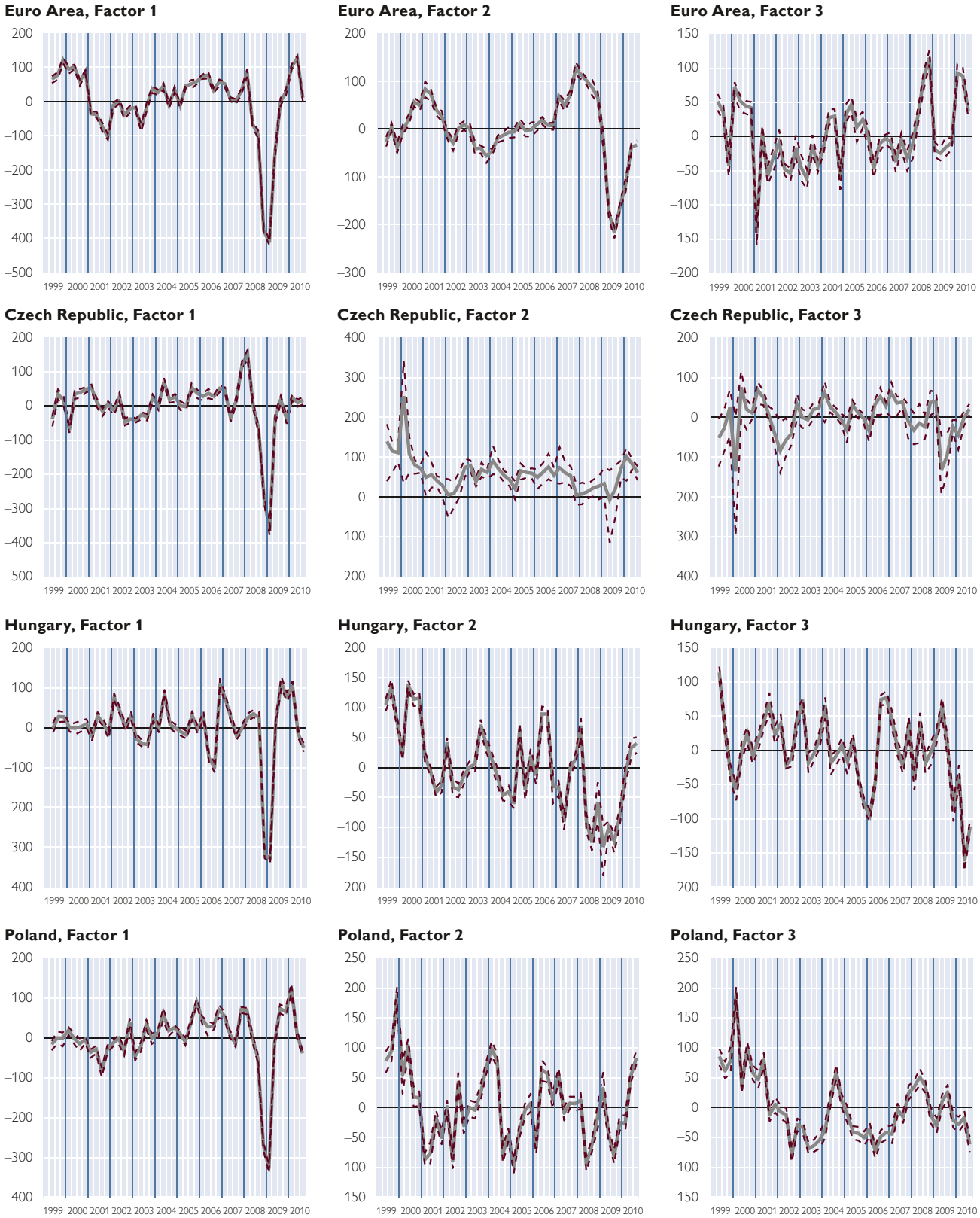
In order to give individual factors a precise economic meaning, we would need to apply a rotation method which increases the correlation between a factor and a particular group of observable macroeconomic variables. However, since we are more interested in the monetary shock transmission to an individual variable, which can be retrieved from the effects on all defined common factors, we skip this step and provide only the approximate and intuitive definition of obtained unobservable factors.

For all four regions the first factor can be interpreted as an "activity" factor. The highest loadings for the first factor are observed in industry, external trade and confidence variables. In each region, the first factor indicates the boom periods in 2006–07 and the financial crisis in 2008–09. Also, some activity moderation in 2001–02 is captured for the euro area and Poland. "Activity" factors are highly correlated between the euro area and all three countries s (the correlation is around 0.75–0.8), which mainly comes from the similar dynamics during the

Chart 1

Unobservable Factors for the Euro Area, the Czech Republic, Hungary and Poland

%, with 70% confidence bands



Source: Authors' calculations.

Note: Unobservable factors estimated using equation (A2) in the online appendix, confidence intervals calculated using bootstrap method.

financial crisis. Before 2008, this correlation was not so pronounced (below 0.4). As to the second and third factors, the interpretation is more ambiguous, although factor loadings can give us some clues. For the euro area, the second factor shows some similarities to price dynamics (high inflation in 2007–08 and low inflation in 2009–10) and changes in monetary aggregates, while the third factor is likely to be correlated with exchange rate movements. In the Czech Republic, Hungary and Poland, the second and third unobserved factors have the highest loadings for several price indices, i.e. HICP, PPI and trade deflators.

Table 1

Explanatory Power (R^2) for Selected Macroeconomic Variables

	Euro area	Czech Republic	Hungary	Poland
Real GDP	0.885	0.586	0.744	0.51
Real consumption	0.384	0.155	0.356	0.188
Real capital formation	0.7	0.3	0.162	0.147
Real exports	0.911	0.573	0.649	0.126
Real imports	0.903	0.448	0.633	0.301
Employment	0.661	0.184	0.318	0.149
Exports of goods	0.901	0.777	0.823	0.77
Imports of goods	0.918	0.741	0.85	0.855
Manufacturing production	0.905	0.498	0.785	0.767
Retail trade turnover	0.799	0.598	0.607	0.491
HICP	0.522	0.222	0.59	0.905
PPI in manufacturing	0.787	0.798	0.845	0.686
GDP deflator	0.419	0.321	0.269	0.386
Consumption deflator	0.674	0.219	0.303	0.593
Capital formation deflator	0.689	0.229	0.572	0.301
Export deflator	0.813	0.768	0.883	0.184
Import deflator	0.774	0.575	0.887	0.479
Confidence (ESI)	0.898	0.529	0.774	0.757
NEER	0.796	0.814	0.915	0.891
REER	0.793	0.702	0.886	0.88
3-month interest rate	1	0.408	0.093	0.343

Source: Authors' calculations.

Note: R^2 for equations (A3) and (A4) in the online appendix.

Table 1 reports the fraction of variance explained by the common unobservable factors and the policy variable for selected variables (see equations (4a) and (4b)). It shows a high *R2* in most of the cases, meaning that the variables of interest are well described by common factors. Comparing different regions, the explanatory power is high for the euro area: The fraction of common variance is below 50% only for real consumption, the GDP deflator and M1, while for other variables *R2* is typically above 70%. The fit is not as good in the Czech Republic, Hungary and Poland, obviously due to more volatile data, although on average it exceeds 50%. As for differences among variables, activity indicators are explained better than price indices. The factor model is good in fitting export and import data, industry production, real GDP, confidence and exchange rates. On the other hand, price indicators, especially the deflators of GDP, private consumption and capital formation as well as financial variables are not as well approximated by common factors.

5 Results of the FAVAR Model

In this section we present the estimated impulse responses of the selected macroeconomic variables to a euro area monetary policy shock, with a special focus on comparisons between reactions in the Czech Republic, Hungary and Poland to reactions in euro area variables. In all models we define the monetary policy shock as an unexpected 50 basis point increase in the 3-month EURIBOR (restrictive monetary policy). Note that we use changes in the EURIBOR as the monetary policy variable in our model. Thus the shock will have a permanent effect on the level of the EURIBOR, while the effect on the changes is non-permanent. When denoting the shock as an unexpected one, we draw on standard macroeconometric terminology, while we are well aware of the fact that the euro area is always very keen to inform the markets in advance. In the context of our model, which is based on quarterly data, the assumption of an unexpected shock is appropriate, since the timeliness of informing the markets could only be captured by high frequency (i.e. daily) data.

The size of the shock was chosen to be similar to the one in Blaes (2009) for the ease of comparability. However, the responses to other sizes of the monetary shock as well as an expansionary shock could easily be obtained as the model is linear and symmetric.

The number of lags in the FAVAR model was chosen according to Akaike and Schwarz information criteria, and in all three cases it was indicated to be one quarter. The FAVAR model involves two types of uncertainty: the uncertainty of factors and FAVAR estimates. In order to overcome bias problems in determining confidence intervals of a small sample that are usually present in traditional parametric estimation methods, we apply the bootstrap method (nonparametric approach) to obtain confidence intervals for common factors and impulse responses of FAVAR. The traditional regression bootstrap approach is used to determine confidence bands for the estimated common latent factors. For confidence intervals of FAVAR impulse responses, we follow the bootstrap-after-bootstrap approach proposed by Kilian (1998). The 70% confidence intervals are calculated using 10,000 replications.[7]

5.1 Transmission of Euro Area Monetary Policy Shocks in the Euro Area

First we shortly discuss the estimated impulse responses of the euro area variables to a euro area monetary policy shock (see chart A1 in the online appendix). Overall, almost all the variables of interest respond statistically significantly and with the expected signs: Activity and prices react negatively, while exchange rates react positively (meaning an appreciation of the euro). An unexpected increase in the short-run interest rate by 50 basis points results in a gradual decrease in real GDP, which reaches its peak after 1.5 years, and the cumulative decline after five years is 0.35% compared to the baseline (note that all impulse responses described subsequently are cumulative ones). Our results are well in line with those of Cecioni and Neri (2010) and lie between the ones obtained by Barigozzi, Conti and Luciani (2011) and Blaes (2009) regarding the magnitudes of the responses.

[7] *A 70% confidence band is quite traditional for FAVAR models, see e.g. Boivin and Giannoni (2008) or Blaes (2009). The reasoning for smaller confidence bands may be given by an increased uncertainty due to the large amount of data series underlying the analysis as compared to traditional VAR analysis.*

All three studies follow different empirical approaches, with the latter one being most closely in the vein of ours and therefore constituting our benchmark. Blaes (2009) shows that a monetary policy shock by 50 basis points reduces real GDP by 0.2% after seven years, which is approximately half as much as in our case. The different response could come from differences in the underlying sample period. Blaes (2009) analyzes the period from 1986 to 2006.

The reaction of all real GDP components to the unexpected monetary tightening is also negative and statistically significant. However, in contrast to Blaes (2009), there is a pronounced difference in the size of responses. The weakest reaction was shown by real private consumption, which decreases by 0.13% after five years. The reaction of real capital formation is more pronounced – about 0.70% – which is in line with the usual results of macroeconomic models. The most significant reaction to the restrictive monetary policy stance is observed in real exports and imports – 1.24% and 1.08% respectively. Such a high sensitivity could be explained by the fact that euro area real exports and imports include also intra-euro area trade. Therefore, the reaction of external trade variables is boosted by various foreign demand effects within the euro area. A similar effect can be observed in the response of merchandise exports and imports. The response of manufacturing production is also quite strong and exceeds that of retail trade turnover, as industrial production is closely linked to external activities.

We do not find any evidence of a "price puzzle"[8] for any price indices, except for the GDP deflator. Prices respond a bit more slowly than activity variables, e.g. the HICP response reaches its maximum two years after the monetary contraction and decreases by 0.09% after five years. This result is lower than the one obtained by Blaes (2009), who reports a 0.15% decline in the HICP after seven years in response to a 50 basis point monetary policy shock, although the response is much more delayed in this case. A comparison of different price indices shows the strongest reaction for the deflators of exports and imports. To some extent this could be driven by a tighter link to exchange rate movements. Our results show an appreciation of the euro effective exchange rate in response to an unexpected increase in short-term interest rates, which is in line with theoretical expectations. This response, however, is not statistically significant, perhaps due to the small part of exchange rate variation, which is explained by common factors.

5.2 Transmission of Euro Area Monetary Policy Shocks to the Czech Republic, Hungary and Poland

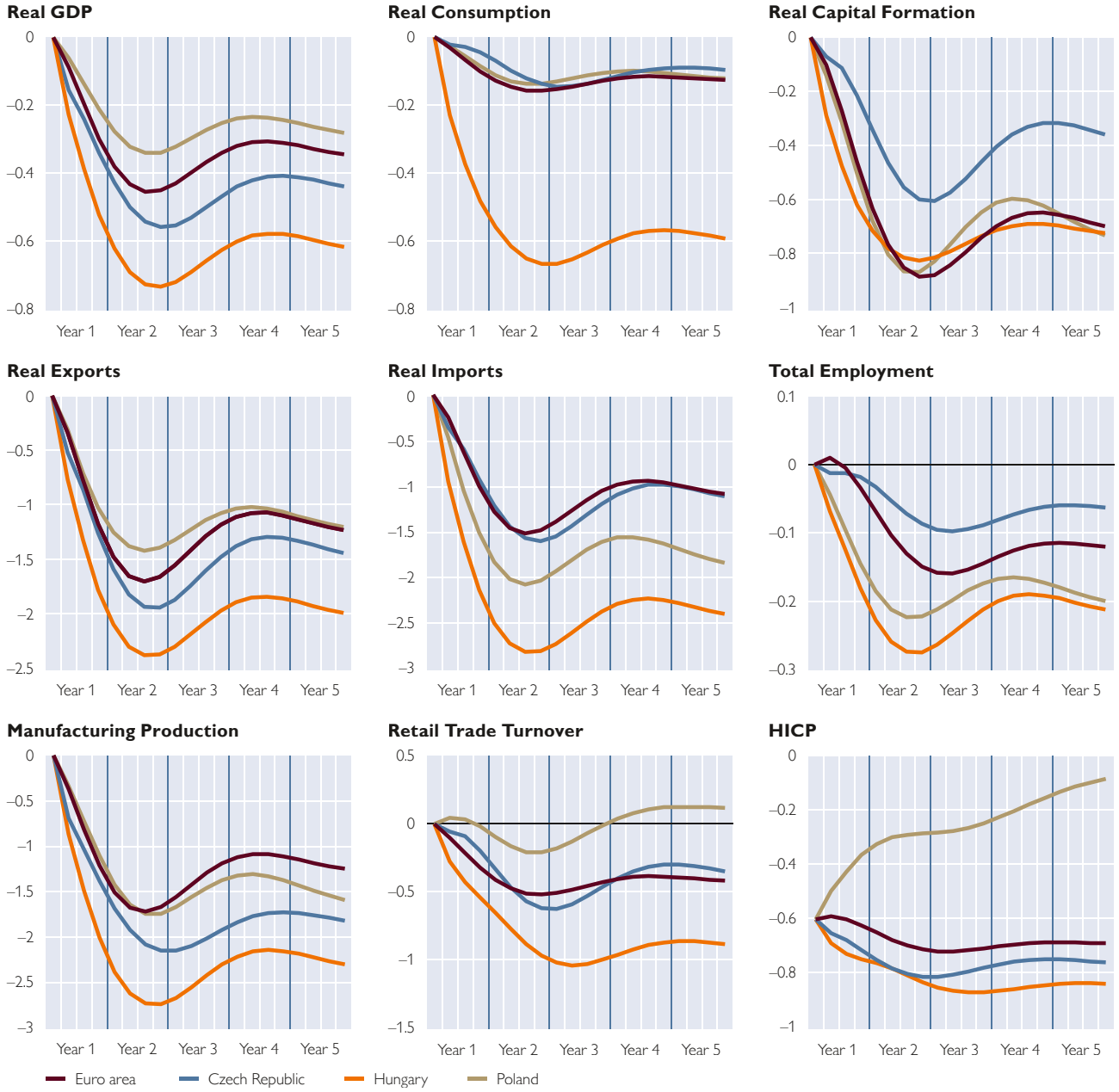
Now we can turn to the results for the three CEECs and compare the transmission of euro area monetary policy to the Czech Republic, Hungary and Poland (see chart 2). In all three *s* the response of real GDP to an unexpected increase in the euro area short-term interest rate by 50 basis points is negative and statistically significant (see charts A.2, A.3, A.4 in the online appendix). The strongest reaction is observed for Hungary, where real GDP declines by 0.60% after five years, while Poland shows the smallest contraction, by 0.29% after five years. The response of real GDP in the Czech Republic is about 0.42% after five years.

[8] *According to Sims (1992), the tightening of monetary policy in traditional VAR models leads to an initial increase of price levels, which contradicts the macroeconomic (monetarist) theory.*

Chart 2

Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from the baseline in % in response to a 50 basis points increase in changes of the 3-month EURIBOR



Source: Authors' calculations.

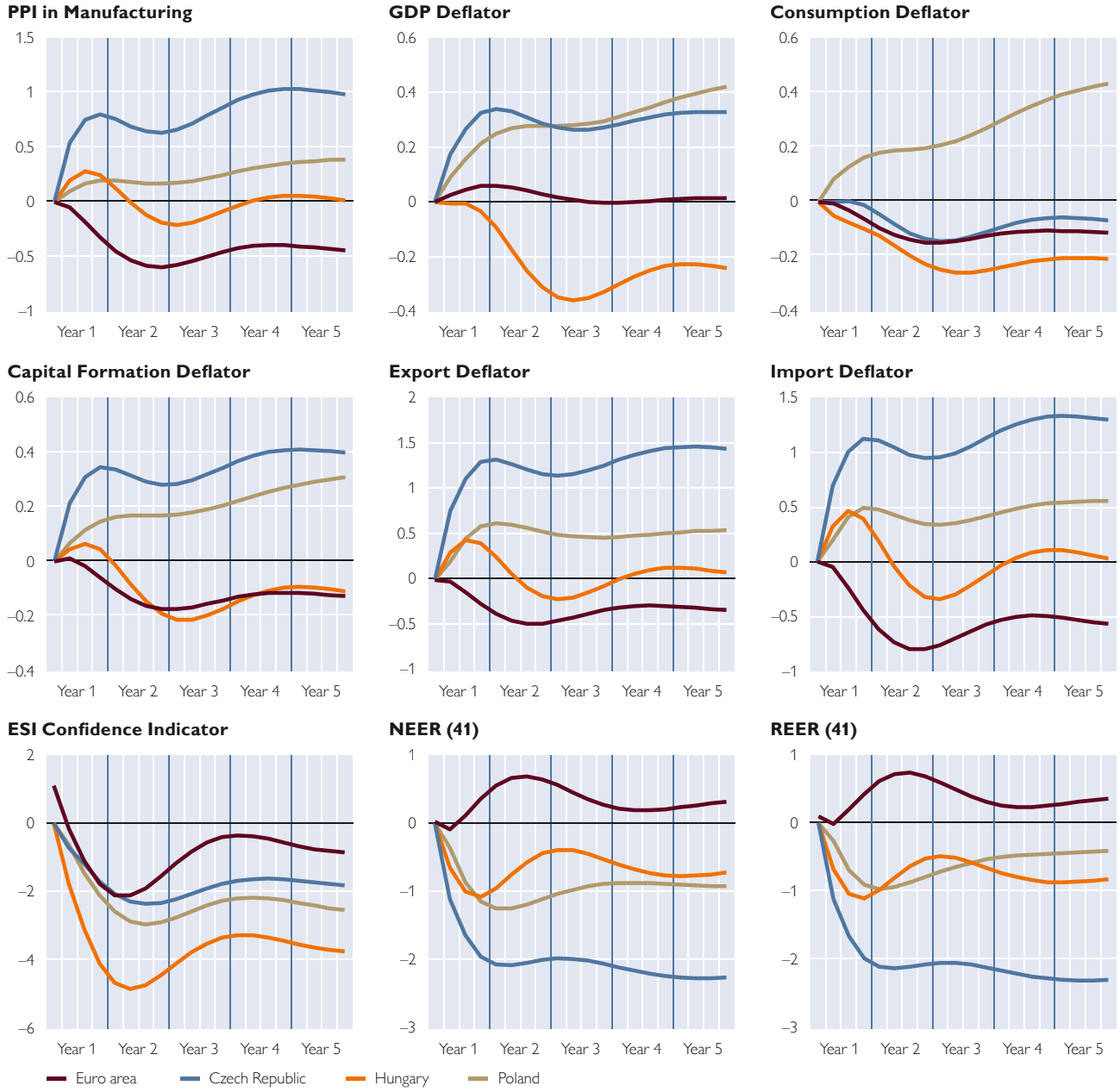
Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Several conclusions can be drawn from these results. First, as monetary tightening in the euro area contracts real activity in the Czech Republic, Hungary and Poland, we can conclude that foreign demand and interest rate effects are stronger than the impact from a depreciation of the local currency vis-à-vis the euro and therefore outweigh the exchange rate effect. This is not surprising given the fact that external demand in these countries is dominated by the euro area coupled with an

Chart 2 (continued)

Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from the baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR



Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

overall high degree of openness. This is further reflected in a strong reaction of external trade variables in all three countries. Second, country size matters indirectly. The weakest response to foreign monetary policy is observed in Poland, the largest economy among the three. Finally, we should not forget about the direct interest rate effect of the euro area monetary policy on these economies via loans issued in foreign currencies (euro among them). This can explain the strong

decline in Hungary's real GDP, as the share of loans granted in foreign currencies is highest in Hungary. A large fraction of these loans is denominated in Swiss francs, but a comparison of the ratio of euro-denominated foreign currency credit to GDP in the three countries shows that in Hungary, the ratio is still almost four times higher than in the Czech Republic and Poland. Moreover, the negative response of real consumption in Hungary is by far more pronounced compared to the other two countries and the euro area, which could be explained by the high share of household loans in foreign currency as well as a lower quality of loan portfolios. In contrast, there is no significant reaction of real consumption in the Czech Republic, where foreign currency consumer loans are practically non-existent (not least because of the negligible interest rate differential to the euro area).

Although foreign demand and interest rate effects clearly dominate in the case of real activity, it does not mean that the exchange rate channel is not operative. The unexpected increase in the short-term euro area interest rates depreciates the effective exchange rates of all three countries in the medium term, which transmits further to the economy. The most obvious effect is seen in the reaction of the export and import deflators. Monetary tightening in the euro area induces an increase in both deflators, obviously following the depreciation of the domestic currency (with the exception of Hungary, where deflators increase only temporarily). The reaction of other prices is ambiguous: In producer prices and capital formation deflators, the exchange rate channel seems to dominate, while for consumer prices decreasing demand is more important.

Our results are comparatively stronger than those reported by Jiménez-Rodríguez, Morales-Zumaquero and Égert (2010), who simulate a larger foreign interest shock and obtain often insignificant (for Poland) or small effects in the magnitude of 0.4% to 0.5%. Furthermore, they report a positive but significant reaction of domestic output for the Czech Republic. However, their focus is on the identification and consideration of structural breaks in the underlying time series. Therefore they use a sample which starts in the early 1990s. This might deliver one explanation for these surprisingly small effects and – in the Czech case – opposing results compared to our analysis. Further, the use of structural break dummies in their analysis may alter the results and thus explain the differences from our exercise.

5.3 Robustness of Results

Finally, we conduct some robustness checks to the FAVAR model, changing the set of variables, the number of unobservable factors, the number of lags, the alternative Cholesky ordering etc. First, we exclude certain blocks of variables from the factor analysis, such as trade turnover, exports and imports of goods, sentiment indicators, etc. The results are qualitatively unchanged as long as we keep a set of activity variables (GDP or industrial production) and price variables. Second, we look at the sensitivity of the results with respect to the number of common factors. As reported above, the results are again robust. When using only two factors instead of three, the results for activity remain more or less unchanged; however, we obtain some differences in the price responses. Since the overall fit of this model is lower, we opt for the model with three factors. On the other hand, increasing the number to four common factors (as suggested by the Bai/Ng criteria for the Czech Republic and Hungary) results in wide confidence bands, rendering

most of the results insignificant. Third, the results appear to be robust to changes in the number of lags used, therefore we keep the lag length of one quarter as suggested by the Akaike and Schwarz information criteria. Given the rather small sample size of 46 time periods, this also minimizes the degree of freedom loss in the model. Fourth, we add the rest of the world as a third regional block to the model in order to account for the influence of exogenous factors, which otherwise would erroneously be ascribed to the foreign monetary policy. This does not change the results, but results in a reduction of the degrees of freedom. Fifth, we change the order of unobservable common factors in the Cholesky decomposition, which has a minor effect on our results. Sixth, although the null hypothesis that lagged values of the variables for the Czech Republic, Hungary and Poland have zero coefficients in the euro area block is not rejected for any of the three countries in our analysis, we relax the Cushman and Zha (1997) assumption that the small country does not affect the large country. The effect of euro area monetary policy remains qualitatively unchanged, although the size of the confidence bands increases due to fewer degrees of freedom in the euro area equations. Seventh, we use the EONIA and main refinancing operation interest rates instead of the EURIBOR. The direction of the responses remains unchanged while the magnitude of the EURIBOR responses are typically less pronounced compared to the ones of the other two interest rates.[9] Finally, we also assess possible changes in the cross-border monetary transmission process during the financial crisis by excluding the years 2008 to 2010 from the sample period. This task was complicated by the extremely short sample period (the number of observations was reduced to 35) and wide confidence bands of the resulting impulse response functions, therefore any conclusions should be drawn with caution. However, we still see the negative response of activity variables in the Czech Republic, Hungary and Poland to a contractionary monetary policy in the euro area; moreover, the magnitude of the reaction is comparable to the full-sample results.

6 Conclusions

We use a FAVAR model to study cross-border effects of monetary policy in three Central and Eastern European EU member countries – the Czech Republic, Hungary and Poland. This method allows us to consider the largest possible number of economic variables, thus eliminating a potential omitted-variables bias in the sense of mistaking the reactions of monetary policy to economic variables for independent policy shocks. It further allows us to analyze the impact of monetary policy on a large number of time series.

The bulk of research on international monetary spillovers focuses on the U.S.A. Both the formation of the euro area in 1999 and the expansion of the EU in 2004 raised the interest in monetary policy spillovers from the euro area. While early studies on the euro area were mainly concerned with the transmission channels among euro area members, a nascent stream of the literature has also focused on the future EU members in Central, Eastern and Southeastern Europe. However, this part of the literature is not abundant to date, which may be due to the fact that the euro was introduced only a relatively short time ago and due to

[9] *The only significant difference is in inflation in Poland, which shows a different reaction when we use main refinancing operation rates or the EONIA instead of the EURIBOR. The results are available from the authors upon request.*

the even shorter period for which CEECs have been EU members. Nevertheless, this field of study is of utmost importance given the strong interlinkages between the euro area and these economies and these countries' plans to adopt the euro. Also, during the recent financial and economic crisis, the euro area took strong and supportive monetary action, thereby proving a large and dominant neighbor for the Czech Republic, Hungary and Poland (see Lenza, Pill and Reichlin, 2010, for the effectiveness of ECB monetary policy in the recent recession).

Based on a data set spanning roughly 170 to 200 variables for each region (the euro area and each of the three CEECs) over 46 periods (from the first quarter of 1999 to the third quarter of 2010), we first establish that the reactions of euro area variables to a contractionary ECB monetary policy shock show the expected signs and are of plausible magnitude.

Our analysis then shows that euro area monetary policy is a significant factor for all three CEECs. The response of real GDP to an unexpected increase in the euro area short-term interest rate by 50 basis points is negative and statistically significant. Thus, the overall economic reaction is similar in all three economies under consideration. This is not surprising given their homogeneity with respect to their openness to foreign capital flows and the degree of flexibility of their labor and consumer markets. Further, in recent years all three countries have adopted a similar monetary policy framework (inflation targeting). As monetary tightening in the euro area contracts real activity in the three CEECs, we can conclude that foreign demand and interest rate effects are dominant in the exchange rate channel for activity variables, although exchange rate movements are important for price indices. An unexpected increase in short-term euro area interest rates leads to a depreciation of the effective exchange rate in all three CEECs in the medium term, resulting in higher export and import deflators.

Nevertheless, we observe some heterogeneity in the individual responses. The strongest reaction is observed for Hungary, while we see the smallest contraction for Poland, the country whose trade links with the euro area are not as close as those of the other two countries. For economic activity variables, these differences relate only to the magnitude of the response and are particularly pronounced with respect to the trade variables. Hence, we conclude that differences in the degree of trade openness (which is of course also related to differences in country size) are mainly responsible for this finding. A potential direct interest rate effect may materialize in Hungary due to strong foreign currency borrowing in this country. Also, not taking account of Swiss franc-denominated loans and looking only at the ratio of euro-denominated loans to GDP, Hungary surpasses the other two countries by a factor of almost four. This compounds the foreign demand and general interest rate effects mentioned above and may explain the strong reaction of the Hungarian variables (especially private consumption) to the foreign shock. Thus, just as monetary policy in the euro area is likely to have supported economic activity not only within the euro area, but also in the neighboring CEE EU members, the ongoing and future exit from the loose policy stance back to a normalization of monetary policy is again likely to have considerable dampening effects on these countries. As such, the small and open CEE economies will have to monitor and analyze the design, timing and implementation of euro area monetary policy carefully in order to be able to react timely and sufficiently to the repercussions on their domestic economies.

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Appendix

Estimating Unobservable Factors

The dynamic factor model approach is commonly employed to extract common unobservable factors from a large set of variables. As in Bernanke, Boivin and Eliasz (2005) and Boivin and Giannoni (2008), we employ the less restrictive form of a dynamic factor model (DFM) – the approximate DFM (equation 2), obtaining common factors by the principal components method. Stock and Watson (2002a) prove that principal components are consistent estimates of common factors in an approximate DFM.

During the first step of the estimation of $\hat{F}_t$, the common factors $\hat{C}_t$ are estimated using the first K principal components of X_t. However, these common factors cannot be used in equation (1) directly. The Cholesky ordering often used[10] to identify the monetary shock assumes that latent factors do not respond to a monetary policy shock in the same period. Therefore one needs to eliminate the immediate effect of any monetary policy variable from $\hat{C}_t$ in a second step.

One way of doing so is to draw out the effect of policy variables directly from observable macroeconomic variables, as was done in Boivin and Giannoni (2008). The original paper of Bernanke, Boivin and Eliasz (2005) follows a slightly different route by splitting observable macroeconomic variables into "slow-moving" and "fast-moving" ones. "Slow-moving" variables are assumed to be largely predetermined in the current period and thus do not react to the monetary policy shock immediately, while "fast-moving" variables react instantly to a contemporaneous monetary shock.

[10] *See Bernanke, Biovin and Eliasz (2005) or Blaes (2009).*

Akin to Bernanke, Boivin and Eliasz (2005) we estimate "slow-moving" factors $\hat{F}_t^s$ as the principal components of X_t^s, the subset of "slow-moving" variables. By construction these factors are not immediately affected by the monetary policy shock. Regressing the common factors $\hat{C}_t$ on the set of extracted slow-moving factors and controlling for the policy rate (equation (A1)), we can extract the proportion of variance explained by slow-moving factors (equation (A2)).

$$\hat{C}_t = \beta_s \hat{F}_t^s + \beta_R R_t + \upsilon_t \tag{A1}$$

$$\hat{F}_t = \hat{\beta}_s \hat{F}_t^s + \hat{\upsilon}_t \tag{A2}$$

The system summarized by equations (1)-(2) can now be estimated by replacing the true unobservable factors F_t with their estimates $\hat{F}_t$ from equation (A2).

We make one slight modification to this classical Bernanke, Boivin and Eliasz (2005) methodology. Equation (2) states that all macroeconomic series from X_t are determined by a small number of unobservable factors as well as the current value of the observable policy instrument, irrespective of being "slow-moving" X_t^s or "fast-moving" X_t^f. Here we imply an additional restriction on Λ^R to be zero for "slow-moving" variables:

$$X_t^s = \Lambda^{F,s} \hat{F}_t + e_t^s \tag{A3}$$

$$X_t^f = \Lambda^{F,f} \hat{F}_t + \Lambda^{R,f} R_t + e_t^f \tag{A4}$$

This additional restriction does not alter the results when $T \to \infty$, as estimates of Λ^R for "slow-moving" variables should converge to zero if the assumption of no immediate effect of monetary policy is true. However, our additional restriction should ensure the consistency of results in short samples.

Table A1

Number and Grouping of Variables

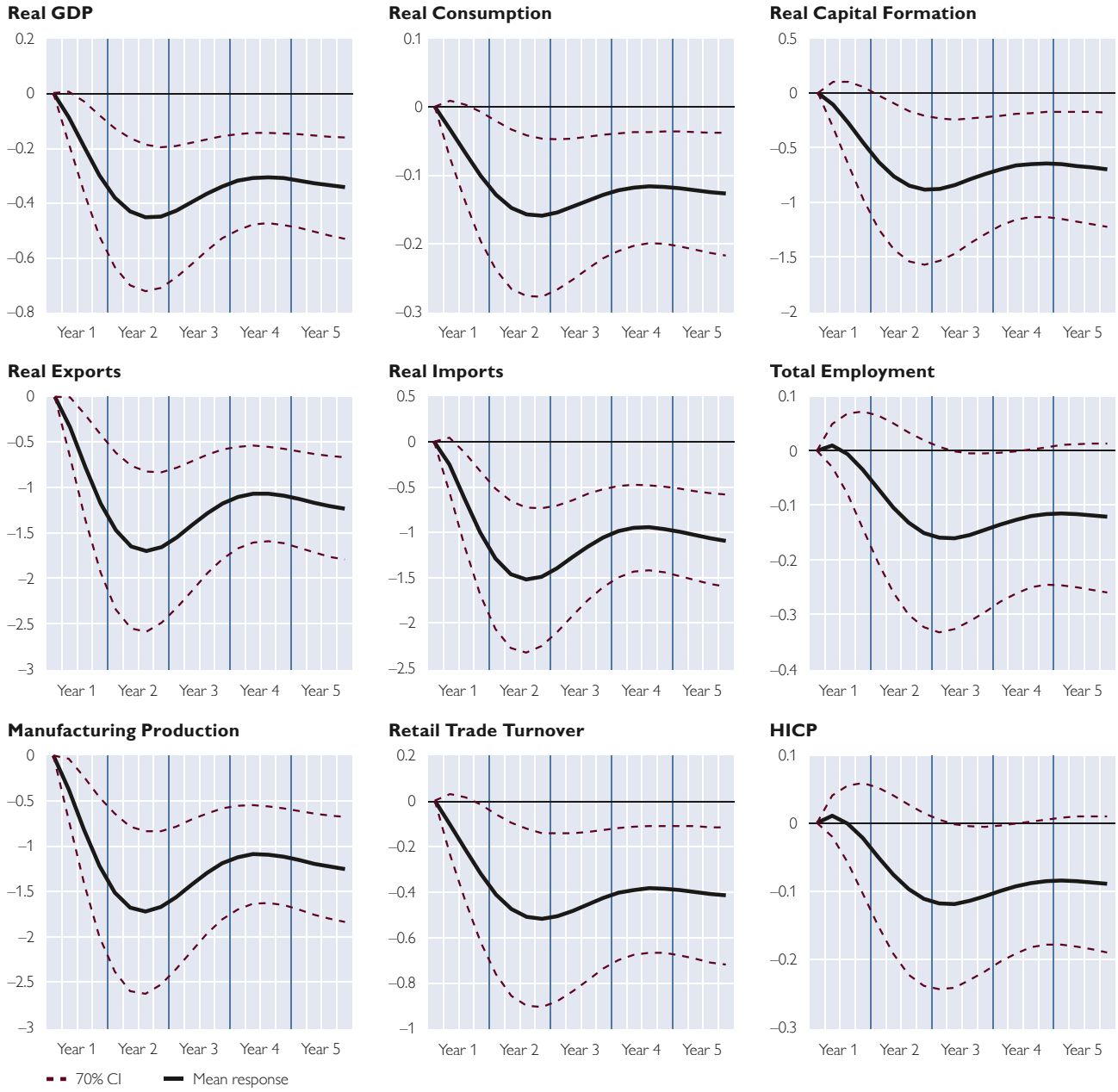
Variable block	Type	Number of variables			
		Euro area	Czech Republic	Hungary	Poland
Real GDP (expenditure side)	Slow	7	7	7	7
Employment by production sectors	Slow	8	8	2	1
Industry production index by sectors	Slow	32	30	32	32
Trade turnover by categories	Slow	29	20	16	16
Exports and imports of goods	Slow	20	20	20	20
Business and consumer confidence indicators	Fast	46	39	39	26
HICP by main categories	Slow	13	13	13	13
Industry producer price index by sectors	Slow	18	32	33	34
GDP deflator (expenditure side)	Slow	7	7	7	7
Exchange rates, nominal and real	Fast	7	9	9	9
Interest rates	Fast	2	2	2	2
Monetary aggregates	Fast	3	0	3	3
Deposits and loans	Fast	6	0	0	0
Total "slow-moving" variables	Slow	134	137	130	128
Total "fast-moving" variables	Fast	64	50	53	42
Total		198	187	183	170

Source: Authors' calculations.

Chart A1

Euro Area: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



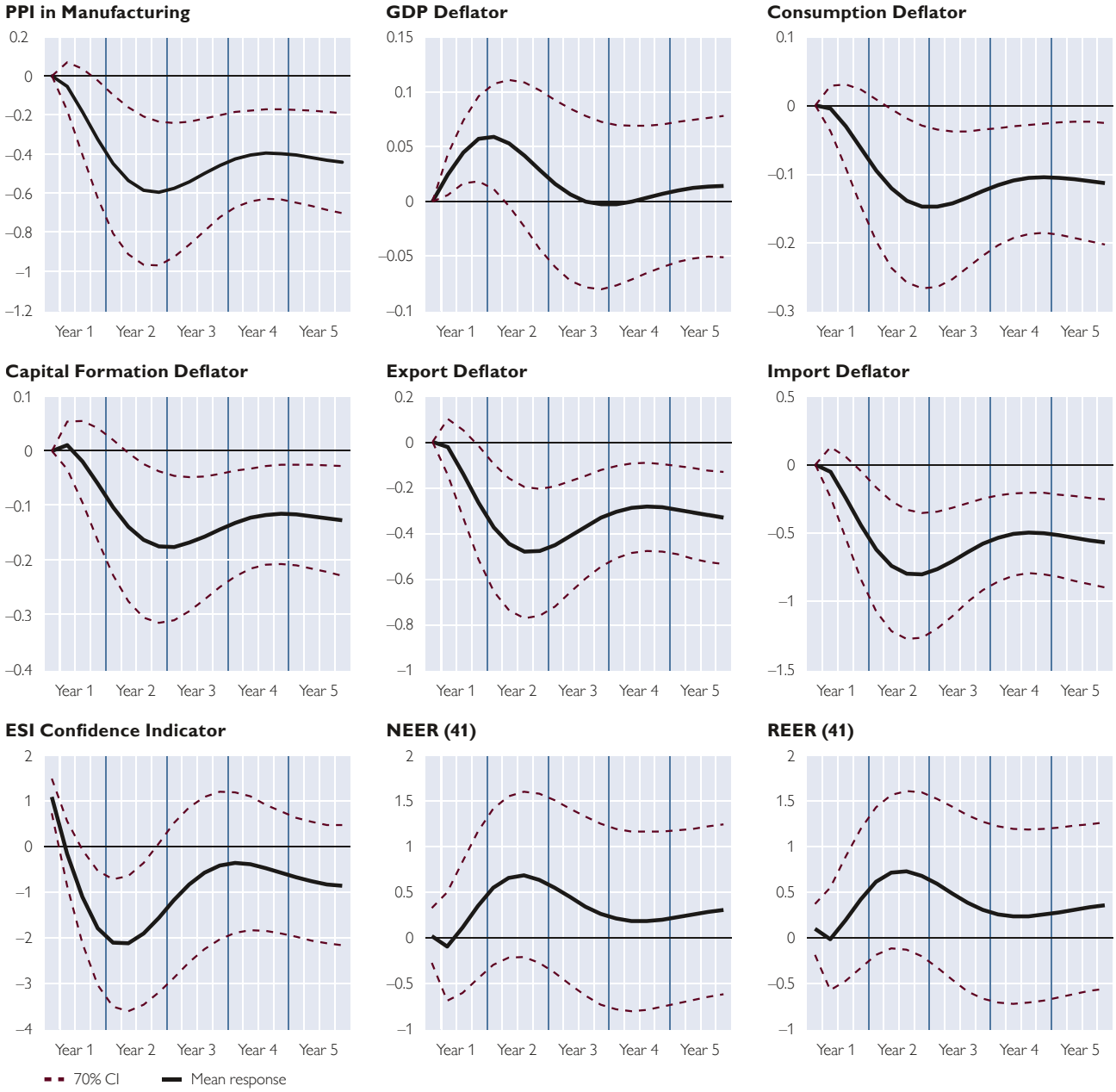
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A1 (continued)

Euro Area: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



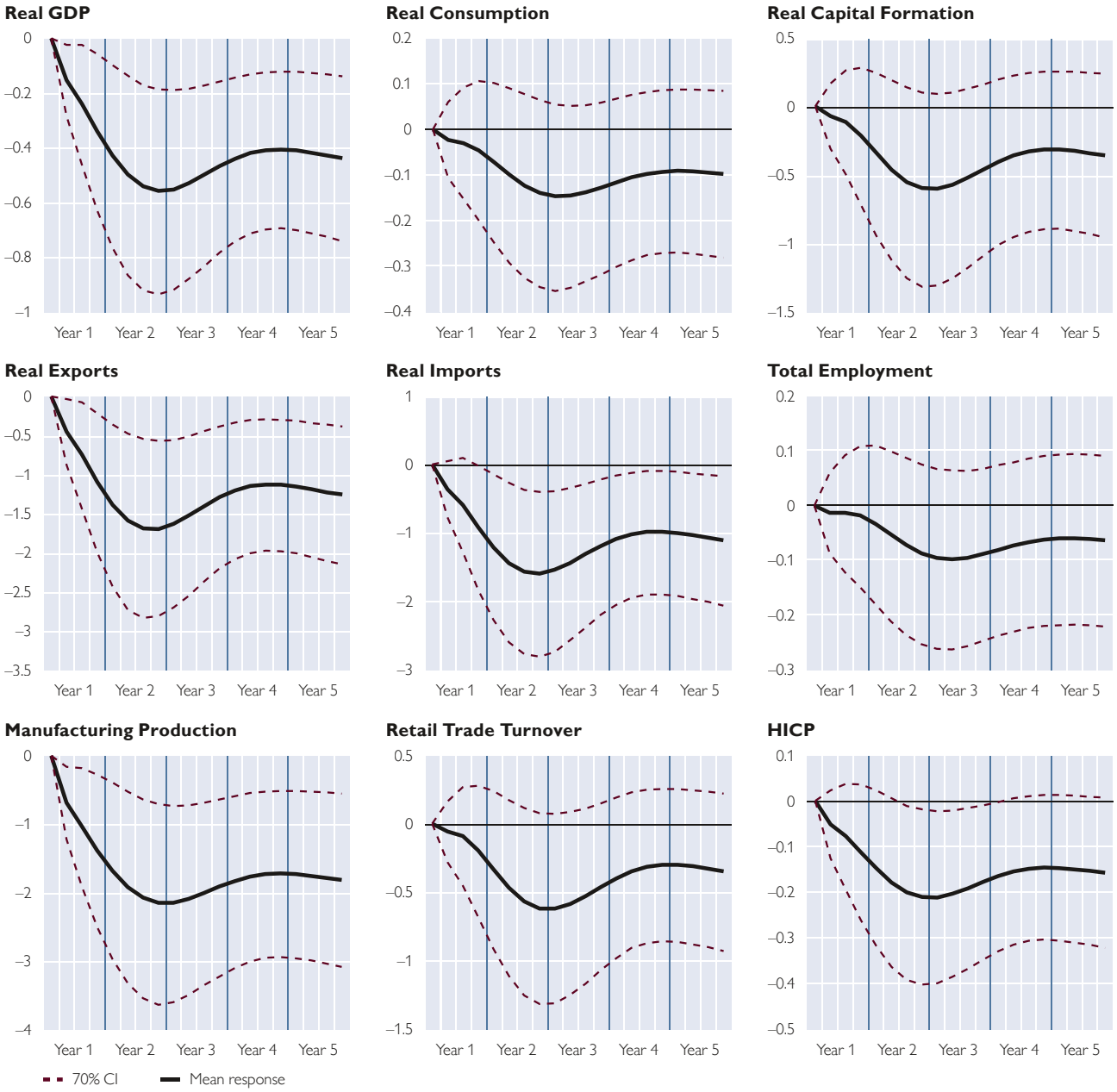
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A2

Czech Republic: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



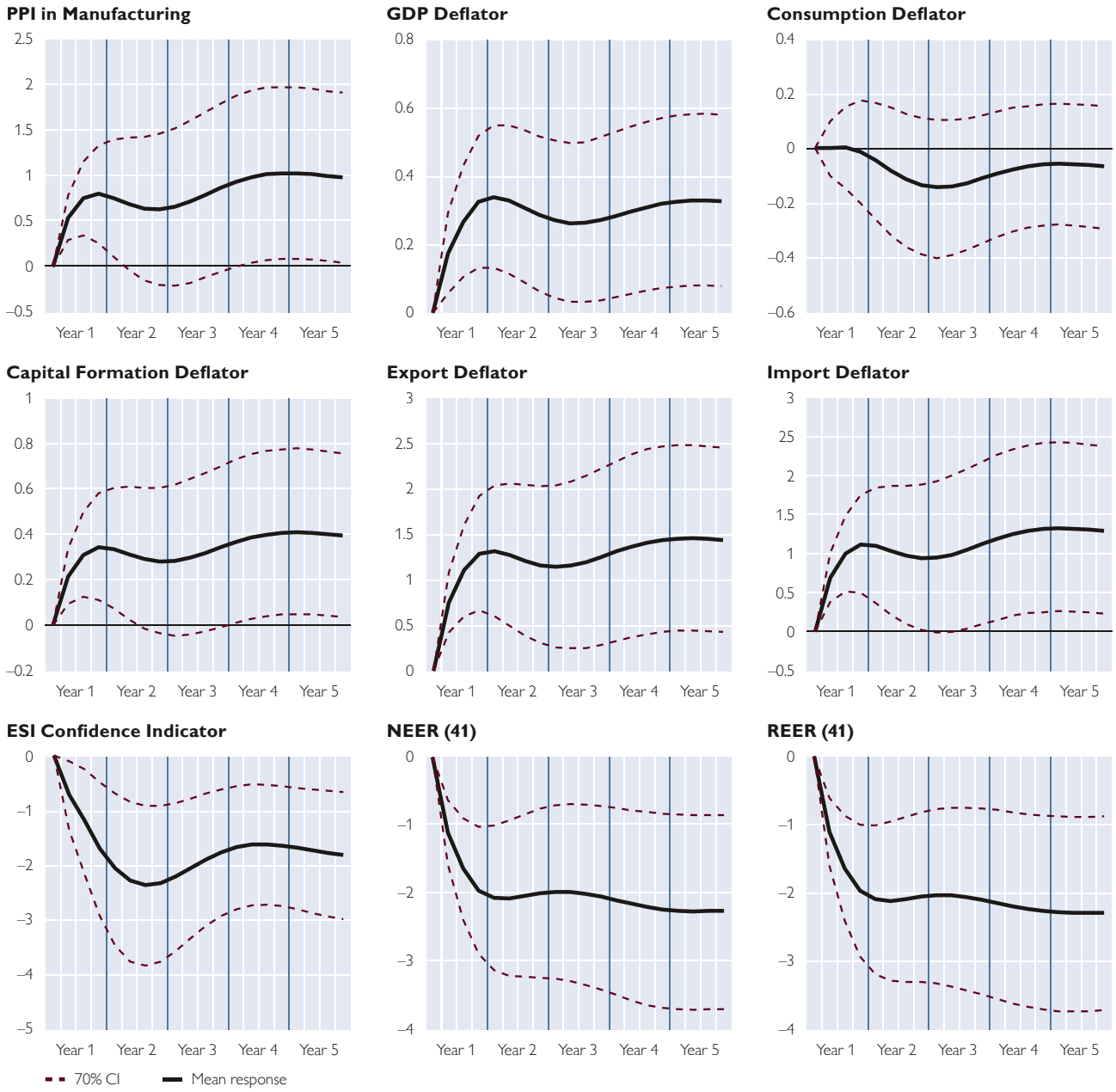
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A2 (continued)

Czech Republic: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



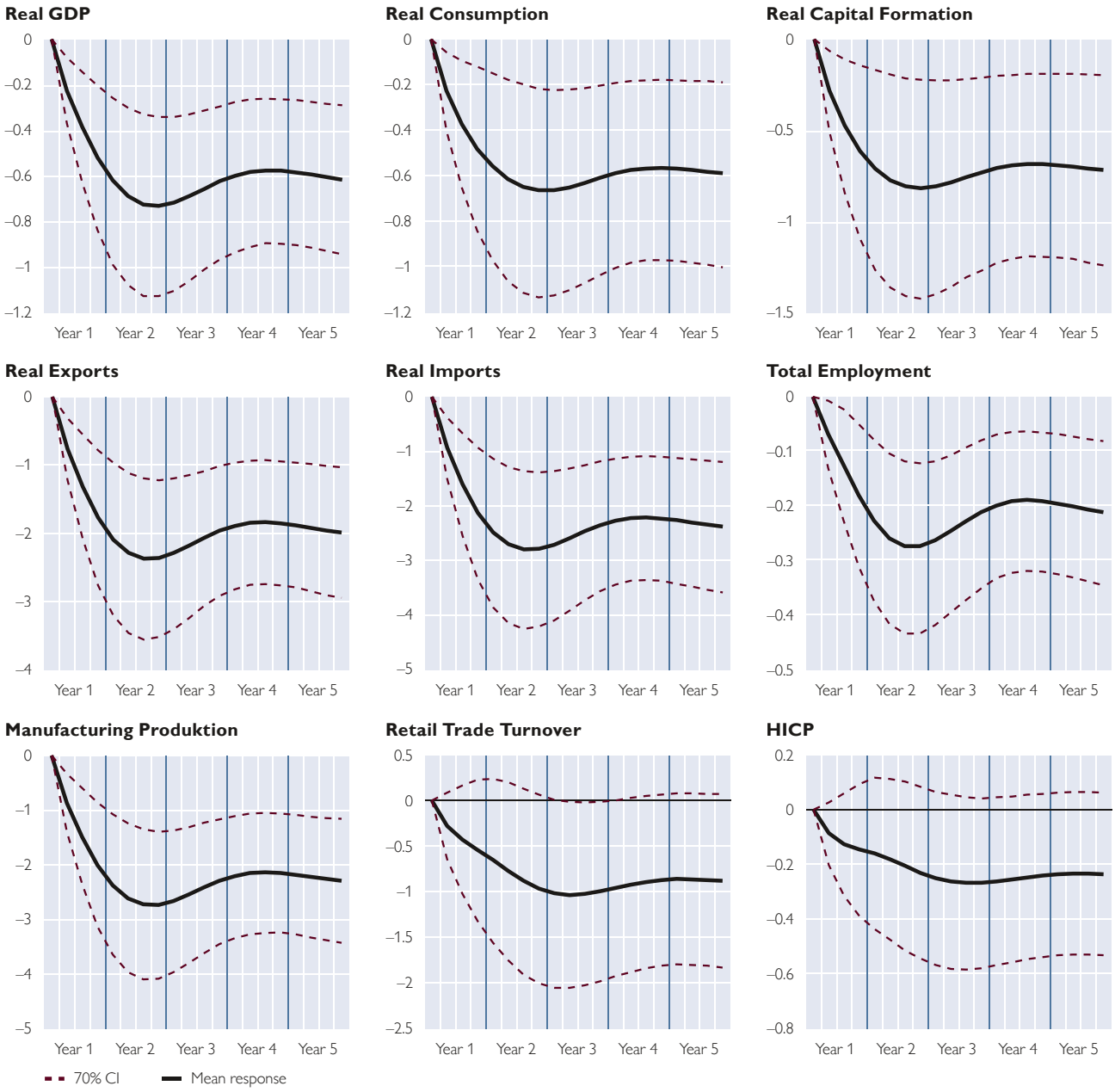
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A3

Hungary: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



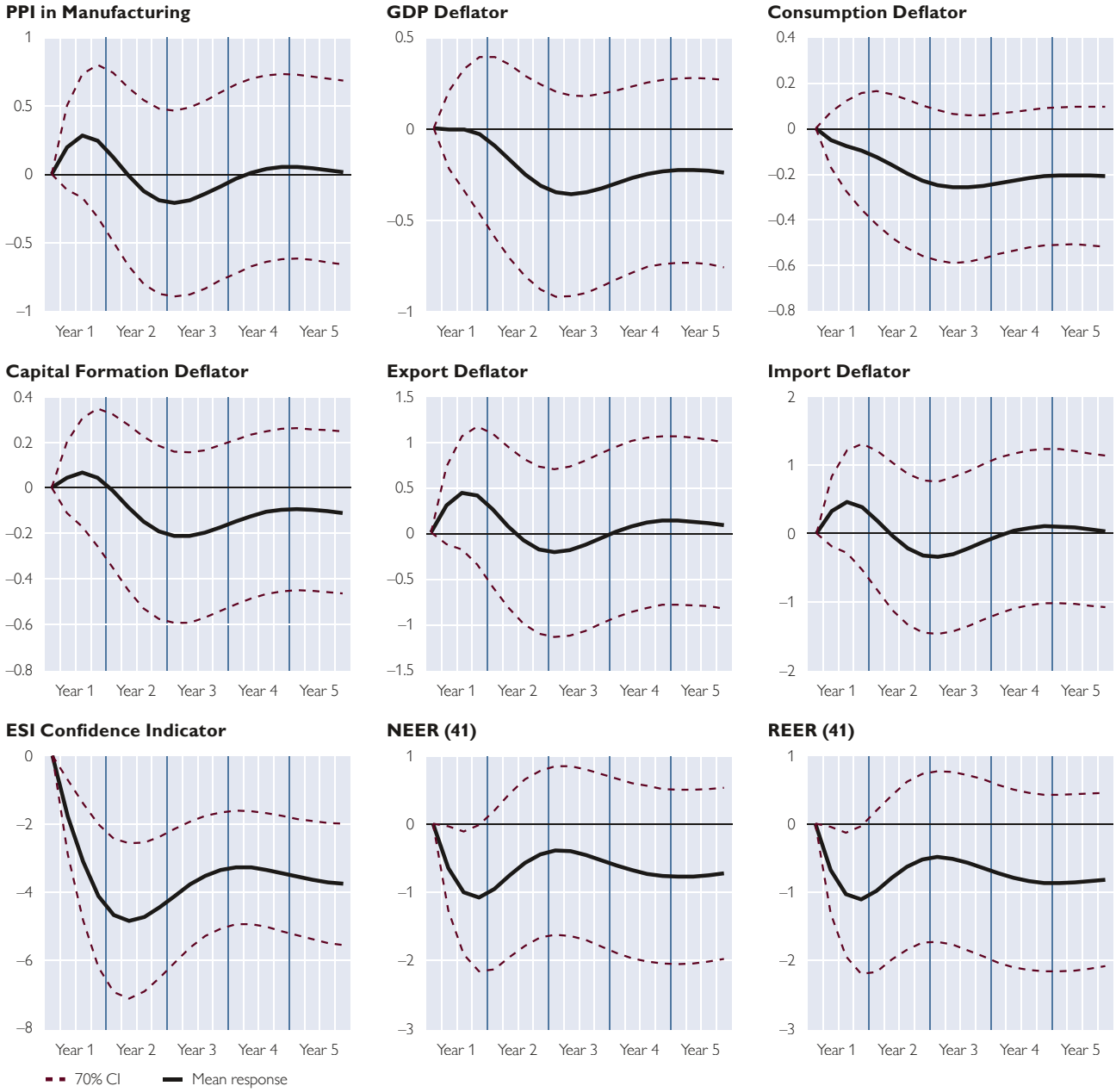
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A3 (continued)

Hungary: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



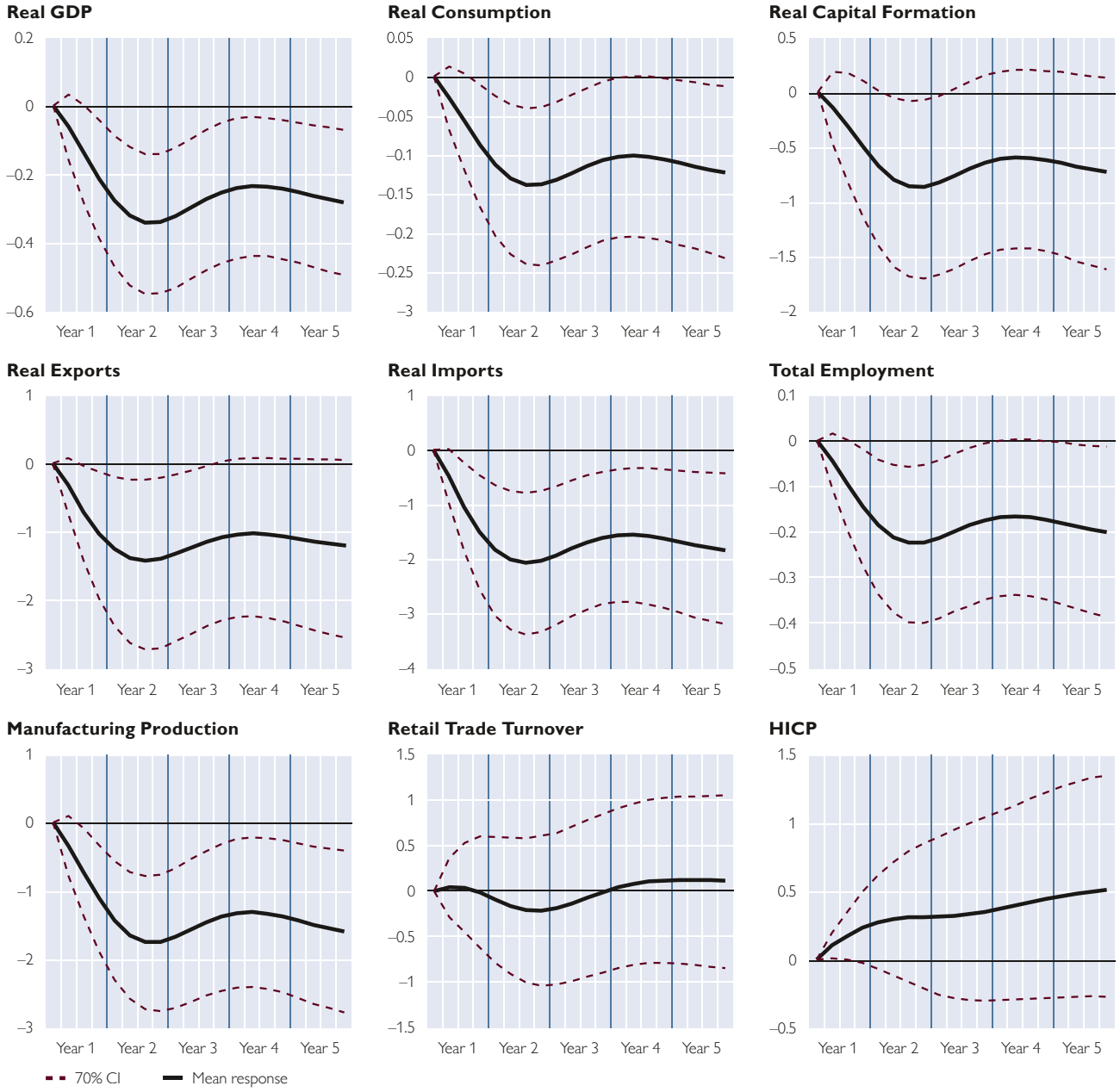
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A4

Poland: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



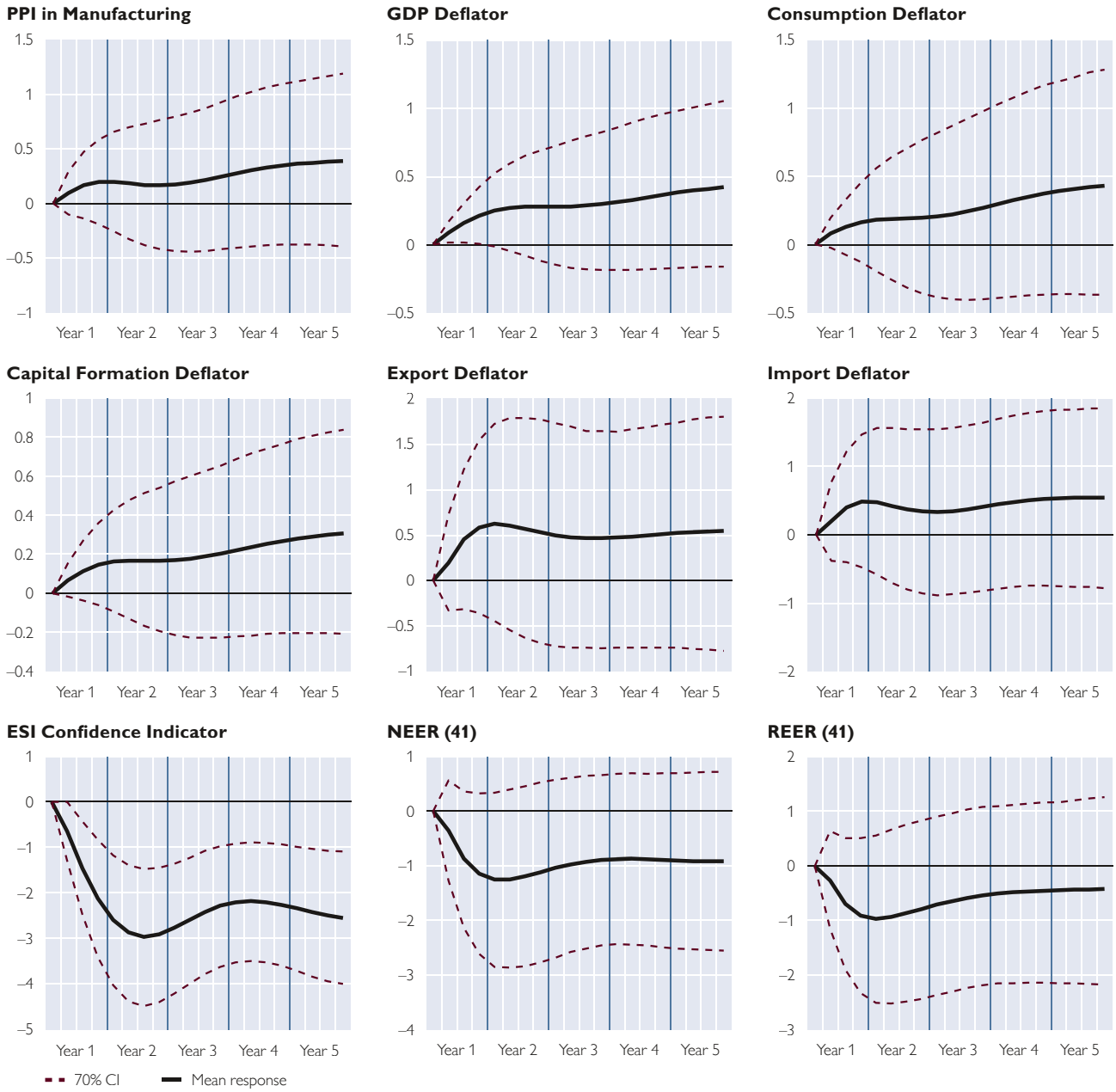
Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Chart A4 (continued)

Poland: Comparison of Impulse Responses to a Euro Area Monetary Shock

Cumulative deviation from baseline in % in response to a 50 basis point increase in changes of the 3-month EURIBOR, with 70% confidence bands



Source: Authors' calculations.

Note: See equations (3) and (4). Confidence bands calculated using bootstrap-after-bootstrap method, see Kilian (1998).

Shifts in International Trade and Value Added from 1995 to 2007: Insights into the Drivers of Growth

Joseph F. Francois,
Julia Wörz[1,2]

We decompose global export growth into a structural and a pure growth component in order to highlight the importance of structural change at the regional and industry level for the impressive growth performance of international trade. For this, we combine data on exports, output and sector-specific prices for a sample of roughly 150 countries and 22 manufacturing industries over the period from 1995 to 2007. While structural change played only a minor role for Western Europe, NAFTA and also Southeast Asia over this period, the region of Central, Eastern and Southeastern Europe shows an outstanding amount of restructuring at the industry level. Especially the new EU member countries were rapidly restructuring toward globally important industries despite their initial harmful specialization pattern. Furthermore, this region shows by far the highest elasticity of exports to output and demand changes at the industry level. While we do not observe an excessive reaction of exports to output expansion at the level of individual industries, exports react highly elastically to changes in global demand. However, elasticity differs greatly among individual regions and among industries. This corroborates the view that rapid growth in world trade arises from changes in the regional and sectoral composition of global production and trade, with faster-growing economies moving rapidly into more trade-intensive activities.

JEL classification: F14, F15, O57
Keywords: Trade growth, industrial export structure, trade elasticities, Central, Eastern and Southeastern Europe

1 Introduction

For many years, the global trade volume expanded considerably faster than global output. While real annual export growth was at 6% on average over the past 15 years, global GDP and production grew only half as fast in real terms, namely by approximately 3% per annum (WTO, 2010). Similarly, trade fell disproportionately strongly in the recent crisis, which again triggered calls for explanations for the "overshooting" in the trade response to the economic crisis. What factors caused trade to grow faster than world output over the past decades? And are these factors going to shape world trade growth in the future? In this paper we attempt to identify the drivers of export growth by decomposing real world export growth into its regional and sectoral components. We will put special emphasis on Central, Eastern and Southeastern European (CESEE) economies. Their export orientation played an important role in their successful catching-up performance shown over the past two decades. Not only export growth was impressive for the region, CESEE export patterns were also subject to enormous qualitative upgrading and regional reorientation. In a recent time series analysis, Fidrmuc and Martin (2011)

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[2] *This paper was prepared for the Conference of European Economic Integration "Catching-Up Strategies after the Crisis" organized by the Oesterreichische Nationalbank in Vienna on November 15 and 16, 2010. The authors would like to thank Doris Ritzberger-Grünwald, Peter Mooslechner, Jarko Fidrmuc, Martin Schneider, Mariya Hake and Josef Schreiner (all OeNB), two anonymous referees as well as participants of the 12th ETSG meeting in Lausanne, the wiiw Seminar in International Economics (Vienna) and the OeNB Conference on European Economic Integration (Vienna) for their comments. We are indebted to Angelika Knollmayer and Andreas Nader for their research assistance.*

find empirical evidence for the export-led growth hypothesis in the new EU Member States. Hence, the recovery of the global trading system will continue to be of importance for the future development in the region (EBRD, 2010).

Several reasons have been identified to explain the continuously strong global trade growth prior to the recent collapse. One prominent strand of the literature focuses on the role of institutional factors, such as the dismantling of trade barriers within the GATT/WTO negotiations, the European economic integration process or similar developments in other regions (see Baldwin, Martin and Ottaviano, 2001). Strong trade growth is often attributed to, for instance, falling trading costs as a result of lower or abolished tariff and nontariff barriers, improved business conditions, falling transportation costs or technological progress (see e.g. Hummels, 2007, on transportation costs; Anderson and van Wincoop, 2004; and Jacks, Meissner and Novy, 2008, on trade costs more generally). Another explanation refers to the increasing fragmentation of production, also called international outsourcing, and the rising importance of global value chains (Feenstra, 1998). Although vertical specialization is more frequently studied within the context of foreign direct investment, it clearly has strong implications for traditional trade flows. Finally, another strand of the literature analyzes the income elasticity of trade (Baier and Bergstrand, 2001; Irwin, 2002). These studies usually report an income elasticity of trade of 2 or even higher. As to Central and Eastern Europe, a number of studies exist for individual countries. For example, Bobić (2010) stresses that the sensitivity of exports to income is rather high for Croatia (2.5), while the response to price changes is much more modest. Tomšík (2000) estimates the income elasticity of exports to be 5.3 for the Czech Republic, which is contrasted by Benáček, Podpiera and Prokop (2005), who report a value of 1.5. Wdowinski and Milo (2002) find an estimate of 2.1 for Poland, and Mervar (2003) of 0.9 for Croatia. All these studies analyze aggregate trade flows without differentiating between individual industries.

It is interesting to note that the explanations for the recent "trade collapse" are strikingly similar to those referred to as long-run determinants of global trade. The very recent, rich literature proposes the following reasons for the strong negative trade reaction in the crisis: sharply rising trade costs including problems with trade financing (Auboin, 2009; Chauffour and Farole, 2009), the increased importance of vertical specialization manifested in increasing global supply chains (Escaith, 2009; Yi, 2009) and falling demand (Bems, Johnson and Yi, 2010; Eaton et al., 2010; Freund, 2009). In addition, structural differences between domestic and external economic structures have lately been put forward as another explanation for the recent trade collapse in connection with an asymmetric crisis impact on different types of goods. Capital and investment goods were clearly affected more strongly in the crisis than nondurables and consumption goods, these goods also account for a large fraction of international trade (Francois and Woerz, 2009; McKibbin and Stoeckel, 2009).

In this paper, we take a long-term view on global trade and apply a sectoral decomposition to analyze the long-run growth of real world exports. Decomposing global export growth into its structural components, we find that the long-term rise in world export volumes largely reflects regional and sectoral shifts of emerging economies into more trade-intensive activities, such as machinery, electronic goods, motor vehicles, chemicals and textiles. In order to test our hypothesis that

world export growth can plainly be explained by decomposing aggregate trade flows into their structural and regional components, we estimate the elasticity of exports to supply and demand conditions at the detailed industry level. We take our rather low elasticity estimates as evidence that the export response to changes in demand and supply conditions is not unusually strong. Once we move the analysis to the level of individual industries, we observe a great differentiation depending on the region as well as on the industry under consideration. This suggests that changes in the country and industry composition of global trade are important in explaining the often cited rising elasticity of global trade to income at the aggregate level. When faster-growing economies are moving rapidly into more trade-intensive activities, this will cause an increase in the overall elasticity of trade to world GDP.[3]

A novel aspect of our analysis is the use of sector-specific price indices, which are used in deflating export and domestic production data. This seems to be important since radically different price developments were observed in different industries. While for instance prices for office and accounting machinery, including computers, fell drastically in the last two decades, prices for chemicals, food and beverages increased considerably.

The paper proceeds as follows: In the following section, we describe our database and provide some descriptive statistics of world export growth in a regional and sectoral perspective. In section 3 we develop a decomposition of export growth into a pure growth effect (abstracting from structural change) and two structural effects (the effect of initial specialization and the effect of changes in specialization patterns). In section 4 we use simple growth-accounting relationships to differentiate between the traditional trade-to-GDP elasticity and an export-to-output elasticity measure at the industry level. We moreover calculate export-to-demand elasticity. We have to differentiate between output and demand since there is no equivalent to GDP at the sector level. Section 5 concludes, placing special emphasis on the CESEE region.

2 Stylized Facts in World Trade since 1995

Our focus is on analyzing long-term regional and sectoral patterns of trade and the trade response to output growth. To this end, we take a look at the detailed industry level, which implies that we have to combine data from different sources. For trade data, we use the UN COMTRADE database. Using WITS,[4] we aggregate 6-digit HS export and import data directly into 2-digit ISIC (revision 3) industries. Data on domestic production (value added, output, wage and employment) are taken again at the ISIC (revision 3) 2-digit level from the UNIDO Industrial Statistics Database 2010. All data are given in U.S. dollar, converted at year-average exchange rates from the IMF's International Financial Statistics database. In total,

[3] *In other words, the apparent "puzzle" of extraordinary trade growth can be deconstructed in analogy to the demystification of the East Asian growth miracle by Young (1995), who showed that the extraordinary growth performance of the four East Asian "tigers" can be explained in a satisfactory way by rapid factor accumulation and structural shifts of labor from relatively unproductive (agricultural) activities into highly productive manufacturing sectors.*

[4] *WITS, short for World Integrated Trade Solution, is a software giving access to the UN COMTRADE database and was developed jointly by the World Bank and UNCTAD. It is possible to aggregate countries and goods prior to downloading data.*

we arrive at a sample consisting of a maximum of 196 countries over the period 1995 to 2007. The sample covers 22 manufacturing industries ranging from ISIC (revision 3) code "15" (food) to "36" (other manufacturing). On average, 150 exporters report trade data every year. Thus, we obtain roughly 40,000 observations spanning 13 years.

We classify countries broadly into seven geographic regions. The EU-15 comprise all EU Member States prior to the 2004 enlargement round. NAFTA includes the U.S.A., Canada and Mexico. CESEE countries are divided into two regions: the CEE-10 refer to the ten EU Member States which joined the EU in 2004 and 2007, while the remaining ten Eastern and Southeastern European countries are grouped as CIS & Balkans, including Russia. Southeast Asia contains ten ASEAN members plus China, India, Japan and South Korea. Latin America consists of 14 mainland Latin American countries. All remaining countries are classified as rest of the world (ROW). A list of all countries and their grouping is given in table A1 in the annex.

A major concern was to deflate all data in order to reflect different price developments within individual industries. Since industry-specific price deflators were not available for all countries in the sample, we use sectoral U.S. prices as a proxy. This implies the rather crude assumption that price developments do not vary across countries; however, it does take account of the fact that certain goods (e.g. computers) were becoming constantly cheaper over the observation period, while other goods (e.g. chemical products and food and beverages) were subject to continuous price increases. We use industry-specific U.S. import price indices to deflate export data. Since the U.S. imports goods from almost all countries in the world, we are confident that these price indices reflect average world price developments for traded goods. For domestic production data (value added, output and wages), we use the U.S. producer price index.

A detailed description of the major stylized facts in global trade flows from 1995 to 2009 is given in Francois and Wörz (2011). Regardless of the recent crisis, we observe a global shift of world output and trade toward emerging economies as a consequence of the large growth differential between the two groups of countries. Average real export growth amounted to 6.9% in advanced countries over the 1995 to 2007 period, only about half the 13.3% annual growth performance recorded for emerging markets' exports. The impressive growth of Southeast Asia's share in world exports is not least due to the rising importance of the Chinese economy. But also the CEE-10 and CIS & Balkans were expanding their world market shares rapidly over this period. The gains in world market shares by the emerging countries of Southeast Asia and the CEE-10 came mainly at the expense of Western Europe, NAFTA, Japan, but also Latin America.[5]

We furthermore observe a huge growth gap between exports and GDP. Several factors can explain this growth differential. One of them is related to structural differences between domestic output and the external sector: GDP largely consists of nontradables, the share of services in GDP is often around 70% and services continue to be considerably less suitable to trade than goods. Another explanation

[5] *Within Western Europe, Germany maintained its world market share remarkably well, which may be related to European integration and the accompanying rising importance of intra-EU trade.*

of this growth differential may be found in conceptual differences between GDP (which is a value-added concept) and exports (which are measured on a gross basis). Finally, the increasing importance of outsourcing and fragmentation is also frequently cited in this context.

The rising importance of individual players in global exports went hand in hand with a great deal of restructuring over the past two decades. When measured in constant prices of the year 2000, the five most important industrial activities in 2007 were machinery and equipment; radio, TV and communication equipment; motor vehicles; chemicals and related products; accounting and office machinery. Together, these industries accounted for 58% of world manufacturing exports, whereas in 1995 their cumulative share was 44%. Rather diverse developments were observed for each of these industries as from 1995: Motor vehicle exports represented the most important category in world trade, accounting for 12.5% of all manufacturing exports in 1995. This share fell to 10% in 2007. Also, the share of other transport equipment was on a moderate but continuous decline, from 4% to 3% of real manufacturing exports. The 2008–09 crisis reinforced these developments. Motor vehicles were hit most strongly among manufactured goods during the crisis. On the other hand, exports of office and accounting machinery showed a tremendous increase in real terms (i.e. accounting for the price decline in this category). The share of computers and related products in the global export volume rose from 2% in 1995 to 9% in 2007. Real export shares of machinery and equipment as well as radio, TV and communication equipment also increased from 9.4% and 8.4%, respectively, in 1995, to more than 13% by 2007, while the share of chemicals and chemical products remained rather constant at 11% in this period.

The regions reporting the highest real export growth rates – the CEE-10, CIS & Balkans and Southeast Asia – are also increasing their world market share in the most important trade categories. In particular, Southeast Asia is moving strongly into exports of machinery, communication equipment, and computers. In the latter category, this region is dominating the world market in real terms, with a world market share exceeding 50%. The CEE-10 increased their world market shares in all five globally most important categories. The increase was particularly strong in motor vehicles, where they held a market share of 7% in real terms in 2007. This is nearly twice as high as their market share in total merchandise exports of 4.4% in 2007 (up from 2.2% in 1995).

It should be noted that, out of all the regions in our sample, the CEE-10 region probably underwent the most dramatic structural change during the observation period. This is not surprising for transition countries. Interestingly, the impressive real export growth of the region went hand in hand with substantial structural change at the industry level. In the next section, we will systematically extract the contribution of structural change to export growth.

3 Decomposing Global Export Growth

We are interested in a decomposition of real trade growth along several dimensions, including the national and regional components of changes in trade, the sector composition of changes in trade, and finally also changes in the sector composition of regional trade. To do this in a more systematic way than in the previous section, we developed a simple decomposition of export growth into a pure growth component, the contribution of the initial industry structure and

the component added by structural change.[6] We start by defining exports $X_{i,c}$ very generally as exports X in sector i by region c. Total exports of region c are then given by $X_c = \sum_i X_{i,c}$. We define export shares by region for each sector as:

$$\varphi_{i,c} = \frac{X_{i,c}}{\sum_i X_{i,c}} \tag{1}$$

Globally, we can also define global shares by industry, i.e. by summing up a given industry's exports over all exporters:

$$\Phi_i = \frac{\sum_c X_{i,c}}{\sum_c \sum_i X_{i,c}} \tag{2}$$

Our first decomposition is related to national deviations from the global composition of trade. By definition, the proportionate change in a region's exports from one time period to the next can be written as:

$$\dot{X}_c = \frac{X_c^1 - X_c^o}{X_c^o},$$

where we used $\dot{X}$ to denote a proportionate change. We can rearrange this basic definition as follows:

$$\begin{aligned}
\dot{X}_c &= \frac{X_c^1 - X_c^o}{X_c^o} = \sum_i \frac{X_{i,c}^1 - X_{i,c}^o}{X_c^o} = \sum_i \frac{X_{i,c}^1 - X_{i,c}^o}{X_c^o}\frac{X_{i,c}^o}{X_{i,c}^o} = \sum_i \frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o}\frac{X_{i,c}^o}{X_c^o} = \\
&= \sum_i \varphi_{i,c}^0 \frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o} = \sum_i \varphi_{i,c}^0 \frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o} + \sum_i \left(\Phi_i^0 - \Phi_i^0\right)\left[\frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o}\right] = \\
&= \sum_i \Phi_i^0 \left[\frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o}\right] + \sum_i \left(\varphi_{i,c}^0 - \Phi_i^0\right)\left[\frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o}\right]
\end{aligned} \tag{3}$$

In arriving at the final version of equation (3), we have employed a number of manipulations of the basic definition of rates of change, rearranging the total rate of change to reflect the contribution of each constituent sector i to the total change for region c. The final version of equation (3) gives national exports, decomposed into a global effect, and an exporter effect based on regional deviations from the global industry pattern in the beginning. We can also specify a decomposition of changes in national exports based on deviations from global export growth rates within each industry. To do this, we define global exports of an industry as follows:

[6] *Our decomposition approach looks similar to, but differs conceptually from the traditional shift-share analysis or constant market share analysis, which is used to decompose world market shares, i.e. the changing importance of individual regions in world exports. Since we are interested in decomposing the growth of exports, we decompose the change in export volume. In either exercise, the total change in the variable of interest (growth or market share) is decomposed into a pure growth effect and different structural components.*

$$X_i = \sum_c X_{i,c} \tag{4}$$

Leaving implicit a manipulation similar to the one made explicit in equation (3), our second decomposition is related to national deviations from the global growth patterns within each industry. The change in a region's exports can thus also be written as:

$$\dot{X}_c = \frac{X_c^1 - X_c^o}{X_c^o} = \sum_i \varphi_{i,c}^0 \left[\frac{X_i^1 - X_i^o}{X_i^o} \right] + \sum_i \varphi_{i,c}^0 \left[\frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o} - \frac{X_i^1 - X_i^o}{X_i^o} \right] \tag{5}$$

Finally, we can also define a combined or total decomposition based on (3) and (5) as follows:

$$\dot{X}_c = \frac{X_c^1 - X_c^o}{X_c^o} = A + B + C$$

A: global change in total exports = $\sum_i \Phi_i^0 \left[\frac{X_i^1 - X_i^o}{X_i^o} \right]$ (6)

B: initial deviation from global industry structure = $\sum_i \left(\varphi_{i,c}^0 - \Phi_i^0 \right) \left[\frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o} \right]$

C: shift in composition = $\sum_i \Phi_i^0 \left[\frac{X_{i,c}^1 - X_{i,c}^o}{X_{i,c}^o} - \frac{X_i^1 - X_i^o}{X_i^o} \right]$

In equation (6), the first term, A, captures changes in the global volume of exports. In the case where region *c* is identical in initial export structure and in structural change to the global average, this also represents the change in export volume for region *c*. Put differently, the term A captures the pure growth effect in the absence of changes in the underlying sector structure. The terms B and C capture reasons why region *c* may have export growth that is different from the global average. Both of these terms refer to a different impact of the sector structure of trade. In other words, a large contribution of these two effects to the region's overall export growth reflects a high importance of industrial structure or structural change for the region. The second term, B, captures differences in the importance of various sectors *i* for region *c* – for example if steel exports are more important for region *i* than they are for the world as a whole. This reflects the contribution of the initial export structure to subsequent export growth. A positive effect implies that the region's initial export structure is beneficial for future export growth. In contrast, a negative value would reveal that the initial industry structure has been a drag on subsequent growth. The final term, C, captures differences in the change in exports at the sector level for region *c* relative to the world – for example if steel exports fall or rise more for region *i* than they do for the world as a whole. This effect quantifies the importance of structural change for export growth. A positive value would again reveal a growing share of industries with a large share in global trade, which thus improves the region's trade performance.

Table 1

Structural Decomposition of World Export Growth, 1995–2007

	Cumulative export growth	A – Pure global growth effect	B – Initial specialization effect	C – Effect of structural change
	%	*percentage points*		
CEE-10	445	175	–678	948
CIS & Balkans	283	175	–142	250
Southeast Asia	260	175	36	50
ROW	242	175	–90	158
EU-15	125	175	–7	–42
Latin America	115	175	–166	106
NAFTA	117	175	7	–64

Source: Authors' calculations.

Note: ROW denotes the rest of the world.

Table 1 reports the results of this decomposition analysis applied to exports. While the EU-15, NAFTA and also Latin America recorded a cumulative growth performance over the 1995 to 2007 period which remained below the global export growth rate of 175% in the absence of structural change (i.e. they were relatively underperforming), both CESEE regions (the CEE-10 and CIS & Balkans) and the Southeast Asian countries posted export growth beyond the "pure growth" effect. Structural change played only a minor role for the two most advanced regions in our sample, NAFTA and the EU-15. In both regions the contribution of structural change to overall export growth was negative, i.e. they were growing more slowly than the world average in those economic activities whose importance in global trade was increasing.

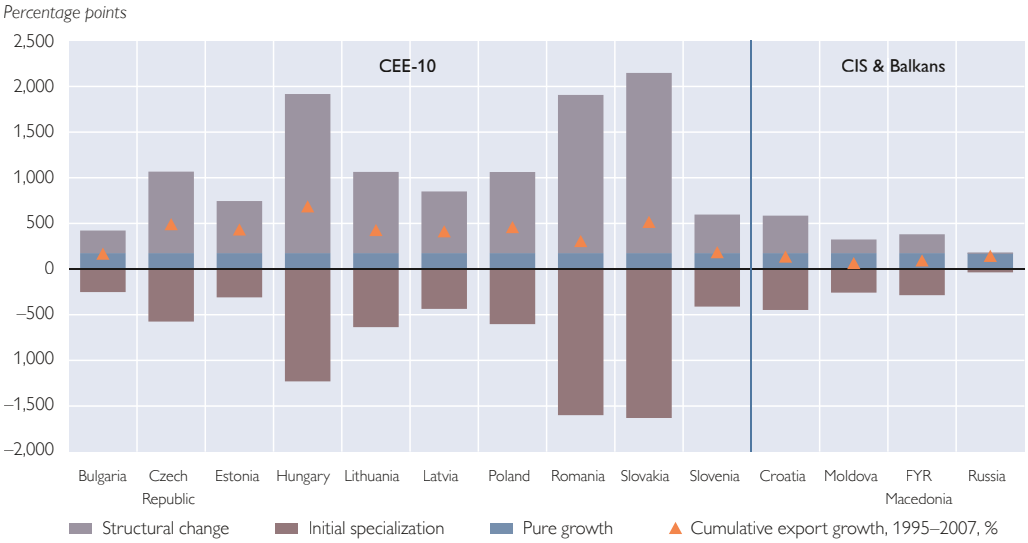
When looking into the two effects of industrial structure on the successful emerging regions' export growth, we find an interesting distinction between CESEE and Southeast Asia. The initial export structure of the CESEE countries was not conducive to future rapid export growth. However, the CEE-10 exhibited substantial structural change, showing particularly strong export growth in industries with great global importance. Thus, they managed to change their initially unfavorable export structure toward an export structure well aligned with world patterns. This reflects their structural catching-up process. In contrast, Southeast Asia shows less evidence of structural change over the period from 1995 to 2007. The already beneficial initial export structure was supported by favorable structural change, both effects were positive for this region and added about one-third to the above-average export performance over the period.

Latin America also showed some restructuring toward fast-growing industries, this effect was, however, not strong enough to offset the region's unfavorable initial export structure.

To summarize the global decomposition of real export growth in the recent past, the CEE-10 clearly represented the region characterized by the most substantial shift of export shares at the industry level. This region also exhibited the most dynamic export growth performance in real terms – despite the region's particularly strong specialization in motor vehicles, whose share in global trade flows has actually been declining gradually (although export growth is still high in this category in absolute terms and motor vehicles are one of the most important

Chart 1

Structural Decomposition of CESEE Export Growth, 1995–2007



Source: Authors' calculations.

export categories). At the same time, the CEE-10 moved strongly into globally fast-rising export sectors, such as machinery, communication equipment and office and accounting machinery. This longer-term trend can be attributed to the positive effects of EU integration. As observed also by Havlik (2008), the CEE-10 increasingly specialize in high-tech and medium-high-tech products, and EU accession and FDI inflows certainly promoted the industrial restructuring process and modernization. Fidrmuc and Martin (2011) furthermore show that exports were a major growth determinant in CESEE countries. Contrary to this development, CIS & Balkans showed hardly any signs of restructuring toward higher-tech activities and reinforced their specialization in resource-intensive industries, such as metals and petroleum refineries. Havlik (2008) attributes this to a delay of policy reforms and weak performance in attracting FDI.

Given the uniqueness of the CEE-10 region, chart 1 shows the contribution of all three effects to total cumulative real export growth in more detail. Structural change toward rapidly growing export sectors was most pronounced in Hungary, Romania and Slovakia. Owing to substantial restructuring over the observation period, these countries moved away from the initial disadvantageous specialization patterns prevalent in the mid-1990s. Poland and the Czech Republic likewise show significant structural change, while the CIS & Balkan countries (including Bulgaria) do not exhibit a great deal of structural change, which results in generally lower export growth in those countries. In Russia in particular, total export growth corresponds to the pure growth effect only.

4 Relative Changes in Exports and Output

Having described recent developments of global export flows, we now turn to the relationship between exports and economic activity. On a global basis, trade growth has outpaced output growth consistently in recent decades. Indeed, this has been used as proof of increased globalization and regional integration, and as

evidence of falling natural and man-made barriers to trade in the post-World War II period.

Similar to the upward trajectory of trade during periods of growth, the collapse of world trade in late 2008 and at the beginning of 2009 far exceeded the decline in world output. This seemingly excessive trade response caused a great deal of discussion and analysis. Most of the resulting literature adopted a demand-oriented explanation, besides placing emphasis on the role of trade credit during the recession. In our view, however, a valuable clue to the macro-relationship between global trade volumes and GDP growth can be found in the sector pattern of the recent recession. The collapse in trade was actually driven by shocks to demand and output at the sector level. Because some sectors are more important as a share of trade than they are for GDP, the same shock to trade and output at the sector level can lead to substantial divergence in aggregate measures. This means that changes in the composition of output at the sector level can drive an apparent divergence between trade and output at the aggregate level. Such a development will be reinforced further when the trade response to output changes differs between individual economic activities.

To better understand the role of sector composition in the pattern of relative trade and output growth, we examine exactly this trade response to output as well as to demand changes at the industry level in this section. We first develop a simple framework that allows us to look at the relative relationship between trade and output within the same sector. To the extent that trade does or does not prove over-responsive to changes in output at the sector level, we consider this as support for (or evidence against) the importance of changes in the composition of trade, as examined in the previous section, when relating output to trade at the aggregate level. We also apply this framework to estimate the elasticity of exports to changes in global demand at the industry level. Most studies dealing with this subject stop at the economy-wide level, where GDP offers a measure of both demand and supply. However, there is no equivalent measure at the industry level, given important interlinkages between individual sectors. Therefore we estimate two different elasticities of exports, with respect to either domestic output or global import demand, in each industry.

We are interested in the long-run relationship between exports and output, two variables that are both I(1) and likely to be subject to spurious correlation. In the panel it is possible to estimate consistently the long-run association between non-cointegrated I(1) variables and thereby avoid the spurious regression problem (see Phillips and Moon, 1999, and Kao, 1999, for asymptotic results and Coakley, Fuertes and Smith, 2001, for small sample evidence based on Monte Carlo simulations). Therefore we use the following model to estimate the output elasticity of exports:

$$\ln X_{ict} = \alpha + \beta_1 \ln Y_{ict} + \beta_2 \ln Y_{kct} + \gamma \mathrm{ulc}_{ict} + \delta \mathrm{prod}_{ict} + \varphi time + \mu_{ic} + \varepsilon_{ict} \qquad (7)$$

We employ a fixed effects estimator and include a time trend (see also Baltagi, Griffin and Xiong, 2000, for the use of the within estimator). The coefficient β_1 gives us an estimate of the output elasticity of exports by sector in response to output of the same sector. We then use the same model to estimate the elasticity of exports to foreign demand. Foreign demand is constructed by global imports in

the respective industry excluding the reporter region. We furthermore include output (and foreign demand, respectively) in all other sectors, apart from sector *i*, denoted by subscript *k*. This captures supply and demand linkages across sectors and is particularly important when estimating the demand elasticity.[7] We estimate equation (7) in a panel of 70 to 80 countries over the period from 1995 to 2007. We also include two control variables: differences in unit labor costs and labor productivity are important determinants of international competitiveness and therefore considerably impact exports.

The literature, focusing on the elasticity of trade to income, generally reports an elasticity of 2 to 4 for aggregate trade flows. In order to check the quality of our data, we start by summing up industry-specific exports to total manufacturing exports and relate this to GDP. We thus obtain an estimate for output elasticity (which coincides with income elasticity) of around 2, which is roughly in line with the existing literature.[8] The discrepancy between our coefficient and the higher estimates found in the recent literature (Irwin, 2002, and Freund, 2009) can be explained by differences in the underlying definition of exports. We use manufacturing exports here, while previous studies often used total economy-wide exports (including goods and services).[9]

However, when we focus on elasticity with respect to manufacturing output (instead of GDP), our estimated coefficient drops considerably. On average, manufacturing exports respond positively to an expansion of domestic output; elasticity remains, however, well below 1 (see table 2). Thus, within the same sector, we do not find an overshooting in the trade response to output changes.

This can be explained when taking into account that GDP is a composite of goods and services, whereby total GDP growth is the weighted average of value added growth in goods and services, with the weights representing the respective share of goods and services in GDP. Then, the growth differential between goods trade and GDP equals the sum of the growth differential between goods trade and value added in goods plus the growth differential between goods and services value added (i.e. productivity in goods and services), with the latter being weighted by the share of services in GDP. To the extent that productivity growth in services is lower than that in goods, the elasticity of exports to GDP will point to export growth that seems to exceed growth in GDP.[10] The magnitude of this productivity growth differential on the one hand and the share of services in GDP on the other

[7] *We would like to thank one anonymous referee for pointing our attention to these cross-sector linkages. The problem of cross-sector linkages does not arise in the results which are presented in table 2 and 4, as these are based on data aggregated over all sectors.*

[8] *We would like to stress that we work with a dataset that has been deflated using U.S. price deflators (albeit at the sectoral level). This implies that cross-country differences in price developments are not captured, which is less of a concern for traded goods, but may be relevant for nontraded goods, as their importance in developing countries may be understated. This might in turn introduce an upward bias in the trade elasticity to income, which corroborates our hypothesis that the high elasticity of trade to income found in the literature might be overstated. We thank one anonymous referee for pointing this out.*

[9] *A comparison of the elasticity based on nominal exports versus our exports deflated by sector showed no substantial differences arising from the specific deflation used here.*

[10] *According to WDI data, this indeed seems to be the case. World average annual growth in manufacturing value added was 4.1% from 1995 to 2007, while average annual growth in services was 3.3%. For low- and middle-income countries, the respective figures were 6.7% and 5.5%, while for the OECD the difference was smaller at 3.1% average annual growth in manufacturing value added and 2.9% average annual growth in services value added.*

hand determine the extent to which exports exceed GDP growth, with a higher services share in GDP increasing this elasticity.[11] With a services share of roughly 70% and a realistic growth differential between the service and goods sector, this elasticity can easily be around 2 or 3, as commonly reported in the literature (Irwin, 2002; Freund, 2009). The notably lower elasticity of exports to goods output corroborates our view that the impressive real trade growth rates which we witnessed in the past couple of years represent in fact structural change at the country and industry levels.

The literature in general regresses exports on a gross basis on GDP, with the latter being a value-added concept. In order to eliminate the conceptual difference between the net concept of value added and the gross measure of exports, we run the regressions, using manufacturing output instead of value added. As a sensitivity check of our results, we also estimated the elasticity with respect to industry-

Table 2

Elasticity of Manufacturing Exports to Manufacturing Output, 1995–2007

	No time effects		Common coefficient		Regional coefficients	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(output)	0.839 ***	0.782 ***	0.409 ***	0.429 ***		
	11.46	8.64	6.82	6.6		
CEE-10					0.637 ***	0.647 ***
					14.45	16.13
CIS & Balkans					0.353 ***	0.371 ***
					7.62	7.86
Southeast Asia					0.517 ***	0.524 ***
					7.32	7.34
Other					0.311 ***	0.302 ***
					3.67	3.34
EU-15					0.286 ***	0.274 ***
					3.25	2.55
Latin America					0.517 ***	0.517 ***
					6.55	6.09
NAFTA					0.403 ***	0.370 ***
					6.65	5.57
Time trend			0.066 ***	0.066 ***	0.065 ***	0.064 ***
			13.7	13.15	14.41	13.38
Unit labor costs		0.874 *		0.839 ***		0.522 **
		1.7		3.01		2.12
Productivity		0.001 ***		–0.000		0.000
		2.24		–0.43		0.64
Constant	2.299 ***	3.059 ***	9.067 ***	8.689 ***	9.231 ***	9.224 ***
	1.86	2.01	9.17	8.02	12.73	11.3
Observations	860	815	860	815	860	815
No. of countries	105	102	105	102	105	102
R2-within	0.579	0.587	0.803	0.812	0.819	0.830
R2-overall	0.916	0.917	0.897	0.899	0.165	0.132
R2-between	0.905	0.907	0.903	0.903	0.281	0.249
F-value	131.4	57.1	269.9	171.9	545.7	360.8

Source: Authors' calculations.

*Note: The dependent variable in this fixed effect panel regression is the log of real manufacturing exports; *, **, *** indicate that the coefficient estimate is statistically significant at the 10%, 5%, 1% significance level: t-values are given below the coefficients.*

[11] *The argument by O'Rourke (2009) posted in a blog in June 2009 is essentially identical to ours when we furthermore assume that trade in goods is more vertically integrated across countries than trade in services.*

specific value added instead of gross output. The results are broadly similar, suggesting that this conceptual difference does not induce a bias in the results. According to this reasoning, the conceptual difference between exports and GDP would be ruled out as a reason for the "puzzlingly" large trade response during the global recession.

In line with the existing literature, we can confirm a rising elasticity of exports to value added over time. The time trend is positive and highly significant. Our estimated elasticity falls substantially (from 0.8 to 0.4) when we control for time effects, which corroborates the rise in output elasticity over time.

We furthermore observe notable differences between regions. The elasticity for the CEE-10 is significantly higher than for all other regions at the 1% level. Moreover, Southeast Asia shows a higher elasticity compared to CIS & Balkans, the rest of the world and the EU-15. This simply reflects these regions' greater outward orientation, which has led to their strong integration in international production chains. As a general observation, we see a higher elasticity of exports to output in emerging regions (the CEE-10, Southeast Asia and Latin America) than in more advanced regions.

In table 3, we report the output elasticity coefficients of exports from regression (2) above, again controlling for differences in unit labor costs, productivity and a time trend. Thus, each entry in table 3 is based on a regression model, where manufacturing value added is interacted with a dummy for each region in our sample.[12] The first column represents the common coefficient (global average), the

Table 3

Elasticity of Exports to Output by Industry

	World	CEE-10	CIS & Balkans	South-east Asia	Other	EU-15	Latin America	NAFTA
Food	**0.50**	**0.74**	**0.67**	**0.41**	**0.55**	0.14	**0.32**	–0.15
Textiles	**0.54**	**0.52**	0.34	**0.34**	**0.69**	0.27	**0.42**	**0.54**
Clothing	**0.45**	**0.62**	–0.21	0.03	**0.64**	**0.73**	**0.93**	0.38
Wood	**0.39**	**0.41**	**0.38**	0.08	0.40	**0.61**	0.44	0.02
Paper	**0.74**	**0.78**	**0.92**	0.24	**0.69**	**1.24**	**0.88**	**1.09**
Chemicals	**0.48**	**0.63**	**0.26**	**0.60**	**0.45**	**0.68**	**0.70**	0.00
Rubber	**0.45**	**0.54**	0.19	0.04	**0.45**	–0.25	0.44	0.26
Minerals	**0.54**	**0.50**	**0.60**	0.29	0.60	0.12	**0.65**	**0.58**
Basic metals	**0.44**	**0.37**	**0.42**	**0.45**	**0.50**	0.03	0.29	**–0.68**
Fabricated metals	**0.60**	**0.76**	0.21	**0.39**	**0.52**	0.21	**0.70**	**0.48**
Machinery	**0.43**	**0.72**	0.06	**0.64**	0.34	0.06	**0.51**	0.39
Office & accounting machinery	**0.53**	**0.64**	1.19	–0.05	–0.11	–0.23	–0.20	0.89
Electrical machinery	**0.62**	**0.90**	**0.26**	**0.68**	**0.56**	0.31	**0.88**	**0.80**
Radio, TV & communication equipment	**0.56**	**0.95**	**0.61**	**0.41**	0.09	0.23	**0.88**	–0.67
Precision instruments	**0.35**	**0.90**	0.15	**0.54**	–0.18	**0.47**	0.19	0.37
Motor vehicles	0.34	**0.93**	0.23	**1.08**	–0.12	0.13	0.04	0.11
Other transport equipment	**0.70**	**0.82**	–0.08	**0.72**	**0.98**	0.19	**0.36**	–0.16
Total manufacturing	**0.43**	**0.37**	**0.65**	**0.52**	**0.37**	**0.52**	**0.30**	**0.27**

Source: Authors' calculations.

Note: Elasticities are calculated by a fixed effects panel estimation of ln(exports) on ln(output) controlling for time fixed effects, output in other sectors, unit labor costs and labor productivity. Coefficients in bold are significant at the 5% level or higher.

[12] *Full results for individual industries are available from the authors on request.*

Table 4

Elasticity of Manufacturing Exports to Manufacturing Demand, 1995–2007

	No time effects		Common coefficient		Regional coefficients	
	(1)	(2)	(3)	(4)	(5)	(6)
ln(world imports)	0.817 ***	1.005 ***	1.142 ***	1.037 ***		
	15.85	15.67	6.32	6.2		
CIS & Balkans					1.420 ***	0.878 ***
					6.46	4.37
CEE-10					1.915 ***	1.401 ***
					9.23	8.98
EU-15					1.148 ***	0.613 ***
					5.83	3.72
Latin America					1.236 ***	0.884 ***
					5.76	4.54
NAFTA					1.137 ***	0.610 **
					4.92	2.03
Southeast Asia					1.596 ***	1.026 ***
					6.84	5.69
Other					1.063 ***	0.930 ***
					5.93	4.98
Time trend			–0.030 *	–0.003	–0.036 **	0.003
			–1.7	–0.2	–2.05	0.2
Unit labor costs		0.233		0.232		0.118
		0.65		0.65		0.48
Productivity		0.001 **		0.001 **		0.001 ***
		2.09		2.02		5.14
Constant	–3.537 ***	–6.323 ***	–10.674 ***	–7.026 *	–11.985 ***	–4.681
	–3.03	–4.37	–2.69	–1.91	–3.02	–1.37
Observations	1,931	815	1,931	815	1,931	815
No. of countries	189	102	189	102	189	102
R2-within	0.435	0.753	0.437	0.753	0.478	0.800
R2-overall	0.000	0.019	0.000	0.018	0.119	0.066
R2-between	0.010	0.068	0.013	0.065	0.131	0.037
F-value	251.4	148.1	152.3	111.9	128.2	157.1

Source: Authors' calculations.

*Note: The dependent variable in this fixed effect panel regression is the log of real manufacturing exports; *, **, *** indicate that the coefficient estimate is statistically significant at the 10%, 5% and 1% significance level respectively; t-values are given below the coefficients.*

remaining columns report regional coefficients. Coefficients in bold print are significant at the 5% significance level. The first striking observation is related to the CEE-10 again: Here, the output elasticity of exports is found to be significant in all industries. As a second observation, the ranking of industries does not correspond to the relative importance of individual industries in total trade. The largest coefficients are found for activities such as paper, other transport equipment, electrical machinery and fabricated metals. In three industries, i.e. paper, chemicals and electrical machinery, almost all regions show a statistically significant reaction of exports to supply in the same industry. Out of these, two are also present among the top five export sectors. Ranging from 0.48 to 0.74, the global elasticity still lies below 1. Nevertheless, all these activities with a significant export response to output changes show a comparatively high elasticity coefficient. They are typical of developing and emerging economies, thus underlining a strong relationship between the emergence of new and rapidly growing players in world trade and the rapid expansion of world trade. Furthermore, metals, food and textiles show a significant coefficient in many regions. The CEE-10 exhibit a particularly high

export response to supply conditions in areas such as radio, TV and communication equipment, electrical equipment, precision instruments and motor vehicles (with an elasticity of over 0.9).

Finally, we estimate the elasticity of exports to changes in global demand (distinguishing between demand within the same industry and in other industries). Foreign demand is measured by global imports in the respective industry minus the imports of the reporting region. Table 4 displays the results. Clearly, exports react more strongly to changes in external demand than to changes in the underlying domestic supply. Nevertheless, the coefficient is close to 1 in general and also in all regions. Thus, again we do not find the strong over-reaction of exports here, once we focus on the industry level. The CEE-10 and Southeast Asia emerge again as the regions with the highest reagibility of exports. Controlling for supply-side characteristics (unit labor costs and productivity) does not lower the elasticity estimate in this case; also, the estimate is not as sensitive to the inclusion of a time trend as before. The time trend is sometimes negative, which is surprising, but not always significant.

Table 5 reports the estimated elasticities separately for each industry, allowing for a different reaction by each region. The differences between industries are far greater than between regions. Again, similar categories exhibit the highest elasticity estimates: food, paper and fabricated metals. In addition to those activities, the demand elasticity of exports is significant in all regions for chemicals and rubber. Also textiles and other transport equipment show a significant elasticity in all regions but one. It is interesting to note that the elasticity estimates for machinery are never significantly different from zero in any region. Exports of motor vehicles

Table 5

Elasticity of Exports to Demand by Industry

	World	CEE-10	CIS & Balkans	South-east Asia	Other	EU-15	Latin America	NAFTA
Food	**2.65**	3.73	**3.74**	**2.40**	**2.38**	**2.87**	**2.04**	**1.48**
Textiles	1.31	**3.34**	**3.51**	0.71	**2.20**	**1.46**	**3.18**	**4.08**
Clothing	**1.15**	0.40	0.28	**0.87**	1.12	**2.50**	**2.19**	**–1.95**
Wood	**1.30**	**1.78**	**1.93**	0.79	0.67	**1.70**	2.06	–0.57
Paper	**2.61**	**2.61**	1.31	**1.64**	**2.80**	**1.82**	**1.94**	**1.60**
Chemicals	**1.85**	**2.10**	**1.69**	**2.04**	**1.73**	**2.11**	**1.73**	**1.72**
Rubber	**2.42**	**3.26**	**1.55**	**1.30**	**2.63**	**1.68**	**3.07**	**2.04**
Minerals	**1.48**	**2.17**	1.94	0.94	0.67	**1.55**	**2.30**	**1.64**
Basic metals	**1.40**	**1.74**	1.27	**1.43**	0.85	0.80	**1.81**	0.22
Fabricated metals	**2.12**	**2.72**	1.18	**1.25**	**2.06**	**1.71**	**1.84**	**2.68**
Machinery	0.55	0.92	0.19	0.19	0.66	–0.12	0.88	0.32
Office & accounting machinery	**1.04**	**2.15**	**2.49**	0.19	1.31	0.44	0.24	–0.81
Electrical machinery	**1.52**	**1.73**	1.04	0.80	1.15	0.33	0.87	0.61
Radio, TV & communication equipment	0.72	1.43	**1.43**	0.01	0.16	–0.06	1.81	–1.27
Precision instruments	1.05	**2.01**	1.98	0.87	0.40	1.14	2.30	1.34
Motor vehicles	**1.67**	**2.86**	1.38	**2.53**	1.77	**1.32**	0.15	0.93
Other transport equipment	**2.82**	**2.62**	0.99	**2.49**	**3.45**	**1.70**	**2.37**	**2.53**
Total manufacturing	**1.04**	**1.40**	**0.88**	**1.03**	**0.93**	**0.61**	**0.88**	**0.61**

Source: Authors' calculations.
Note: Elasticities are calculated by a fixed effects panel estimation of ln(exports) on ln(demand) controlling for time fixed effects, output in other sectors, unit labor costs and labor productivity. Coefficients in bold are significant at the 5% level or higher.

respond strongly to changes in demand only in the CEE-10 and Southeast Asia, the two most rapidly expanding regions in general economic terms.

In general, exports react more strongly to demand than to supply factors; the differentiation by economic activity is, however, much more pronounced as well. This underlines the transmission of the recent crisis through the trade channel and also explains the particularly strong downturn experienced by CESEE countries, which are highly open to international trade. The sharp drop in external demand in exactly those sectors where these countries are specialized affected the region particularly badly. By the same reasoning, differences in the demand elasticities of exports by regions and industries also provide an explanation of the more rapid expansion of world trade as compared to global output, despite the fact that at the individual industry level, the elasticity does not exceed 1 by far.

5 General Conclusions and Implications for Central and Eastern Europe

The historical strong rise and the recent deep fall of international trade have caused a great deal of debate among economists and policymakers alike in search of the reasons for and the implications of these developments. The CESEE countries were affected deeply by both developments. First, their impressive growth record over the past two decades was led by their favorable export performance (see e.g. Fidrmuc and Martin, 2011; wiiw, 2010). Second, their strong reaction to the global financial and economic crisis is likely to have been triggered to a large extent by the trade channel. The sharp drop in external demand for CESEE's major export goods (i.e. motor vehicles and machinery) coupled with the particularly strong elasticity of exports to changes in external demand for this region played an important role here. The most commonly cited factors behind the long-term rise and the crisis-related decline of international trade are surprisingly similar and relate to changes in trade costs (transportation costs, tariffs and nontariff barriers for the rise and trade financing for the decline), increasing fragmentation of production and an increasing elasticity of trade to output. Another factor mentioned in the context of the recent severe drop in international trade relates to structural differences between production and export structures. Interestingly, this has not been stressed much in explaining the long-term growth of international trade. In this paper, we take a closer look at the importance of structural change. We find that the long-term rise in world export volumes largely reflects regional and sectoral shifts of emerging and hence rapidly growing economies into more trade-intensive activities, such as machinery, electronic goods, motor vehicles, chemicals and textiles.

For our analysis, we construct a new set of trade and output data at the ISIC 2-digit industry level over the period from 1995 to 2007, using sector-specific price deflators for exports, imports and domestic value added to account for dramatically different price developments in individual industries over the sample period. The use of sector-specific deflators has an impact on the relative importance of individual industries in total exports. In particular, office, accounting and computing machinery experiences a steep expansion, which is not observed as clearly in traditional analyses that do not account for the relative price decline in this industry. Furthermore, the importance of motor vehicles in total world trade shows a more pronounced decline in real terms when deflated at sector-specific

prices than in traditional analyses. On the other hand, sector-specific deflators played no role for our results concerning the influence of restructuring on export growth. In addition, our estimates of the output and demand elasticity of exports were not affected by the form of deflation either.

Decomposing export growth into a pure growth component and two structural effects – the growth contribution of initial industry specialization and the effect of structural change at the industry level – we find that CESEE countries were subject to considerable structural change with an overall positive effect on their export growth performance. This result holds only for the countries that recently joined the EU (the CEE-10), thus suggesting that EU accession and related institutional and economic reforms played a positive role (see also Havlik, 2008). The CEE-10 showed successful restructuring toward globally successful sectors. This implied an increasing specialization of the region in machinery, electronic goods and motor vehicles. It should be noted that from a global perspective, trade in motor vehicles is becoming less important in relative terms, although trade flows remain at a high level. In a more short-term perspective, trade in machinery and cars was severely hit in the recent crisis, which corroborated the negative impact on Eastern Europe. As a consequence, continued domestic restructuring will remain important for the region, as global trade patterns partly move away from current specialization patterns of the CEE-10. Substantially less structural change toward globally important trade sectors has been observed for the CIS & Balkans region (which is clearly dominated by Russia), which suggests a large potential for industrial restructuring in the region.

It is an often-cited stylized fact that global exports grow faster than GDP. This would imply an elasticity of exports to output far beyond 1. An elasticity of 1 would imply that exports and demand expand equally strongly: the growth rate of exports corresponds exactly to the growth of global demand and hence output at the aggregate level. The existing literature often reports elasticity in the range of 2 to 4 (Irwin, 2002; Freund, 2009). We also find evidence for large output or income elasticity of trade. However, at the sector level we cannot confirm an excessive reaction of exports to output or income in all of the industrial activities studied. The high elasticity of exports to output drops to far below 1 when we limit our attention to individual industries. Of course, such a narrow focus does not capture the effects of outsourcing and increasing fragmentation. Nevertheless, this result offers an alternative explanation for the rise of global exports, namely changes in the regional and industrial composition of exports. A great deal of export growth may simply be related to the fact that fast-growing, emerging countries are moving into trade-intensive sectors, rather than to a change in the nature of trade and production (i.e. changes in global supply chains). This may also imply that we overestimate the effect of falling trading costs and global supply chains on export growth. As such, our results may also be of relevance for explaining the developments that had led to the sharp contraction of trade in early 2009. Restructuring and structural upgrading thus remain vital features of a successful growth and catching-up strategy for export-oriented, emerging economies such as the CESEE countries.

Export elasticity to external demand is in general much higher than the sensitivity to supply conditions. But again, it is much lower than standard estimates reported for aggregate trade flows in the literature. The results are again highly

heterogeneous for individual regions and industries. All regions show significant demand elasticity of exports for total manufacturing, and in some sectors (food, paper, rubber, fabricated metals and other transport equipment) it even exceeds 2. However, at the detailed industry level we find highly different results. Only the CEE-10 region shows a high and significant export response to changes in foreign demand in all sectors. Also, Southeast Asia and Latin America exhibit a high sensitivity of exports to changes in demand in the same sector, when we control for demand from other sectors. In particular, exports of motor vehicles respond strongly to changes in demand only in the CEE-10 and in Southeast Asia, the two most rapidly expanding regions in general economic terms. We take this as evidence that the sector and regional composition of trade matters crucially for overall trade growth and that structural change at the sector and country level explains a substantial part of the apparent "trade puzzle."

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Annex

Table A1

List of Countries and Regional Grouping

EU-15:	
AUT	Austria
BEL	Belgium
DEU	Germany
DNK	Denmark
ESP	Spain
FIN	Finland
FRA	France
GBR	United Kingdom
GRC	Greece
IRL	Ireland
ITA	Italy
LUX	Luxembourg
NLD	Netherlands
PRT	Portugal
SWE	Sweden
CEE-10:	
BGR	Bulgaria
CZE	Czech Republic
EST	Estonia
HUN	Hungary
LTU	Lithuania
LVA	Latvia
POL	Poland
ROM	Romania
SVK	Slovakia
SVN	Slovenia
CIS & Balkans:	
ALB	Albania
BIH	Bosnia and Herzegovina
BLR	Belarus
HRV	Croatia
MDA	Moldova
MKD	FYR Macedonia
MNE	Montenegro
RUS	Russian Federation
SER	Serbia
UKR	Ukraine
NAFTA:	
CAN	Canada
MEX	Mexico
USA	United States of America
Latin America:	
ARG	Argentina
BOL	Bolivia
BRA	Brazil
CHL	Chile
COL	Colombia
CRI	Costa Rica
ECU	Ecuador
NIC	Nicaragua
PAN	Panama
PER	Peru
PRY	Paraguay
SLV	El Salvador
URY	Uruguay
VEN	Venezuela
Southeast Asia:	
BRN	Brunei
CHN	China
IDN	Indonesia
IND	India
JPN	Japan
KHM	Cambodia
KOR	Korea, Rep.
LAO	Lao PDR
MMR	Myanmar
MYS	Malaysia
PHL	Philippines
SGP	Singapore
THA	Thailand
VNM	Vietnam

Source: OeNB.

A Markov Switch to Inflation Targeting in Emerging Market Peggers with a Focus on the Czech Republic, Poland and Hungary

Marjan Petreski[1]

The objective of this paper is to empirically examine if monetary policy conduct has significantly changed in nine emerging economies, including the Czech Republic, Poland and Hungary, after the switch from exchange rate targeting to inflation targeting. An augmented Taylor rule is estimated with a Markov switching method for each of the nine countries on the basis of monthly data over the period from the early 1990s to end-2009. In general, the results suggest that inflation targeting represented a real switch in eight emerging economies. We identified the following differences for the period of inflation targeting compared to the preceding period of exchange rate targeting: (1) The economic environment became more stable; (2) the central bank's reaction to inflation deviations from the target moderated (as it was probably possible to share the burden of inflationary pressures between interest rate increases and currency depreciations); (3) the central bank's response to the output gap also moderated although it was statistically significant in only half of the countries; this is an indication of strict inflation targeting whereby meeting the inflation target is the primary objective. For the Czech Republic and Poland, an intermediate regime is identified, which is associated with the economic developments in these two countries prior to establishing a full-fledged inflation targeting regime. For Hungary, we identified only one regime, which is likely to reflect the combined strategy of targeting both the exchange rate and inflation that the country followed nearly over the entire period under review.

JEL classification: E42, E52, E58
Keywords: monetary regime switch, inflation targeting, CESEE-3, Markov switching

1 Introduction and Motivation

"Throughout the world, monetary policy regimes have changed dramatically over the decade of the 1990s. [...] The biggest transformation has been the move away from focusing on intermediate objectives, such as money and exchange rates, toward the direct targeting of inflation." (Cecchetti and Ehrmann, 1999, p.1). Inflation targeting (IT) as a monetary regime is relatively new, dating back to the beginning of the 1990s, when New Zealand was the first country to adopt an official inflation target. IT is a regime based on rules and objectives that have to be achieved and which is free of any other monetary policy target. By this definition, there are 26 inflation targeters in the world today (plus three that have switched regimes to join the euro area; see table A1 in the annex).

As a monetary regime, IT emerged in the developed world. Chart 1 depicts the time of IT adoption and the income level per capita in the same year in the countries under review. We denote the adoption of IT by advanced economies as the first wave, which terminated in the mid-1990s (chart 1, blue diamonds). In these countries, the initial results of the new monetary regime were satisfactory: Although the decline in inflation had started before the introduction of IT, "inflation did not bounce back up afterwards as expected" (Mishkin and Posen, 1998, p.90). The majority of quantitative studies on IT are conducted on datasets

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for those countries. However, there is no overwhelming evidence that the new regime significantly affected inflation expectations or that it significantly reduced output volatility. It is important to note that the central banks of these countries enjoy high credibility, which is important for this monetary regime. After the first inflation targeters had successfully established and maintained a low inflation level, a new wave of inflation targeters formed at the end of the decade, namely a number of emerging economies (chart 1, red squares). There has been a growing body of studies on IT in emerging economies, but the review in Petreski (2009a) finds that these studies are merely descriptive. A third wave of IT adoption has been underway in a range of developing countries since 2005 (chart 1, purple triangles); most of these countries used to rely on alternative strategies but embarked on IT expecting their economies to benefit from this regime switch. Finally, a growing number of economies are currently examining the introduction of targets, and several have already launched preparations for formally adopting them. This group includes Albania, Armenia and Kazakhstan, which already have price stability as a stated objective but have yet to adopt a formal IT regime. The world economic crisis might postpone such plans, which are currently not high on the agenda in these countries.

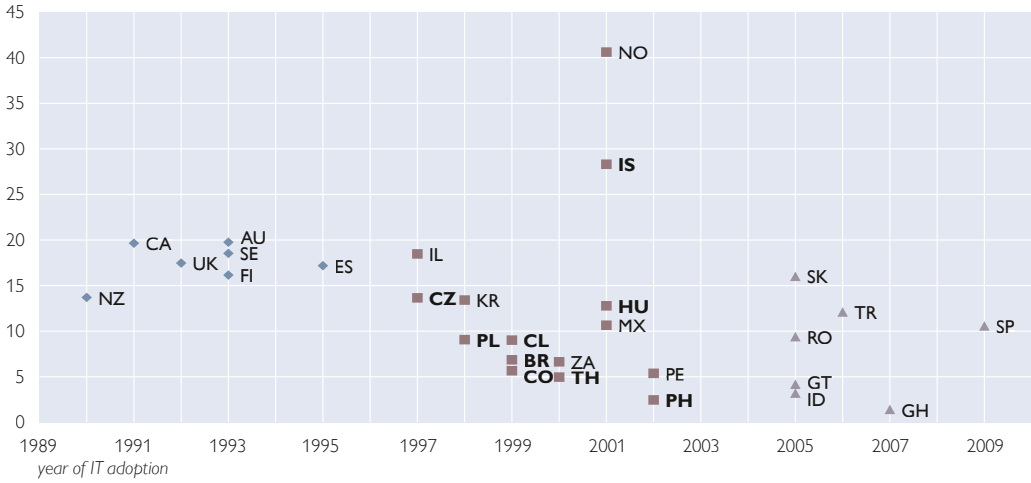
Some of the current inflation targeters switched to the new regime because they faced pressures in the foreign exchange market or even a demise of the fixed exchange rate system. To start with, the United Kingdom and Sweden abandoned the Exchange Rate Mechanism (ERM) due to its crisis in 1992–93. However, the majority of countries that experienced market pressure on the pegged rate of their currencies were emerging economies. Brazil, for instance, abandoned the peg after its real exchange rate crisis in early 1999, embarked on a floating regime and officially adopted IT. In Thailand, following the Asian financial crisis in 1997 and the demise of the Thai baht exchange rate system, a floating rate was introduced alongside a money base target. The latter suffered from the weak link between money and prices and, ultimately, the central bank adopted an IT framework. After the boom of capital inflows in Hungary in the late 1990s, the pressures on the foreign exchange market resulted in a widening of the forint's exchange rate band to ±15% in 2001 and the adoption of IT. The Czech Republic and Poland also introduced IT after exchange rate regime turbulence, albeit the establishment of the new regime in Poland was more gradual. In total, 14 exchange rate peggers embarked on IT. However, it is reasonable to suspect that the switch in developed countries (the U.K., Sweden, Finland and Spain) might have been a different process, which may be ascribed to the higher credibility of these countries' central banks or to the fact that these countries were part of ERM. Moreover, Finland, Spain and Slovakia no longer apply IT, as they have all joined the euro. Nine switchers analyzed in this paper are emerging economies, including three Central, Eastern and Southeastern European emerging economies (CESEE-3) – the Czech Republic, Poland and Hungary – as well as Brazil, Chile, Colombia, Israel, Philippines and Thailand. Of these countries, only Hungary switched to IT but kept the exchange rate target, while all the others introduced a form of managed floating along IT.

The argumentation and empirical evidence (summarized and empirically explored in Petreski, 2009b and 2010) suggest that exchange rate pegging may not be important in affecting the long-term growth performance of an economy but plays a key role in stabilizing output fluctuations. However, when large real shocks

Chart 1

Three Waves of Inflation Targeters

GDP per capita (PPP) in the year of IT adoption in thousand



Source: IMF.

Note: Countries in bold indicate emerging economies that switched from ERT to IT and have therefere been chosen for this paper's investigation.

hit, it may spur output volatility. It is argued that as the links between the real economy and international financial markets increase, real shocks become likely. Further, Petreski (2009a) suggests that the exit from an exchange rate peg will provide the economy with more flexibility in buffering real shocks, but the economy will still need a monetary anchor. IT along with a managed floating exchange rate regime is argued to provide a nominal anchor and to take into consideration the need to reduce output and exchange rate volatility (Goldstein, 2002). Yet, opinions in the literature as to how effectively such a policy can smooth output fluctuations remain divided. Moreover, the role of the exchange rate has been neglected for advanced economies, but has become more important for emerging and developing economies (1) because the exchange rate is the core transmission channel for monetary policy, (2) because of its complex macro-relationships, like the level of currency substitution, and (3) because of these economies' exposure to capital inflows reversals and sudden stops (Eichengreen et al., 1999, and Chang and Velasco, 2000).

The aim of this paper is to empirically examine the monetary policy responses during a switch from exchange rate targeting (ERT; fixed exchange rate) to IT in nine emerging economies. The paper is organized as follows: Section 2 discusses the theoretical background and the empirical methodology. Section 3 discusses data issues. Section 4 reports and discusses the findings. The last section concludes.

2 Theory and Empirical Methodology

2.1 Theoretical Model

Given the objective of the paper to investigate monetary policy responses during a switch from exchange rate targeting to inflation targeting, the first step is to establish a representation of the monetary policy stance. A large strand of the monetary economics literature suggests the Taylor interest rate rule (Taylor, 1993

and 2001), as a neat way to represent monetary policy. In general, such a monetary policy reaction function explains reactions of the central bank to macro variables (like the output gap and inflation), which at the same time is consistent with the description of the IT regime (see, for instance, Svensson, 2000). The economic model is therefore:

$$r_t = \alpha + \rho r_{t-1} + \beta_1 \pi_t + \beta_2 (y_t - y_t^*) + \beta_3 \Delta e_t + u_t \qquad (1)$$

where r_t, π_t, $(y_t - y^*_t)$, and e_t denote the nominal interest rate, inflation, the output gap and the nominal exchange rate, respectively, at time t; Δ is the first difference operator; ρ is the smoothing parameter to be estimated; βs are coefficients to be estimated, measuring the central bank response to the changes in these variables, which can partly reflect authorities' preferences in designing monetary policy; and u_t is the error term. This is an interest rate rule augmented with the exchange rate due to the latter's role in the monetary policy of emerging economies (see Frankel, 1979). Moreover, interest rate smoothing is allowed for in the equation by adding a lagged endogenous variable. Mohanty and Klau (2005) offer several reasons for smoothing: (1) the reduction of the risk of policy mistakes when uncertainty about model parameters is high and when policymakers have to act on partial information; (2) the authorities' concern about the implications of their actions for the financial system: If markets have limited capacity to hedge interest rate risk, a sudden and large change in the interest rate could expose market participants to capital losses and may raise systemic financial risks; and (3) the avoidance of reputation risks to central banks from sudden reversals of interest rate directions, to mention just a few.

2.2 Empirical Methodology

2.2.1 Nonlinear Switching Regression

The second step in achieving the objective of the paper is to design a methodological framework for analyzing a switch from one monetary regime to another. A switch in the data itself represents a source of nonlinearity in the data. Hence, a nonlinear method will be used. The last two decades marked a substantial increase in the application of this type of methods to macroeconomic and financial data. The regime switching methods can be largely classified in two groups: threshold autoregressive (TAR) methods and Markov switching (MS) methods. The threshold autoregressive method models the behavior of a variable in relation to a threshold value (Tong, 1983) and depends on two factors: (1) the choice of the threshold variable and (2) the information about the official switch. In contrast to the TAR approach, the structural break in the MS approach is the outcome of an unobserved discrete random variable, which is assumed to follow a Markov process.[2] This strand of the literature was steered by the seminal contributions of Hamilton (1989 and 1994), although the work was originally motivated by Goldfeld and Quandt (1973). Since then, a growing literature on regime switching in applied macroeconomic time series analysis has emerged. However, these applications are

[2] *A Markov process is a stochastic process in which only the present value of the variable is relevant to predict its future behavior, i.e. its past values and the way in which the present value has emerged from the past are irrelevant. Hence, Markov processes are not path dependent.*

still largely limited to business cycle analysis (Cecchetti et al. 1990; Ravn and Sola, 1995; Diebold and Rudebusch, 1996). A small part of the literature (Ang and Bekaert, 2002; Valente, 2003; Sims and Zha, 2006; Vázquez, 2008) analyzes interest rates but – to our knowledge – no study has used these methods to analyze monetary policy in the context of a monetary regime switch. Also, these empirical applications are largely limited to developed countries.

Why should we use the MS approach? Firstly, Ball and Sheridan (2005) argue that a simple switching approach whereby a dummy is added to capture the switch in the switching group is still open to the identification strategy problem, i.e. whether the chosen comparison group is indeed a reliable control group. Moreover, Creel and Hubert (2009) point out that contrary to the simple switching approach and the TAR methods, MS methods will circumvent the task of predefining a switch or a threshold and will simply reveal if and when different regimes occurred in the switching economies. Letting data speak freely will address the concern that investigating the presence of distinct regimes rather than assuming a strict break would enable checking if anti-inflation policies existed in the past (i.e. the authorities might have started to target medium-term inflation before they officially announced a switch) or if the exchange rate target was not fully abandoned even after the official switch to IT (i.e. the authorities continued to target the exchange rate for a certain period after they officially switched). Finally, by allowing the variance of residuals to differ in both regimes, MS methods make it possible to investigate whether the economic environment changed due to monetary policy.

2.2.2 Designing a Markov Switching Regression

In an MS regression, explanatory power is assigned to the existence of a few "states" (regimes) among which the economy shifts:

$$y_t - \mu_{S_t} = \sum_{i=1}^{4} \phi_i (y_{t-i} - \mu_{S_{t-i}}) + \varepsilon_t \qquad (2)$$

where y_t is a univariate time series to be explained; s_t is a latent dummy variable taking the value of 0 or 1 and representing two states in which the economy could fit; and ε_t is Gaussian white noise (Hamilton, 1989). μ is a mean term conditional upon the state in which the economy is; the state is assumed to be unobservable and has to be inferred from the data. In cases where the null of $\mu = 0$ cannot be rejected, only one state governs the process and this could be represented by the standard AR model.

To complete the description of the dynamics of (2), we need to define a probability rule of how y_t changes between regimes. A Markov chain is the simplest time series method for a discrete-valued random variable, such as the regime variable s_t. s_t is assumed to follow an ergodic[3] first-order Markov process (and is, hence, serially correlated) and is characterized by the matrix Π, consisting of the transition probabilities p_{ij} from state i to state j:

[3] *Similarly, a stochastic process is said to be ergodic if no sample helps meaningfully to predict values that are very far away in time from that sample. To put it differently, the time path of the stochastic process is not sensitive to initial conditions.*

$$\Pi = \begin{bmatrix} p_{11} & p_{21} & \cdots & p_{N1} \\ p_{12} & p_{22} & \cdots & p_{N2} \\ . & . & \cdots & . \\ p_{1N} & p_{2N} & \cdots & p_{NN} \end{bmatrix}$$

$$p_{ij} = p(S_t = j \mid S_{t-1} = i,\ S_{t-2} = k, \ldots) = p(S_t = j \mid S_{t-1} = i) \tag{3}$$

$$\sum_{j=1}^{N} p_{ij} = 1;\ i = 1,2,3 \ldots N;\ 0 \le p_{ij} \le 1$$

For a two-regime state space, transition probabilities can be expressed as follows:

$$\begin{aligned} &p[S_t = 1 \mid S_{t-1} = 1] = p \\ &p[S_t = 2 \mid S_{t-1} = 1] = 1 - p \\ &p[S_t = 2 \mid S_{t-1} = 2] = q \\ &p[S_t = 1 \mid S_{t-1} = 2] = 1 - q \end{aligned} \tag{4}$$

Here, the probability that the economy has been in regime 1 and will stay in the same regime is p; the probability that it was in regime 1, but it is now in regime 2 is $1\text{-}\rho$, and so on. With these transition probabilities the regime switch is dependent only on the state before the switch, while the expected duration of each regime is constant (Kim et al., 2008). In other words, Hamilton's (1989) approach does not require any prior information to characterize the current state of the economic series. Hence, the evolution of the regime switch occurs exogenously. However, this specification appears very restrictive in the description of regime changes.

2.2.3 Endogeneity in a Markov Switching Regression

As argued above, Hamilton's (1989) model is a univariate framework that assumes the regime shift being exogenous to all realizations of the regression disturbance. Since Hamilton (1989), many applications have used MS models that included additional explanatory variables (see Maddala and Kim, 1998, pp.463, for a review). In these models, however, independent variables, as in every other form of regression, may be endogenous and the switch may evolve endogenously. Neither source of endogeneity in the MS regression was resolved until Krolzig (1998), who developed the MS methods in the area of vector auto regressions (hereafter MS-VAR; see Krolzig, 1998). These are standard VAR models, in which some or all of the parameters are allowed to switch when the regime changes. In its most general form, the MS-VAR process has the following form:

$$y_t = v(S_t) + \sum_{i=1}^{p} A_i(S_t) y_{t-i} + \varepsilon_t \tag{5}$$

where $y_t = (y_{1t}, ..., y_{nt})$ is an n-dimensional transposed vector, v is the vector of intercepts, $A_1, ..., A_p$ are the matrices with the autoregressive parameters and ε_t is the white noise vector process; all can be dependent on the switching variable S_t.

By allowing the potential determinants of the switch to interact in a dynamic framework, the endogeneity arising from the selection of observables is addressed. However, given that transition probabilities are constant, one may still be concerned about switch endogeneity stemming from unobservables. Moreover, it is reasonable to believe that a regime's duration may inflict a switch and hence duration can be another source of switch endogeneity. The possible presence of remaining switch endogeneity can be checked only indirectly, though. Vázquez (2008) argues that there would be a cause for concern if estimated probabilities differed under alternative MS-VAR specifications, that is, the switching variable would exhibit endogeneity stemming from unobservables if the probabilities depended on the MS-VAR specification. Any remaining endogeneity because of duration is checked following the procedure of Pelagatti (2008) (see section 4.2). At present, hence, the non-comprehensive approach to dealing with switch endogeneity seems to be the major drawback of the MS-VAR.

2.3 Derived Estimation Equation

After defining the representation of monetary policy (section 2.1) and the MS method for capturing nonlinearities in the data (section 2.2), our economic model (1) needs to be defined in a reduced Markov-switching vector autoregressive (MS-VAR) form, as follows:

$$y_t = v(S_t) + \sum_{i=1}^{p} A_i(S_t) y_{t-i} + \sum_{i=0}^{p} B_i(S_t) x_{t-i} + \varepsilon_t \qquad (6)$$

where y_t is our four-dimensional vector comprising the nominal interest rate r_t, inflation π_t, the output gap_t, and changes in the nominal exchange rate Δer_t; x_t is a vector of exogenous variables, which could enter contemporaneously or with a lag, but is not mandatory; v is the vector of intercepts, $A_1, ..., A_p$ and $B_0, ..., B_p$ are the matrices containing the autoregressive parameters and ε_t is the white noise vector process. The model is set as *MSIAH(2)-VAR(ρ)*, allowing the intercept *(I)*, autoregressive terms *(A)* and the variance *(H)* to switch between two regimes. The intercept and regressors are allowed to switch, but additionally, by allowing the overall variance of the vectors to change and be part of the regime switching identification, we may check if the monetary environment changed between the two regimes. No exogenous regressors are included in the baseline specification. ρ denotes the number of lags, which is chosen by appeal to the Schwarz information criterion (SIC), after serial correlation has been eliminated. Based on the statistical properties of the identified regimes, we will argue later if these can be reconciled with the switch from ERT to IT. Some authors (for instance, Clarida et al., 2000, or Rudebusch, 2002) suggest and estimate empirical Taylor rule versions which are based on lagged variables only, which is the case with any VAR framework, including MS-VAR. To estimate our MS-VAR model, the expectation-maximization (EM) algorithm (Dempster et al., 1977) is used.

3 Data Issues

For the estimation of equation (6), monthly data from the beginning of the 1990s to the end of 2009 are used, with the starting date depending on data availability. The use of monthly data is justified by the fact that almost all central banks decide on the interest rate at a fortnightly frequency. The data are from the IFS database. The policy interest rate r_t is represented by the money market rate, as it best mirrors the monetary policy stance; the discount rate is used in cases where the money market rate was not available. Inflation, output gap and the exchange rate enter the baseline specification as potentially endogenous regressors. Inflation (π_t) is calculated as the year-on-year monthly percentage change of the consumer price index. The output gap (gap_t) is calculated by applying a Hodrick-Prescott (HP) filter to the industrial production index since GDP is not available on a monthly basis. The difference in the exchange rate (Δer_t) is approximated by the year-on-year monthly percentage change of the nominal exchange rate of the national currency against SDRs, since other series, like the nominal effective exchange rate, were missing for a major part of our sample. Reserves growth and currency substitution enter as exogenous variables (x_t) in the robustness checks (the conceptual reasons for including theses variables are provided in section 4.2). Reserves growth is calculated as the year-on-year monthly percentage growth of the official reserves minus gold. Currency substitution in the economy is approximated by net foreign assets in the banking system as a percentage of GDP. Further data-related details are provided in table A2.

4 Empirical Results

4.1 Baseline Results

Table 1 provides the results of our study for each country. It includes only the vector for the interest rate because it represents our economic model (1). The linearity test is provided in the last row of table 1. This test is based on the likelihood ratio statistic between the estimated model and the derived linear model; under the null hypothesis the linear model is preferred (Doornik and Hendry, 2009). The first p-value is based on the conventional chi-squared distribution, while the second one is derived by Davies (1987). In all cases, the linearity test suggests that the model is significantly nonlinear (i.e. the variation in interest rates can be described by more than one single regime) and that parameters switch between regimes. The remaining diagnostic tests are available on request. They suggest that the errors can be considered normally and independently distributed, while the model is stable. All the remaining vectors are similarly well specified; they are also available on request.

Now we focus on four aspects in explaining the results in table 1: (1) the persistence of the system in each regime, (2) the volatility of innovations in each regime, (3) estimates of the model in each regime, and (4) the date of switching inferred from the data. Note that since we have not yet related the identified regimes to ERT or IT, the reporting in table 1 and the explanation henceforth is set so that regime 1 corresponds to the earlier regime in time and regime 2 to the later one.

The transition probabilities p_{11} and p_{22} refer to the probability that the regime which prevailed in the previous period will continue to operate in the current period and, in that way, are an indication of regime persistence. The reported transition probabilities suggest that regimes are highly persistent, i.e. there are no

Table 1

Baseline Results

Dependent variable	Czech Rep.	Hungary	Poland	Brazil	Chile	Colombia	Israel	Philippines	Thailand
Interest rate	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*
REGIME 1									
Constant	3.048***	7,007	5.160***	14.862**	4.078***	–3.372	0.311	10.565***	2.580**
∑ Interest rate lags	0.695***	0.797***	0.672***	0.599***	0.075	0.532***	0.947***	0.352***	0.762***
∑ Inflation AR lags	0.071**	–0.192	0.069*	–0.48	1.232*	0.801***	0.036	–0.186	–0.111
∑ Gap AR lags	0.056	0.161*	0.204*	0.575*	0.791*	0.169*	0.058	–0.089	0.062*
∑ Exchange rate AR lags	0.067**	0.13	0.021	–0.011	0.05	0.148*	0.008***	0.018	0.053*
Regime volatility	1.636	0.685	1.857	4.399	3.705	4.805	0.556	4.003	2.356
Rough regime timing	1994:4 – 1999:2	1992:7 –1996:10	1992:5 – 1998:7	1997:3 – 1998:8	1993:8 – 2001:8	1995:4 – 2000:3	1992:3 – 1998:4	1992:2 – 1999:5	1992:2 – 1999:1
REGIME 2									
Constant	0.052***	0.09	0.163	0.033	–0.066**	–0.433	0.012	0.359***	0.086*
∑ Interest rate lags	0.960***	0.949***	0.931***	0.999***	0.933***	0.828***	0.989***	0.954***	0.910***
∑ Inflation AR lags	0.022***	0.045***	0.041***	0.024***	0.031***	0.258***	0.004***	–0.012	0.048***
∑ Gap AR lags	–0.003	–0.009	0.018**	0.026*	–0.006	0.009	0.007*	0.002	0.003*
∑ Exchange rate AR lags	0	0.004	–0.004	0	–0.007***	–0.001	0.006	0.006*	–0.006*
Regime volatility	0.147	0.329	0.394	0.248	0.245	0.374	0.159	0.287	0.221
Rough regime timing	1999:3 – 2009:10	1996:11 – 2009:10	1998:8 – 2009:11	1998:9 –2009:7	2001:9 – 2009:9	2000:4 – 2005:9	1998:5 – 2009:10	1999:6 – 2008:12	1999:2 – 2009:11
p11	0.984	0.682	0.969	0.695	0.969	0.964	0.971	0.927	0.988
p22	1	0.949	0.981	0.928	0.979	0.984	0.982	0.959	1
No of observations	188	211	211	153	194	126	212	203	214
Lags (based on SIC)	2	3	4	2	4	1	2	1	1
Inferred switch	1999:03	1996:11	1998:08	1998:09	2001:09	2000:04	1998:05	1999:06	1999:02
Official switch	1997:12	2001:06	1998:01	1999:06	1999:09	1999:10	1997:06	2002:01	2000:05
Linearity test Ho: The linear model is preferred									
(chi-stat)	0	0	0	0	0	0	0	0	0
(Davies)	0	0	0	0	0	0	0	0	0

Source: Author's calculations.

*Note: *, **, *** indicate significance at the 10%, 5% and 1% level, respectively. ∑ indicates that whenever more than one lag was used, the estimated cumulative effect (the sum of the lags for each variable) is reported along with the Wald test of joint significance. Regime volatility is measured by the standard error of the residuals of the interest rate vector. "Rough regime timing" indicates periods in which the respective regime prevailed for a longer period (and not only for a few months).*

temporary and frequent switches between regimes. In particular, in the cases of the Czech Republic and Poland both identified regimes are highly persistent, while in the case of Hungary regime 1 is not as persistent as regime 2, i.e. regime 1 appears only sporadically.[4]

The standard error of the residuals of the interest rate equation in each regime, which approximates the overall volatility of the economic environment in the respective regime, is reported within each regime's panel in table 1. The volatility is much higher in regime 1 than in regime 2. Therefore, regime 2 can be identified as the regime with a lower volatility compared to regime 1. In the case of the Czech Republic and Poland, the volatility of the residuals under regime 1 is eleven and five times higher, respectively, than the volatility under regime 2. In Hungary, the economic environment under regime 1 is only twice more volatile than under regime 2.

[4] *Note that linearity was also rejected in the case of Hungary. Thus, despite a comparatively small persistence of regime 1, the nonlinear (two-regime) model should be more informative than a simple linear (one-regime) specification.*

The estimated coefficients are given in the panels headed "Regime 1" and "Regime 2" in table 1. Whenever more than one lag was used, the cumulative effect (the sum of the lags for each variable) is reported, along with the Wald test of their joint significance. The results suggest that the coefficient associated with the lagged interest rate generally ranges above 0.9 in regime 2 and between 0.6 and 0.7 in regime 1, suggesting a higher degree of interest rate smoothing under regime 1. It is likely that under IT, policymakers are more cautious in the conduct of monetary policy, i.e. they are more vigilant to avoid policy mistakes. This is consistent with the view that under ERT, monetary policy depends on the monetary stance in the anchoring country, and hence smoothing might decline.

The estimated coefficients suggest that central banks respond significantly to inflation in regime 2, while the response in regime 1 remains insignificant in five out of nine countries. In regime 2, the central bank response to a change in inflation of 1 percentage point ranges from very mild in Israel (0.004 percentage points) to considerable in Columbia (0.26 percentage points), with the median being a 0.03 percentage point increase of the interest rate (in Chile). Still, if the significant coefficients between the two regimes are compared, we observe that the reaction to inflation in regime 2 has moderated. In the case of the Czech Republic and Poland, the central banks significantly react to inflation under both regimes, but the reaction moderates two to three times under inflation targeting. A coefficient on inflation similar to that in the Czech Republic and Poland in regime 2 is observed in Hungary, but the respective coefficient under regime 1 is insignificant.

The output gap effect in both regimes is significant in about half of the countries, frequently only at the 10% level. The estimated responses, where significant, suggest that the policy reaction to output fluctuations in regime 2 has moderated as well. Moreover, when compared to the response to inflation, the response to the output gap in regime 2 is found to be milder, ranging from 0.003 percentage points in Thailand to 0.026 percentage points in Brazil. Within the CESEE-3, only in Poland the policy response to the output gap is significant under both regimes and suggests a response moderation of about ten times. But can this be interpreted as evidence that these central banks were less concerned with the level of economic activity than with inflation? The answer is no, because of Svensson's (1998) argument that the size of the estimated coefficient on the output gap does not necessarily reflect the importance of that variable in the central bank loss function, but that the weight and the size of the coefficient are related in a nonlinear fashion. The objective here is not to find out the weight, because the obtained information that the central bank started to take into consideration, albeit partially, the movements in the real economy, besides inflation, is sufficient for our purpose.

At last, responses to exchange rate movements are largely insignificant under both regimes. Within the CESEE-3, the response to the exchange rate is only significant in the Czech Republic under regime 1, suggesting that the central bank considerably used the exchange rate as a high frequency indicator in guiding monetary policy under regime 1. To check for the concern that the general insignificance of the exchange rate might be due to the fact that pressures on the foreign exchange market are not fully reflected in the nominal rate, which at least under regime 1 was pegged, a robustness analysis with reserves is carried out in section 4.2.

Given the above discussion, we can argue that in our sample of nine emerging market switchers, regime 1 could be reconciled with ERT and regime 2 with IT, for (at least) six reasons:

(1) The volatility of the residuals under regime 2 is considerably lower than under regime 1. Debelle (1999) argues that IT is designed to allow moving not only along the (inflation-output volatility) trade-off curve, but also to the left on a new, lower volatility curve. Also, by allowing for a discretion constrained by a pre-set inflation target and a horizon to achieve it, the central bank is able to manage a multitude of objectives (nominal and real), which potentially involves the lowest possible macroeconomic volatility.

(2) The persistence of both regimes is high in almost all cases, which suggests long-lasting and continuous regimes rather than regimes which appear sporadically and with frequent changes.

(3) The macroeconomic variables are considerably more often statistically significant in regime 2 compared to regime 1. This has been expected given the nature of the two regimes: Under ERT, monetary policy largely depends on the monetary policy in the anchoring economy, i.e. the room for maneuver for monetary policymakers to achieve domestic goals is restricted (and hence, the estimated effects of variables such as inflation and the output gap are statistically insignificant); on the other hand, IT is a "constrained discretion" strategy whereby the policy is directly geared toward achieving domestic objectives (and hence, variables such as inflation (in almost all cases) and the output gap (only in some cases) are statistically significant).

(4) The significance and magnitude of the coefficients under regime 2 suggests that these countries embarked on strict IT (i.e. inflation is given prime consideration, output is considered only in some cases). This is expected, given that in the early phases of IT in emerging countries, credibility needs to be built through closely monitoring inflation.

(5) The sporadically appearing significance and magnitude of the coefficient on economic activity may still suggest that although these economies geared their monetary policy toward strict IT they did to some extent consider the business cycle, which is an attribute of the IT design.

(6) The date of the switch inferred from the data is close to the official date of the switch from ERT to IT (in all countries except Hungary).

The inferred timing of each regime and, hence, the inferred switch date, is given last in each regime's panel in table 1. Given the argument about the potential endogeneity of the switch, we expected that the real switch, if it can be inferred from the data, would coincide roughly with the official switch (i.e. it can be just equal to the official switch only by chance). In Brazil, Philippines and Thailand, the inferred switch is found to precede the official switch, while in all remaining countries it followed the official switch. In the Czech Republic and Poland, the inferred switch took place 15 and 8 months after the official switch, respectively, suggesting that these countries officially embarked on the new regime (as a firm way to anchor inflation expectations), but most likely continued to closely target the exchange rate for some time after the official switch. For the Czech case, Hrncir and Smidkova (2004) describe the early phases of IT to involve backward-looking expectations, a still important role of regulated prices and exchange rate uncertainty. For the Polish case, note that the de facto exchange rate fluctuated

considerably even under ERT (see table A1); some (Pruski, 2002) relate this with the approach Poland followed as of 1995, which included a crawling peg of ±2.5% and under which – temporarily – numerically expressed inflation rates were targeted. In section 4.2 a three-regime specification is estimated in order to check whether some intermediate regime (between ERT and IT) has been in place in the investigated countries.

Hungary is an exception in these considerations, since the inferred switch to regime 2 took place too long before the official switch to IT and the appearance of regime 1 is rather sporadic. Therefore it cannot be argued that regime 2 in Hungary is really an IT regime. Some intuition behind these results is that Hungary published inflation expectations in its monetary policy guidelines already in 1999. Moreover, the crawling peg since March 1995 served for both achieving exchange rate targets and disinflation. The crawling peg continued besides IT until September 2001; until February 2008 a ±15% band around the central parity was in place. This suggests that Hungary had a de facto mixed system at least until 2008, whereby the exchange rate targets dominated at the beginning and were only gradually substituted by IT. This may be the reason why it is not possible to identify a clear regime switch in Hungary.

What could be caveats to these results? First, the most striking one is that the data may indicate a switch that is not the result of the IT strategy but of something else. For instance, the Czech Republic and Poland went through transition during regime 1, while the largest part of the 2000s was characterized by strong economic growth. But this is not the case in Hungary, which belongs to the same group of countries, geographically and in terms of economic developments. Second, Thailand and Brazil saw financial crises during regime 1 and a more stable period subsequently. Yet, as we argued earlier, a financial crisis can force the country to re-think its monetary regime. Third, these nine countries belong to distinct geographic regions, so the possibility that common regional shocks and potentially strong financial ties drive results is excluded. However, for strengthening confidence in the results, some robustness checks are performed in the subsequent section.

4.2 Robustness Checks

We perform three types of robustness checks: (1) allowing for three regimes, instead of two, to check if an intermediate regime between ERT and IT might have existed; (2) adding some exogenous variables and (3) checking for remaining endogeneity.[5]

First, table A3 in the annex gives the transition probabilities and volatilities for the three regimes: The timing in the table is set such that regime 1 corresponds to the potential period of ERT, regime 2 corresponds to the potential period of IT, and regime 3 stands for any other regime. The persistence and timing of regimes 1 and 2 can be reconciled with ERT and IT respectively; also the standard errors within these regimes are similar to those in table 1. In Brazil and Chile, regime 3 reflects some developments in the early 1990s, but these cannot be attributed to any intermediate regime. In Hungary and Philippines, regime 3 appears only sporadi-

[5] *Detailed robustness check results that are not explicitly shown in the annex are available from the author on request.*

cally (i.e. it has a low probability) and seems to be economically insignificant; moreover, in Hungary even regime 1 has a relatively low probability, as found before (see table 1). In Israel, regime 3 relates to the period of the mortgage crisis. However, in Colombia, the Czech Republic, Poland and Thailand, regime 3 reflects some developments between ERT and IT (bold-typed in table A3). This can be reconciled with the evidence that all these countries embarked on IT in the aftermath of exchange rate turbulence and when the need for disinflation emerged so that some of them pursued a money target for a short period after they had exited the peg and then started to target inflation. In the Czech case, the intermediate regime is likely to reflect the episode of sharp disinflation with a target of 4.5% ±1% by end-2000, which was accompanied by a slowdown of the economy, a reduction of domestic demand pressures and a decline of inflation expectations (Hrncir and Smidkova, 2004). However, the volatility of the economic environment is found to be only about 1.5 times higher than under the subsequent IT. In the Polish case, we identify the period of the eclectic approach mentioned in section 4.1, when the central bank followed multiple objectives. This was a period of structural changes within the financial system and a period of constant disinflation. However, Poland experienced slower disinflation compared to other transition countries, which may have been the cause for the intermediate regime to have lasted relatively long. Moreover, the volatility of the economic environment is found to have been about 4 times higher than under the subsequent IT.

Second, the robustness of our results is tested by adding foreign exchange reserves growth and net foreign assets as a percentage of GDP as exogenous covariates which are allowed to switch across the two regimes. The intuition behind the inclusion of reserves growth is the same as the one behind the inclusion of the nominal exchange rate; apart from that, it should reflect pressures on the foreign exchange market more tightly. It is argued that for the periods under a pegged exchange rate, the nominal rate might not fully reflect these pressures. The ratio of net foreign assets of the banking system to GDP is included to measure the level of currency substitution to examine how it might have affected the conduct of monetary policy (see, e.g., Leiderman et al., 2006). These two variables were treated as exogenous in order to avoid cumbersomeness in the estimation of the VAR system. The baseline results remain robust to this treatment. Surprisingly, reserves growth is significant only in 3 out of 9 cases in regime 1 (which is associated with ERT), albeit its magnitude and negative sign are as expected: Increasing reserves afforded more space for reducing the interest rate in a pegging country. This result is also intuitive, given that reserves are the most important constraint for monetary policy in pegging countries. Under regime 2 the effect of reserves growth fully vanishes (except for Hungary). This might suggest that under IT, the external sector does no longer play a constraining role in monetary policy. However, this conclusion is very partial, given the limited significance of the external sector variables. Currency substitution is found not to have a systematically significant influence: In some countries it matters, but in others it does not. Moreover, the sign of the coefficient for Brazil and Chile is not as expected. In general, the limited evidence may support the idea that a higher exposure of bank net assets to exchange rate risk precludes the central bank from lowering the interest rate (i.e. restricts the monetary room for maneuver), but it is very feeble.

Third, given our discussion in section 2.2.3, the main challenge of the Markov switching analysis seems to be the approach toward addressing the endogeneity of the regime switch. Indirect ways are used to check for any remaining endogeneity of the switch. Valente (2003) argues that if there is remaining endogeneity in the system, regime probabilities will differ among specifications; duration-dependent MS-VAR (Pelagatti, 2008) is used to check for remaining endogeneity due to a regime's duration. The checks do not suggest that endogeneity remains in the switching variable due to unobservables or duration. In addition, the results regarding the transition probabilities within the duration-dependent MS-VAR suggest a very high probability that in long durations there will be a switch from ERT to IT. This is in line with the findings in Petreski (2010) that long pegs are prone to crises and countries tend to exit from pegs under hard attacks. Conversely, the transition probability that a switch from IT to ERT will occur ranges from 0% to 15% and, as expected, suggests that even after a very long duration, there will be no switch back from IT to ERT. This is in line with the argument in Svensson (1998 and 2000) and Debelle (1999) and could be ascribed to the flexibility of IT.

5 Concluding Remarks

The objective of the paper is to empirically examine if the conduct of monetary policy has significantly changed with the switch from exchange rate targeting (ERT) to inflation targeting (IT) in nine emerging economies, including three European countries (the Czech Republic, Hungary and Poland). Only nine emerging markets have so far switched from ERT to IT, while developed switchers are assumed to have followed a different process, which may be ascribed to the higher credibility of the central banks in these countries than in emerging and developing countries or to the fact that they were a part of ERM. The economic model used is a fairly classical Taylor rule augmented with the exchange rate to capture its specific role for emerging countries. The reference period spans from the early 1990s (depending on data availability in each country) until end-2009. The Markov switching vector autoregression was used for each of the nine switchers, allowing the intercept, autoregressive terms and the variance to switch between two regimes.

The conclusion from this investigation is that the switch from ERT to IT represented a real switch in the investigated countries, except Hungary. The results suggest that monetary policy has undergone a significant change in these countries in the late 1990s and/or early 2000s, respectively. First, the evidence provided in this paper opposes the usual statement in the literature that under IT, central banks react strongly – in terms of interest rate setting – to inflation deviations from the target. Compared to the preceding ERT regime, these reactions moderated under IT (although across countries the response to inflation was more often significant under IT than under ERT). One explanation could be that the countries were able to share the burden of inflationary pressures between interest rate increases and currency depreciations (the latter being unfeasible under ERT). Second, the effect of the output gap is found to be statistically significant in only half of the countries and also suggests reaction moderation under IT, pointing to strict inflation targeting, whereby inflation is given prime consideration and output is taken into account only in some cases. Third, exchange rate effects were found to be largely insignificant both under ERT and IT (probably due to the lack

of variability in exchange rates, especially under the former). Fourth, the volatility of the economic environment is found to be lower under IT than under ERT, pointing to more macroeconomic stability under IT. Finally, the inferred timing of the detected regimes can largely be reconciled with the official switch to IT.

In the cases of the Czech Republic and Poland, IT has been clearly identified as a separate monetary policy regime. In both countries the response to inflation moderated under IT. While the Czech Republic did not respond to the business cycle position in either regime, the respective response in Poland moderated under IT. In both countries, a third intermediate regime is identified, which is associated with the economic developments in these two countries prior to the establishment of fully fledged IT. Monetary policy conduct in Hungary is characterized by one regime only, which is likely to reflect the combined strategy of ERT and IT it followed over nearly the entire investigated period.

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Annex of Tables

Table A1

Fully Fledged Inflation Targeters and Switch

Country	Inflation targeting intro-duced in	Inflation rate at the beginning of inflation targeting (%)	Inflation target / band (%)	Monetary regime from which the switch has been made	De facto exchange rate regime (RR classification)			De jure exchange rate regime (IMF classification)		
					De facto ERR before the switch	Duration of ERR (years)	De facto ERR after the switch	De jure ERR before the switch	Duration of ERR (years)	De jure ERR after the switch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
New Zealand	1989:12	3.3	1–3	Implicit nominal anchor	Managed floating	5	Managed floating	Free floating	6	Free floating
Canada	1991:2	6.9	1–3	Implicit nominal anchor	Limited flexible	20	Lim-flexible and flexible (2002)	Free floating	very long	Free floating
U.K.	1992:10	4	2	ERM I	Fixed	<2	Managed floating	Free floating	20	Free floating
Sweden	1993:1	1.8	2 (±1)	ERM I	Limited flexible	15	Managed floating	Fixed	16	Managed fl. and free fl.
Finland[1]	1993:1	2.6		ERM I	Limited flexible	21	Fixed	Fixed	22	Free floating
Australia	1993:6	2	2–3	Implicit nominal anchor	Free floating	9	Free floating	Free floating	9	Free floating
Spain[1]	1995:1	4.2		ERM I	Fixed	2	Fixed	Limited flexible	6	Limited flexible
Israel	1997:6	8.1	1–3	Exchange rate targeting	Managed floating	6	Managed floating	Managed floating	6	Managed floating
Czech Rep.	1997:12	6.8	3 (±1)	Exchange rate targeting	Limited flexible	6	Managed fl. and lim-flexible (2002)	Fixed	6	Managed floating
Poland	1998:1	10.6	2.5 (±1)	Exchange rate targeting	Managed floating	6	Managed floating	Managed floating	8	Free floating
South Korea	1998:4	2.8	3(±1)	Monetary targeting	Limited flexible	18	Managed floating	Managed floating	17	Free floating

[1] *Finland, Spain and Slovakia abandoned IT upon entry into the euro area in 1999 (Finland, Spain) and 2009 (Slovakia) respectively.*

Table A1 (continued)

Fully Fledged Inflation Targeters and Switch

Country	Inflation targeting intro-duced in	Inflation rate at the beginning of inflation targeting (%)	Inflation target / band (%)	Monetary regime from which the switch has been made	De facto exchange rate regime (RR classification)			De jure exchange rate regime (IMF classification)		
					De facto ERR before the switch	Duration of ERR (years)	De facto ERR after the switch	De jure ERR before the switch	Duration of ERR (years)	De jure ERR after the switch
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Brazil	1999:6	3.3	4.5 (±2)	Exchange rate targeting	Limited flexible	6	Managed floating	Managed floating	5	Free floating
Chile	1999:9	3.2	2–4	Exchange rate targeting	Managed floating	7	Managed floating	Managed floating	18	Free floating
Colombia	1999:10	9.3	2–4	Exchange rate targeting	Managed floating	16	Managed floating	Managed floating	20	Free floating
South Africa	2000:2	2.6	3–6	Monetary targeting	Free floating	5	Free floating	Free floating	17	Free floating
Thailand	2000:5	0.8	0–3.5	Exchange rate targeting	Fixed	24	Managed floating	Fixed (1997) Free float (2000)	27	Managed floating
Mexico	2001:1	9	3 (±1)	Monetary targeting	Managed floating	5	Managed floating	Free floating	6	Free floating
Norway	2001:3	3.6	2.5	Implicit nominal anchor	Managed floating	55	Managed floating	Managed floating	6	Free floating
Iceland	2001:3	4.1	2.5	Implicit nominal anchor	Limited flexible	14	Managed floating	Managed floating	4	Free floating
Hungary	2001:6	10.8	3.5 (±1)	Exchange rate targeting	Limited flexible	7	Limited flexible	Managed floating	5	Fixed
Peru	2002:1	–0.1	2.5 (±1)	Monetary targeting	Limited flexible	8	Limited flexible	Free floating	12	Limited flexible
Philippines	2002:1	4.5	4–5	Exchange rate targeting	Limited flexible	5	Limited flexible	Free floating	13	Free floating
Slovakia[1]	2005:1	5.8	6 (±1)	Exchange rate targeting	Limited flexible	6	Limited flexible	Fixed	2	Managed floating
Guatemala	2005:1	9.2	5.5 (±1)	Monetary targeting	Limited flexible	14	Limited flexible	Free floating	16	Managed floating
Indonesia	2005:7	7.4	5.5 (±1)	Monetary targeting	Managed floating	6	Managed floating	Managed floating	4	Managed floating
Romania	2005:8	9.3	4 (±1)	Monetary targeting	Managed floating	5	Managed floating	Limited flexible	3	Managed floating
Turkey	2006:1	7.7	4(±2)	Monetary targeting	Free floating	3	Free floating	Free floating	6	Free floating
Ghana	2007:5	10.5	0–10	Monetary targeting	Limited flexible	6	Limited flexible	Managed floating	6	Managed floating
Serbia	2009:1	6.5	8–12	Monetary targeting	Managed floating	6	Managed floating	Managed floating	6	Managed floating

Source: Reinhart and Rogoff (2004), Pétursson (2004), Hammond (2009), Roger (2009), IMF, national central banks and Carmen Reinhart's website.

Note: Countries in bold type represent the switchers from exchange rate targeting to inflation targeting.

[1] *Finland, Spain and Slovakia abandoned IT upon entry into the euro area in 1999 (Finland, Spain) and 2009 (Slovakia) respectively.*

Table A2

Variables: Definition and Sources

Abbreviation	Description	Unit	Source	Notes
R	Money market interest rate	% per month	IFS[1] and national central banks	Wherever not available, the discount rate is used.
CPI	Consumer prices	Index number	IFS	
INF	Inflation	% per month (year on year)	Author's calculation	Inflation = log(cpi)–log(cpi[–12])
IND	Industrial production	Index number	IFS and national statistics offices	
GAP	Output gap	Percentage points	Author's calculation	The residual series between the actual and the potential output estimated from the industrial production by HP filtering.
ER	Exchange rate	Units of national currency per SDR	IFS	
DER	Change in the exchange rate	% per month (year on year)	Author's calculation	DER = log(ER)–log(ER[–12])
RES	Reserves minus gold	USD million	IFS	
DRES	Change in reserves	% per month (year on year)	Author's calculation	DRES = log(RES)–log(RES[–12])
NFA	Net foreign assets to GDP	National currency (million/ billion)	IFS	NFA refers to the difference between foreign assets and foreign liabilities of the banking system, taken as an absolute value. The annual GDP is used for each month.

Source: Author's compilation.

[1] *IMF International Financial Statistics.*

Table A3

Regimes' Persistence and Volatility for Three Regimes

Country	Transition probabilities [regime volatility]			When does regime 3 ("Other") appear?
	p11	p22	p33	
	ERT	IT	Other	
Czech Rep.	**0.983 [1.510]**	**0.946 [0.100]**	**0.785 [0.161]**	**1998:12–2000:4**
Hungary	0.667 [0.553]	0.551 [0.115]	0.106 [1.407]	Very sporadically
Poland	**0.974 [3.154]**	**1 [0.295]**	**0.989 [1.175]**	**1995:3–2002:6**
Brazil	0.768 [2,167.3]	0.946 [1.328]	0.610 [84.636]	1992:7–1993:8
Chile	0.908 [2.331]	0.989 [0.151]	0.841 [6.165]	1993:8–1994:12
Colombia	**0.946 [2.934]**	**0.942 [0.091]**	**0.938 [0.700]**	**1999:4–2004:12**
Israel	0.861 [0.892]	0.909 [0.174]	0.859 [0.268]	2009:1-2009:11
Philippines	0.778 [1.070]	0.989 [0.248]	0.640 [4.586]	Sporadically
Thailand	**0.988 [0.258]**	**0.988 [0.143]**	**0.946 [2.357]**	**1999:2–2000:10**

Source: Author's calculations.

Note: Figures in square brackets are regime volatilities. Serial correlation has been accounted for. Bold type signifies 'other' regime that is identified between regime 1 and regime 2.

CESEE-Related Abstracts from Other OeNB Publications

The abstracts below alert readers to studies on CESEE topics in other OeNB publications. Please see *www.oenb.at* for the full-length versions of these studies.

Preserving Macrofinancial Stability in Serbia: Past Legacies, Present Dilemmas and Future Challenges

Sándor Gardó

In the course of the boom years from 2004 to 2008, Serbia accumulated sizeable macrofinancial imbalances, which made the country vulnerable to external shocks during the global crisis and rendered the process of crisis management more complex. As these vulnerabilities materialized, Serbia had to take recourse to international support, which helped stabilize the country's macrofinancial conditions. Some macrofinancial risks prevail, however, mainly with regard to fiscal and external sustainability. At the same time, financial stability concerns are mitigated by the banking system's high shock-absorption capacities, the strategically oriented presence of foreign banks and vigilant central bank action. A major future challenge will be to avoid a renewed rise in financial and external vulnerabilities. This calls for a prudent economic policy mix and increased efforts toward structural reform.

Published in *Financial Stability Report 21*.

Event Wrap-Ups

69th East Jour Fixe[1]
Credit to the Private Sector: Threat to or Opportunity for Growth in CESEE?

Compiled by
Mariya Hake and
Thomas Scheiber

The 69th East Jour Fixe hosted by the OeNB on June 20, 2011, dealt with the development of credit to the private sector in CESEE countries from a macroeconomic perspective. While credit dynamics in the CESEE region have been explored in depth from a financial stability perspective, the interlinkages between credit and macroeconomic variables like GDP growth or private consumption have received comparatively little attention as yet. To fill this void, the 69th East Jour Fixe provided a platform for stocktaking and for assessing the implications of future credit growth in the CESEE region.

The keynote session was chaired by *Peter Mooslechner,* Director of the OeNB's Economic Analysis and Research Department. In his opening statement he underlined the importance of the credit-growth nexus in the CESEE countries yet questioned whether credit levels had indeed been in line with fundamentals before the recent financial and economic crisis. He pointed out the need to consider the implications that the private sector's elevated debt levels might have for economic recovery in general, and for private consumption and investment in the region in particular. Accordingly, the aim of the OeNB's 69th East Jour Fixe was to draw lessons from the latest credit boom episode, with a view to getting a better handle on credit dynamics in boom periods and on the real-time assessment of sustainable credit growth.

In the first keynote address, *Martin Brown,* Professor at the University of St. Gallen, contrasted the microeconomic and the macroeconomic perspectives of private-sector credit growth in the countries of Central and Eastern Europe. He shared insights into the debt overhang existing in the corporate sector as derived from the Business Environment and Enterprise Performance Survey (BEEPS). While according to BEEPS data, the credit-to-GDP ratio of the private sector increased by 29 percentage points prior to the crisis (2003 to 2008) and foreign currency-denominated credit accounted for as much as 48% of outstanding credit in 2007, the share of firms, large ones in particular, that relied above all on bank credit to finance their investment projects was fairly small. Moreover, the results revealed that the crisis-related contraction of GDP and export growth, especially in certain CESEE countries (e.g. Baltic countries), was highly correlated with excess corporate leverage. Hence, the debt overhang in the corporate sector might be of increasing relevance for financial stability especially in the tradable sector. Moving on to the debt overhang threat in the household sector, Brown presented recent results based on the EBRD's latest Life in Transition Survey. According to this survey, the debt overhang appears to be less of a threat in the household sector than in the corporate sector, as only a small share of CESEE households have mortgages and only a small share thereof is denominated in foreign currency. Furthermore, financial constraints appear to have had a negligible impact in the crisis on the household sector relative to income shocks.

[1] *The presentations and the workshop program are available at http://ceec.oenb.at (Events).*

In the second keynote lecture, *Märten Ross,* Deputy Governor of Eesti Pank, voiced concerns about the ability of policymakers to detect credit booms in real time and about the effectiveness of policy measures in mitigating the boom. Real-time data for Estonia before the crisis, for instance, provided little guidance as to whether double-digit quarterly credit growth rates were contributing to an overheating of the economy rather than being a natural phenomenon of financial deepening. Accordingly, Ross advocates a policy of keeping actual figures in good times consistently below the levels that would be considered optimal. Most importantly, credit should grow in line with the strength of the financial sector. Ross also stressed that policy measures to contain credit growth are likely to have limited effectiveness, especially when the banking system consists almost exclusively of foreign-owned banks, as is the case in Estonia. For instance, following the launch of several administrative measures by Eesti Pank in 2006 to rein in credit growth, the credit and asset price cycle did indeed turn in early 2007, but it is difficult to disentangle the combination of underlying reasons. At any rate, these measures contributed to financial stability in the course of the crisis. At the same time, the crisis also revealed the importance of having prudent policies and safeguards in place both in home and in host countries. Finally, Ross sees the broadening of the EU supervisory framework as a positive development in this respect, subject to the caveat that more players are involved in the decision-making process and that some important issues are still left to the host countries (e.g. burden sharing).

In the ensuing discussion it was argued that Brown's micro-based findings (especially for households) imply less severe an impact than expected from a macro perspective, which in turn raised the question whether the macro models had overestimated the threat for the financial sector. Brown countered that the financial stability threat had to be seen separately from the debt overhang, explaining that what the models had overestimated was the real impact of the debt overhang. Regarding the debt overhang in the corporate tradable sector, Ross elaborated that this was not really an issue as long as foreign parent banks continued to provide liquidity (as Swedish banks did in Estonia).

Credit Developments in CESEE: Where Do We Stand and What Do We Know?

The first session of the workshop, chaired by *Peter Backé,* Deputy Head of the Foreign Research Division at the OeNB, was devoted to stocktaking, exploring inter alia how current credit-to-GDP ratios relate to fundamentals and how deleveraging may affect macroeconomic dynamics. *Aleksandra Zdzienicka,* researcher at CEPII (Centre d'études prospectives et d'informations internationals), opened the session by elaborating on the issue whether credit growth has been excessive in the CESEE region and has increased the risk of a debt overhang. Zdzienicka used an unbalanced panel data set of 13 CESEE countries to assess the impact of a credit expansion on economic growth as well as to shed light on recent developments in banking credit in CESEE. Her main results underline that the causal relation runs from credit to economic growth and that excessive credit growth has a detrimental impact on growth. Her assessment yielded the result that Estonia, Bulgaria and Hungary might face debt overhang problems. With a view to mitigating the risks of a debt overhang, Zdzienicka underlined the need for prudential regulation and

supervisory measures during episodes of rapid credit growth and stressed the importance of an effective regulatory response to growing private-sector indebtedness (bankruptcy, debt reliefs, bailouts).

Mariya Hake, economist at the OeNB, reported on a meta-analysis testing the robustness of seven macroeconomic determinants of foreign currency borrowing in the private sector in CESEE countries, namely interest rate differentials, inflation and exchange rate levels and volatilities, deposits in foreign currency and the ratio of inflation volatility and real exchange rate volatility (minimum variance portfolio). Given the increasing number of studies with controversial results, the meta-analysis approach aims at estimating the study-independent unbiased impact of the seven determinants accounting for between-study differences related to data definition and structure, estimation method as well as control variables. The meta-analysis found the coefficients for all determinants of foreign currency borrowing to have been influenced by the features of the studies. In several estimations, Hake and her coauthors identified strong support for the robustness of the negative impact of exchange rate volatility and the positive impact of the minimum variance portfolio as well as of foreign currency deposits. Only weak evidence was found for common determinants such as the interest rate differential and inflation volatility. From a policy perspective these results stress the importance of macroeconomic stability for the future development of foreign currency lending in the CESEE region, although country-specific differences must of course be taken into consideration.

Naotaka Sugawara, economist at the World Bank, addressed the impact of adverse shocks on the capability of households with mortgage loans to fulfill their financial liabilities in a timely manner (i.e. household stress-testing). In particular, he referred to a World Bank project that had investigated the impact of macroeconomic risks on the vulnerability of the household sector in the CESEE and CIS regions given two distinct types of shocks: exchange rate depreciation and an increase in (foreign as well as domestic) interest rates. The size of the shock was defined as the largest depreciation of the local currency and the largest increase in interest rates observed during the period from January 2007 to December 2009, respectively. Households were considered to be "vulnerable" if their debt service-to-income ratios exceeded 30% or if they were servicing their debt with negative household income. The stress test results indicate that, on average, the share of vulnerable households more than doubled from 7% to 16% during the crisis – an increase that was, however, rather marginal from the perspective of the whole economy. In Estonia, for instance, where 30% of all households are indebted, the simulations showed the share of vulnerable households to increase from 4% to 8%. Proportionately, the social classes affected most by shocks (e.g. rising interest rates and falling currencies) are middle- to upper-income families, which weakens the social case for government intervention. Finally, though stress-testing is a useful tool for assessing the risks facing the private sectors of the CIS and CESEE regions, further analysis would benefit from the incorporation of more country-specific information and possible countermeasures (e.g. selling durables).

Questions raised addressed the weak significance of the interest rate differential for borrowing in foreign currency. Hake argued that a possible explanation could be that the macroeconomic fundamentals driving the increase of the interest rate differential appear to be more robust determinants of foreign currency lending than the interest rate differential itself.

The Way Forward: Creditless Recoveries, a Revival of Credit Growth or Subdued Economic Performance Due to Insufficient Credit Supply?

The second session, chaired by *Doris Ritzberger-Grünwald,* Head of the OeNB's Foreign Research Division, was devoted to the possible scenarios for CESEE countries after the crisis. The first presenter, *Fabrizio Coricelli,* Professor at the Université Paris 1 (Paris School of Economics) and CEPR, investigated the topic how credit conditions shape economic recoveries. The nature of the recovery is linked to the nature of the output decline. Severe crises are often associated with sudden stops of credit flows. In the short run, the availability of alternative sources of financing such as trade credit, the reallocation of production to less credit-dependent sectors, or the take-up of unutilized capacity may enable the economy to grow despite the creditless character of the recovery. In the long run, the restoration of credit flows is crucial, in particular when investment has fallen sharply during the recession. Among the EU Member States, the Baltic countries and Hungary experienced a sudden stop in net capital inflows, which has been slowing down the incipient economic recovery and hence reduced long-run growth perspectives. Which prompts the question: will credit flows return? The special feature of the unconditional income convergence miracle of EU integration was based on rapid trade and financial integration through dominant foreign ownership of banks and large cross-border capital flows. As long as the banking system in the core countries remains weak and endangered by the sovereign debt crisis, respectively, less capital will flow to the CESEE countries. Furthermore, even if capital flows do pick up again, sustainable long-term growth can only be achieved when the issue of vulnerability that comes by and large from the lack of restraint on risk-taking and moral hazard by euro area financial institutions will be addressed properly through efficient coordination in regulation and the presence of a supranational lender of last resort.

Abdul de Guia Abiad, International Monetary Fund, discussed the nature of creditless recoveries in general. On average one in five recoveries can be qualified as creditless either because credit is not available or because credit is not needed. The relative frequency of creditless recoveries increases significantly in the aftermath of banking crises and credit boom-busts for instance associated with real construction investment booms. Episodes of creditless recoveries are characterized by slower growth and more protracted recovery due to significantly lower investment activity and private consumption and a decline in total factor productivity. Finally, sectoral analysis suggests that creditless recoveries tend to be credit supply-driven rather than demand-driven, i.e. they reflect impaired financial intermediation.

The global financial and economic crisis had a relatively strong impact on CESEE countries, as their preceding economic expansion had been financed by relying heavily on cross-border capital flows. With the macroeconomic adjustment process coming to an end, *Martin Bijsterbosch,* European Central Bank, investigated how the post-crisis recovery phase could look like and what the role of credit could be in such a recovery. Results from estimated panel probit models suggest that creditless recoveries are typically preceded by large declines in economic activity and financial stress, in particular if private-sector indebtedness is high and the country relies on foreign capital inflows. The predicted probability of a creditless recovery during the coming years is relatively high in the Baltic

states, where credit growth has been subdued due to a combination of supply and demand factors. Loan-to-deposit ratios still signal some need for deleveraging for the banking sector, which probably supresses credit growth. Capacity utilization rates are still below precrisis peaks, although aggregate demand pressures may be higher than capacity utilization rates suggest. As a near-term challenge, Bijsterbosch identified the fact that subdued lending may not only dampen output growth but also endanger structural change, which needs to be financed as well. In the medium term, capital flows will return if the right policies are pursued – together with the risk of a renewed lending boom and the risk of a re-emergence of macroeconomic imbalances.

The ensuing discussion centered on the question whether creditless recoveries are a blessing or a curse. Coricelli and Abiad stressed that as long as core European banks are financially distressed, impaired intermediation will hinder the efficient reallocation of credit from less productive to more productive sectors, with potentially harmful consequences for CESEE economies. The introduction of new regulations and higher capital requirements for banks may put an additional drag on investment and consumption. Furthermore, in countries which have built up large current account deficits in the precrisis period, firms and households might find access to credit particularly difficult. Nevertheless, a return to the unsustainable precrisis episodes of double-digit current account deficits is equally undesirable.

Notes

Periodical Publications

See *www.oenb.at* for further details.

Geschäftsbericht (Nachhaltigkeitsbericht) — German
Annual Report (Sustainability Report) — English

This report reviews the OeNB's mandate, responsibilities and organization as well as the monetary policy of the Eurosystem, economic conditions and developments both in the financial markets and in financial market supervision during the reporting year. Furthermore, it contains the OeNB's financial statements, Intellectual Capital Report and Environmental Statement.

Geldpolitik & Wirtschaft — German
Monetary Policy & the Economy — English

This quarterly publication analyzes current cyclical developments, provides medium-term macroeconomic forecasts and presents studies on central banking and economic policy topics. It also provides summaries of macroeconomic workshops and conferences organized by the OeNB.

Finanzmarktstabilitätsbericht — German
Financial Stability Report — English

This semiannual report contains analyses of Austrian and international developments with an impact on financial stability and studies designed to offer in-depth insights into specific financial stability-related topics.

Focus on European Economic Integration — English

This quarterly publication provides analyses on the Central, Eastern and Southeastern European (CESEE) region. Contributions include studies dealing with macrofinancial and monetary integration as well as economic country analyses and cross-regional comparisons.

Statistiken – Daten & Analysen — German, English summaries

This quarterly publication contains analyses of Austrian financial institutions, cross-border transactions and positions as well as financial flows. Some 200 tables provide information about macroeconomic, financial and monetary indicators. On the OeNB's website, these tables are also available in English. In addition, this series includes special issues on selected statistics topics published at irregular intervals.

Research Update — English

This quarterly newsletter is published online *(www.oenb.at/research-update)* and informs readers about selected findings, research topics and activities of the OeNB's Economic Analysis and Research Department.

Proceedings of OeNB Workshops — German, English

These proceedings contain papers presented at OeNB workshops at which national and international experts discuss monetary and economic policy issues.

Working Papers — English

This series provides a platform for the publication of studies by OeNB or other economists on particular monetary policy topics.

Conference Proceedings of the OeNB's Economic Conference — English

These proceedings contain contributions to the OeNB's annual Economics Conference, an international platform for exchanging views and information on monetary and economic policy as well as financial market issues.

Conference Proceedings of the OeNB's Conference on European Economic Integration — English

These proceedings contain contributions to the OeNB's annual Conference on European Economic Integration (CEEI), which focuses on Central, Eastern and Southeastern European issues and the ongoing EU enlargement process.

Publications on Banking Supervision — German, English

For an overview, see
http://www.oenb.at/en/presse_pub/period_pub/finanzmarkt/barev/barev.jsp

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