The transmission of Euro Area shocks to the Czech Republic, Hungary, and Poland

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Abstract

The aim of this study is to investigate the transmission of shocks in the Euro Area to the Czech Republic, Hungary, and Poland. We make use of a structural vector error correction approach that minimizes the dependence of the results on arbitrary modeling assumptions. Based on a dynamic open economy framework we derive long-run relationships which are imposed as identifying restrictions on the cointegration space. The model is then employed to analyze the transmission of shocks by means of generalized impulse response functions.

JEL classification: C11, C32, F41

Keywords: European Economic Integration, Structural Vector Error Correction Model, Generalized Impulse Response Analysis

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1 Research Question

Over the past two decades, Central and Eastern European (CEE) economies managed to achieve a high level of economic and political integration with Western Europe, particularly those Eastern European countries that joined the European Union (EU). Yet, the interrelations between the EU and CEE still lack a thorough empirical investigation. To a certain extent, this might be due to the absence of sufficiently accurate data and the unsatisfactory coverage of existing time series (Benkovskis et al., 2011). In the underlying study, we aim to contribute in closing this gap by assessing the transmission of economic shocks in the Euro Area (EU-12) to the Czech Republic, Hungary, and Poland. In so doing we aim to develop a theoretically guided empirical macroeconometric model for each of the three economies that can serve as a tool to assess how shocks in the Euro Area translate to CEE countries.

From a political perspective it is important to know how CEE economies in general, and the Czech Republic, Hungary, and Poland in particular, are affected by shocks that hit the Euro Area. First, as many Eastern European economies, the Czech Republic, Hungary, and Poland represent a large market for exports from the EU-12 and the EU-12 are an important source of foreign direct investments in these countries. Second, the currency markets of the Czech Republic, Hungary, and Poland are expected to become ever more integrated because of the prospect of joining the European Monetary Union. Monetary policy decisions of the ECB which not only have to take into account their impact on the domestic economy but also on foreign regions which are highly relevant to the Euro Area. Besides that, the degree of homogeneity in the responses to monetary policy and to other macroeconomic shocks is an essential precondition for a monetary union. Last but not least, the flow of workers between the Euro Area and the three countries that are the subject of this study is expected to increase because of the opening up of labor markets to CEE citizens, which deepens the economic ties even further.

2 Related Literature

Most studies on the transmission of shocks in Eastern Europe concentrate on domestic shocks. In these studies, it is mainly the monetary transmission mechanism which is of interest (see Égert et al., 2006a; Égert and MacDonald, 2008).

There are very few studies which look at the impact of foreign shocks on CEE economies. Only a couple of studies exist which explicitly assess foreign shocks and their impact upon CEE countries. As one of the first similar studies in this area, Jiménez-Rodriguez et al. (2010) base their assessment on data for the Euro Area and the USA as the foreign economy and employ a near VAR model with structural breaks. Their results indicate that the response to commodity price shocks differs among the ten CEE countries, and that a shock in the foreign interest rate leads to a fall in industrial production in all and to a fall in prices in most of these countries. Besides this, increased foreign industrial production has a positive spillover effect on domestic industrial production and yields to an appreciation of domestic currencies. They find that Eastern European countries show a high degree of homogeneity in the responses to shocks in industrial production, which is a good pre-condition for joining the monetary union.

In a study with a similar undertaking as ours, Benkovskis et al. (2011) address the spillovers of monetary policy shocks from the Euro Area to Poland, Hungary and the Czech Republic. Using a factor augmented VAR (FAVAR) model, they show that monetary policy shocks in the Euro Area significantly impact on economic activity in Poland, Hungary, and the Czech Republic. They argue that the effect comes through the interest rate channel and through changes in foreign demand. Furthermore, the exchange rate is shown to be important in explaining movements in CEE prices.

Crespo-Cuaresma et al. (2011) study the interconnectedness of Germany and the CEE-5 countries focusing on fiscal shocks. Their analysis is based on a structural VAR model including the foreign fiscal balance, domestic government purchases of goods and services, domestic net taxation, domestic output, the exchange rate, domestic inflation, and the interest rate. They find that a fiscal expansion in Germany leads to expansionary fiscal policy in CEE countries. The impact on GDP differs among the five economies included in the study.

The methodology we rely on is based upon a series of papers (Pesaran and Shin, 1998; Garratt et al., 1999, 2003, 2006), where the authors argue in favor of using a structural vector error correction (SVEC) framework combined with generalized impulse response analysis to reveal the effects of exogenous shocks on macroeconomic variables. The advantages of this approach over other frameworks like vector autoregressive models (VARs), structural vector autoregressive models

(SVARs) and standard vector error correction models (VECs) are that (i) theoretical long-run relationships, which are deemed to be more credible than short-run relationships used in SVARs, are derived to identify cointegrating relations and that (ii) the ordering of endogenous variables neither matters for the cointegration space nor for the impulse response analysis. Altogether this minimizes the investigator's need for arbitrary modeling choices. A comparable framework has already been used in Gaggl et al. (2009), Prettner and Kunst (2012), and Prettner and Prettner (2012) to analyze the effects and transmission channels between the United States and the Euro Area, between Austria and Germany, and between the Euro Area and the CEE aggregate, respectively. To the best of our knowledge, there exists no paper that applies a similar modeling strategy that combines long run theory with short run fluctuations to assess the impact of shocks in the Euro Area on the three CEE countries that are the subject of this investigation.

3 The Theoretical Model

In this section we rely on households' dynamically optimal consumption-savings decisions and on a neoclassical description of the production sides of our model economies in deriving restrictions on the cointegration space of the SVECM (cf. Prettner and Kunst, 2012; Prettner and Prettner, 2012).

3.1 Consumption Side

Assume that there are two economies, each populated by a representative household choosing sequences of consumption goods produced at home and abroad in order to maximize its discounted stream of lifetime utility

$$\max_{\{C_t\}_0^\infty, \{C_t^*\}_0^\infty} \sum_{t=0}^{\infty} \beta^t \left(C_t^\alpha C_t^{*1-\alpha} \right). \tag{1}$$

Here β is the discount factor, t is the time index, C_t denotes consumption of the domestically produced aggregate (numéraire), and an asterisk refers to the foreign economy. The utility function has a Cobb-Douglas representation with $0 < \alpha < 1$ being the elasticity of utility with respect to the consumption aggregate produced at home. The household has to obey a budget constraint such that its expenditures and savings in period t do not exceed its income. Furthermore, households face a cash-in-advance constraint in the spirit of Clower (1967) such that individuals are only allowed to buy consumption goods with money and not with wealth that is invested in capital or bonds markets. These two constraints can be written as

$$\begin{aligned} C_t + \frac{P_t^*}{e_t}C_t^* + K_t + B_t + \frac{B_t^*}{e_t} + M_t &= (1+r_t)K_{t-1} + w_t L_t + \frac{1+i_t}{1+\pi_t}B_{t-1} \\ &\quad + \frac{1+i_t^*}{1+\pi_t^*}\frac{B_{t-1}^*}{e_t} + \frac{M_{t-1}}{1+\pi_t}, \end{aligned} \tag{2}$$

$$C_t + \frac{P_t^*}{e_t}C_t^* \leq \frac{M_{t-1}}{1+\pi_t}, \tag{3}$$

where P_t^* refers to the price level of the consumption aggregate produced in the foreign country, K_t denotes the real capital stock, B_t are real bonds issued by the corresponding government, e_t represents the nominal exchange rate, which states how much of the foreign currency one unit of the home currency is able to buy, M_t refers to individual's real money holdings, r_t denotes the real rate of return on capital (equivalent to the real interest rate in our case of no depreciation), i_t represents the nominal interest rate on governmental bonds, π_t is the inflation rate, w_t the real wage rate, and L_t refers to inelastic labor supply as given by the time constraint of the household. Households are rational, consequently they do not wish to hold more money than necessary for the transactions associated with optimal consumption in period t. This implies that the cash-in-advance constraint holds with equality. Altogether this leads to the following results of the dynamic optimization problem

$$CPI_t = \frac{CPI_t^*}{e_t}, \tag{4}$$

$$\frac{1+i_t}{1+\pi_t} = \frac{1+i_t^*}{1+\pi_t^*}\frac{e_{t-1}}{e_t}, \tag{5}$$

$$1+r_t = \frac{1+i_t}{1+\pi_t}, \tag{6}$$

where CPI_t and CPI_t^* denote the consumer price indices in the domestic and foreign economy, respectively. The first equation represents the Purchasing Power Parity (PPP) relationship, stating that — adjusted for the nominal exchange rate — the price levels in the two countries move in line. The second equation refers to the Interest Rate Parity (IRP), stating that there is no difference in the return on investments between home and foreign bonds. The third equation represents the Fisher Inflation Parity (FIP), stating that investments in government bonds and in physical capital should deliver the same return. Altogether these conditions are ruling out arbitrage rents (cf. Garratt et al., 2006; Gaggl et al., 2009).

3.2 Production Side

The production side of the home and foreign economies closely follows that outlined in Prettner and Kunst (2012) who build their description upon Garratt et al. (2006) and Barro and Sala-i-Martin (2004). Output at home Y_t is produced according to

$$Y_t = A_t L_t f(k_t), \tag{7}$$

with f being the intensive form production function fulfilling the Inada conditions, A_t denoting the technology level of the economy, and k_t referring to the capital stock per unit of effective labor. Following Garratt et al. (2006), the employed workforce is a fraction δ of the total population N_t such that

$$L_t = \delta N_t, \tag{8}$$

which implies an unemployment rate of $1-\delta$. Furthermore, there are technology adoption barriers on the vein of Parente and Prescott (1994) such that

$$\eta A_t = \theta A_t^* = \bar{A}_t, \tag{9}$$

where $\bar{A}_t$ is the technological level in the rest of the world and $\eta > 0$ and $\theta > 0$ measure incompletenesses in technology adoption and diffusion between the rest of the world and the economies under consideration. Dividing domestic by foreign output and taking into account Equations (8) and (9) yields an output gap (OG) relation

$$\frac{y_t}{y_t^*} = \frac{\theta\delta}{\eta\delta^*}\frac{f(k_t)}{f(k_t^*)}, \tag{10}$$

where y_t denotes per capita output. Equation (10) implies that differences in per capita between the two economic areas can be explained by the relative size of technology adoption/diffusion parameters, the relative size of employment rates and different capital intensities.

3.3 Stochastic Representations of the Restrictions

Taking logarithms of equations (4), (5), (6), and (10) and rearranging yields

$$\begin{aligned}
\log(CPI_t) &= \log(CPI_t^*) - \log(e_t), && (11)\\
\log(1+i_t) - \log(1+i_t^*) &= \log(1+\pi_t) - \log(1+\pi_t^*), \\
&\quad + \log(e_{t-1}) - \log(e_t) && (12)\\
\log(1+i_t) - \log(1+\pi_t) &= \log(1+r_t), && (13)\\
\log(y_t) - \log(y_t^*) &= \log\left[f(k_t)\right] + \log(\theta) + \log(\delta) \\
&\quad - \log\left[f(k_t^*)\right] - \log(\eta) - \log(\delta^*), && (14)
\end{aligned}$$

which are deterministic relationships holding in a long-run equilibrium. In the short run — during adjustment processes — these equations need not be fulfilled with equality. Instead there are long-run errors denoted by ϵ measuring short-run deviations from these long-run relationships (cf. Garratt et al., 2006). Consequently, the stochastic counterparts to equations (11), (12), (13), and (14) in terms of the endogenous variables of the SVECM read

$$p_t - p_t^* + e_t = b_{1,0} + \epsilon_{1,t+1}, \quad (15)$$

$$i_t - \Delta p_t = b_{2,0} + \epsilon_{2,t+1}, \quad (16)$$

$$i_t - i_t^* = b_{3,0} + \epsilon_{3,t+1}, \quad (17)$$

$$y_t - y_t^* = b_{4,0} + \epsilon_{4,t+1}, \quad (18)$$

where our theoretical considerations imply that the estimates of $b_{1,0}$ and $b_{2,0}$ should be close to zero, the estimate of $b_{3,0}$ should reflect the logarithm of the real interest rate and the estimate of $b_{4,0}$ should reflect the interregional differences in the logarithm of the structural determinants of the output gap.

4 Econometric Model

Starting from the basic model, the general structural Vector Autoregressive Model (SVAR) with k endogenous variables, a constant, and a time trend is given by

$$Az_t = \tilde{a} + \tilde{b}t + \sum_{i=1}^{p} \tilde{\Gamma}_i z_{t-i} + \tilde{\epsilon}_t. \tag{19}$$

A is the matrix of contemporaneous structural coefficients, z_t is a $k \times 1$ vector of endogenous variables, z_{t-i} the vector of lagged endogenous variables up to a lag order i, $\tilde{\Gamma}_i$ is therefore the matrix containing the coefficients of the lagged endogenous variables and $\tilde{\epsilon_t}$ represents a white noise error term. $\tilde{a}$ and $\tilde{b}$ are structural intercept and trend coefficients, respectively. If all the variables z_t are $I(1)$ but there exists a stationary linear combination βz_t, the variables are said to be cointegrated. The model can then be written in Vector Error Correction form

$$A\ \Delta z_t = \tilde{a} + \tilde{b}t - \tilde{\Pi} z_{t-1} + \sum_{i=1}^{p-1} \tilde{\Gamma}_i \Delta z_{t-i} + \tilde{\epsilon}_t. \tag{20}$$

The $k \times k$ matrices $\tilde{\Pi}$ and $\tilde{\Gamma}_i$ contain the coefficients of the error correction and autoregressive part, respectively. In order to get to the reduced form, one has to premultiply with the matrix of contemporaneous structural coefficients A such that

$$\Delta z_t = a + bt - \Pi z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-i} + \epsilon_t, \tag{21}$$

with $a = A^{-1}\tilde{a}$, $b = A^{-1}\tilde{b}$, $\tilde{\Gamma}_i = A^{-1}\Gamma_i$, $\Pi = A^{-1}\tilde{\Pi} = A^{-1}\tilde{a}\beta' = \alpha\beta'$, and $\epsilon_t = A^{-1}\tilde{\epsilon_t}$.

For our purpose, the matrix $\tilde{\Pi} = \tilde{\alpha}\beta'$ is of major interest. Its structure determines the nature of the long-term equilibrium conditions that are supposed to prevail among the variables included in the model. From the view of the dynamics of the model, it contains a self-correcting mechanism that automatically adjusts for deviations from these long-term equilibrium conditions. The matrix $\tilde{\Pi}$ splits into two parts, the loading matrix $\tilde{\alpha}$ that determines the speed of adjustment and the matrix of stationary linear combinations β' that form the equilibrium conditions when premultiplied with the vector of endogenous variables. Unfortunately, the factorization of $\tilde{\Pi}$ is not unique and we need to impose restrictions in order to estimate the model.

If there exist r cointegrating relations, the matrix $\tilde{\Pi}$ has rank r. Even if we would know A, we would have to impose r restrictions on each of the r cointegrating relations to uniquely identify α and β'. As this makes r^2 necessary restrictions, we need another $r^2 - r$ restrictions (r are provided by normalization) which we can impose on β. Exactly this additional information is drawn from the theoretical relationships derived in section 3.

In contrast to (4), we do not include a trend in the model itself but in the matrix of cointegrating relations (in order to account for the convergence process of the CEE economies to the Euro Area) and we add as only exogenous variable the oil price P_t^o. Hence, we consider the reduced form model

$$\Delta z_t = \alpha\beta' a_0 - \alpha\beta' z_{t-i} + \sum_{i=1}^{p-1} \Gamma_i \Delta z_{t-1} + \Psi_i \Delta \ P_{t-i}^o + u_t. \tag{22}$$

For the computation of the generalized impulse responses, we estimate the model in (22) for each economy separately. The vector of endogenous variables $z_t' = (y_t,\ i_t,\ \Delta p_t,\ i_t^*,\ (p_t - p_t^*),\ e_t,\ y_t^*)$ includes two domestic variables — where domestic refers to either Poland, the Czech Republic, or Hungary — namely domestic output and the domestic interest rate (y_t and i_t), the first difference in the price level, i.e., inflation (Δp_t), the foreign (i.e. Euro Area) interest rate (i_t^*), the price differential ($p_t - p_t^*$), the exchange rate (e_t), and foreign (i.e. Euro Area) output (y_t^*).

Employing all four theoretical relations derived in section 3 on the cointegration matrix, we would impose the following structure[1]:

$$\beta' = \begin{pmatrix} 0 & 1 & -1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & -1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}. \tag{23}$$

[1] Note that in our estimation we do not allow for a time trend in the data but we include a constant and a time trend in each cointegrating relation such that the dimensions of α and β change accordingly. The reason for doing so is to account for the convergence process of the CEE economies to the EU-12 (see for example Égert et al., 2006b; Matkowski and Próchniak, 2007).

The first row of this matrix refers to the PPP, the second row to the foreign FIP, the third row to the IRP and the last row to the OG relation.

5 Implementing the model

For each economy, we estimate the model separately. The tests for the optimal lag length and number of cointegrating relations are presented in table 2 and table 3.

For Poland, the BIC chooses the smallest model with respect to the lag length and both the rank and eigenvalue test suggest the presence of two cointegrating (equilibrium) conditions. As the theoretical model provides four possible conditions to be imposed as restrictions on the cointegration space, we have to choose among them. We do so based on the model that reports the smallest BIC, which is in the case of Poland the model that incorporates the FIP and the OG. Hence, the matrix chosen by the BIC for the model with two cointegration vectors is

$$\beta'_{\mathbf{oi,po}} = \begin{pmatrix} 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}. \tag{24}$$

The cointegration test for the Czech Republic suggests the presence of three cointegrating relations. As in the case of Poland, we have to estimate all possible models and choose the cointegrating relationships to be imposed on the cointegration matrix according to the BIC. In this case, the model that exhibits the lowest BIC is the model without the PPP but with the FIP, the IRP, and the OG. Imposing these three relations directly on the matrix would yield the following structure

$$\beta'_{\mathbf{oi,cz}} = \begin{pmatrix} 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & -1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & -1 \end{pmatrix}. \tag{25}$$

For Hungary, the test on the number of cointegrating relations also suggests to use three. In this case the BIC suggests the PPP, the FIP and the IRP to best capture the equilibrating forces of the model. This implies the following structure of the matrix β:

$$\beta'_{\mathbf{oi,hu}} = \begin{pmatrix} 0 & 0 & 0 & 0 & 1 & 1 & 0 \\ 0 & 0 & -1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}. \tag{26}$$

Tables 4-6 depict the estimation output of the respective model for each economy. For all three economies, the error correction term turns out to be an important determinant of the included indicators. Residual analysis concerning autocorrelation does not show any problems. Also, the Jarque-Bera test on normality and the White test on heteroscedasticity arouses no serious concerns. We can therefore proceed using the model as given in equation (22) and applying the country specific long-term structure.

6 Comparing the responses of international shocks

Figures 1-4 show the generalized impulse responses relating to shocks in Euro Area GDP, Euro Area interest rates, in the exchange rate and in relative prices. For each shock, we draw the responses of inflation, GDP, and interest rates for each of the three countries. In all of these figures, column 1 refers to Poland, column 2 to the Czech Republic, and column 3 to Hungary, while row 1 refers to inflation, row 2 to per capita GDP, and row 3 to the interest rate.

Figure 1 depicts the effects of a one percent GDP shock in the Euro Area. While we observe a small and negative impact on consumer prices in Poland, there is no such effect in the Czech Republic or in Hungary. Looking at the spillover effect of a GDP shock in the Euro Area to Eastern European GDP, we see an immediate impact on output in Hungary and this effect is significant, even though small in scale. In Poland and in the Czech Republic the effect on GDP is not significant at the 5% level. The shock does not trigger any responses in the interest rates of any of these countries.

Turning to the impact of an interest rate shock in the Euro Area as shown in figure 2, we find a transmission to the interest rate of Poland and to those of the Czech Republic. In Poland, this effect is associated with a decrease in consumer prices. The impact of the response in the interest rate is, however, temporary and does not affect GDP significantly in any of the considered CEE countries.

As can be seen in figure 3, a 1% shock in the exchange rate (which represents a nominal appreciation of the Euro), has a significant impact only in the Czech Republic. The depreciation of the Koruna to the Euro leads to an immediate and permanent increase in consumer prices. After a peak three quarters following the shock, prices remain at a higher level. At the same time GDP decreases in the

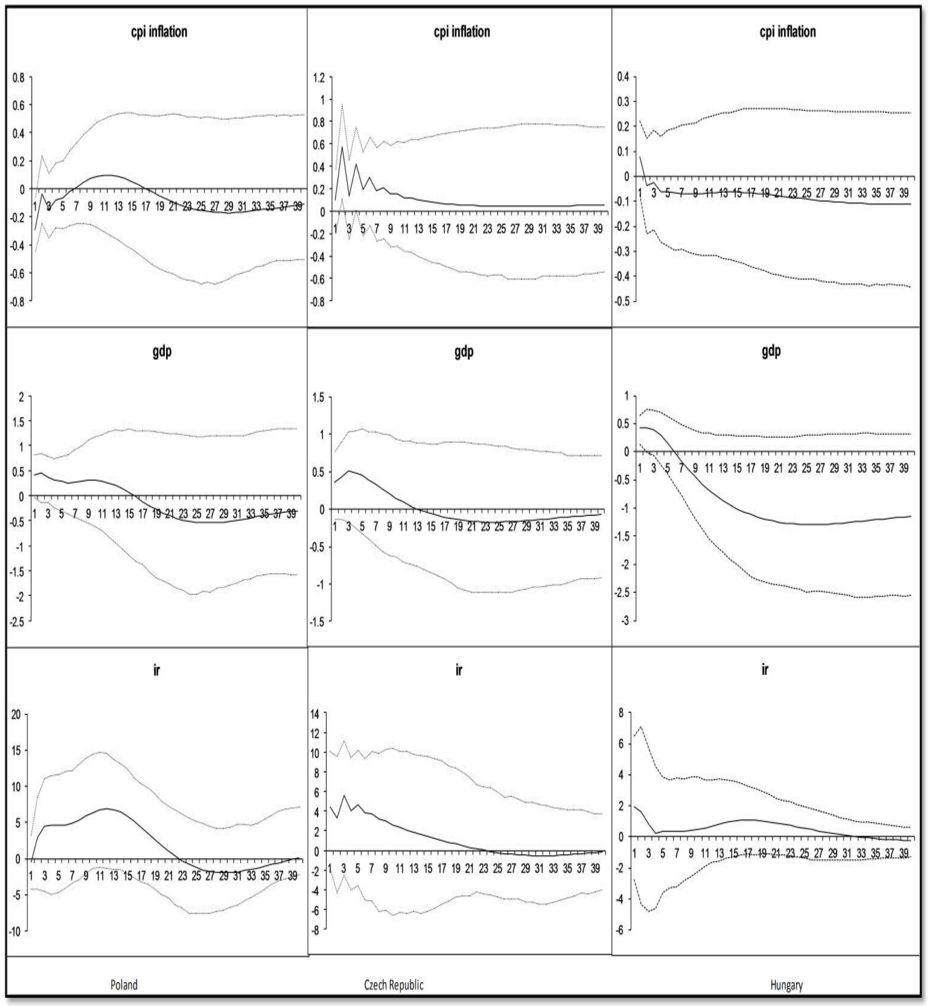

Figure 1: Generalized Impulse Responses to a 1 percent Shock to Euro Area GDP

quarters following the shock, even though this effect is present only in the first four quarters following the shock and might be associated with a J-curve effect, as the value of imports rises before exports begin to increase.

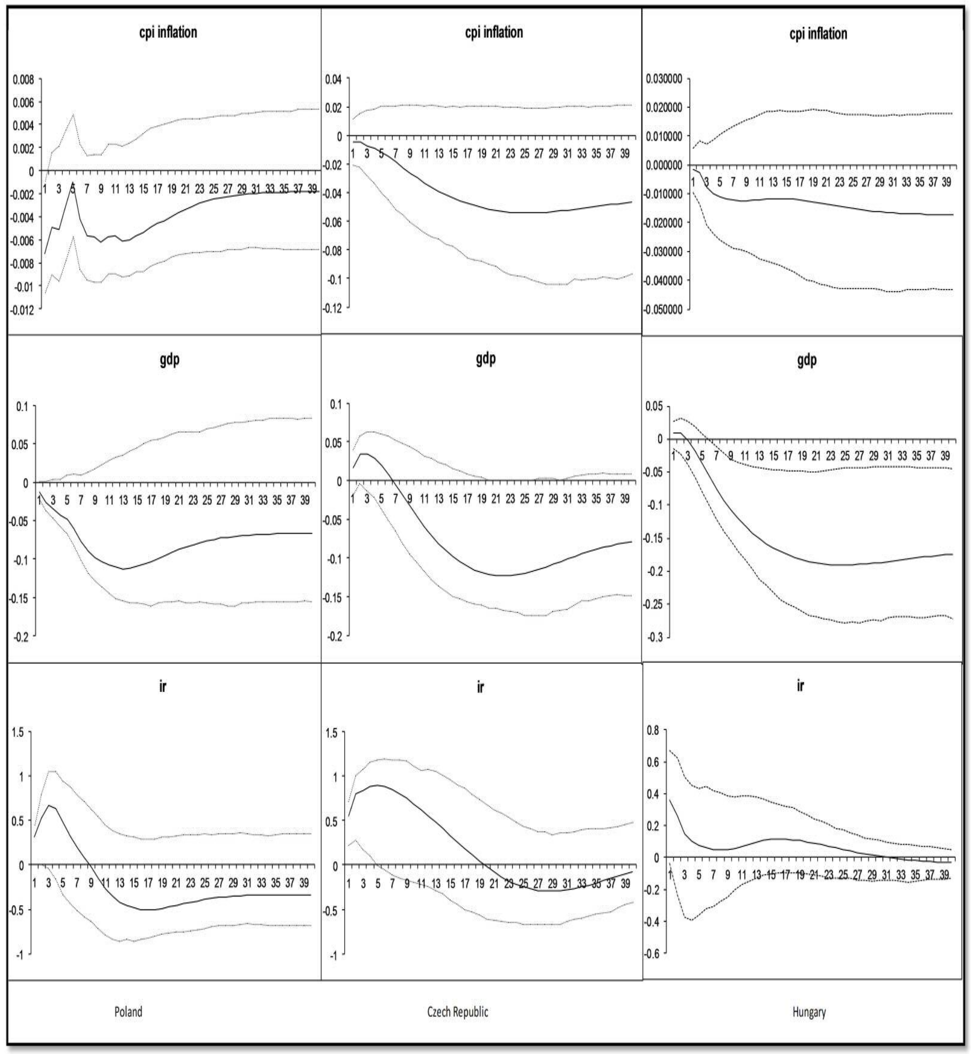

Figure 2: Generalized Impulse Responses to a 1 percent Shock to the Euro Area Interest Rate

Finally, the shock in relative prices shows the impact of a gain in competitiveness compared to the European Union (see figure 4). The responses in CPI

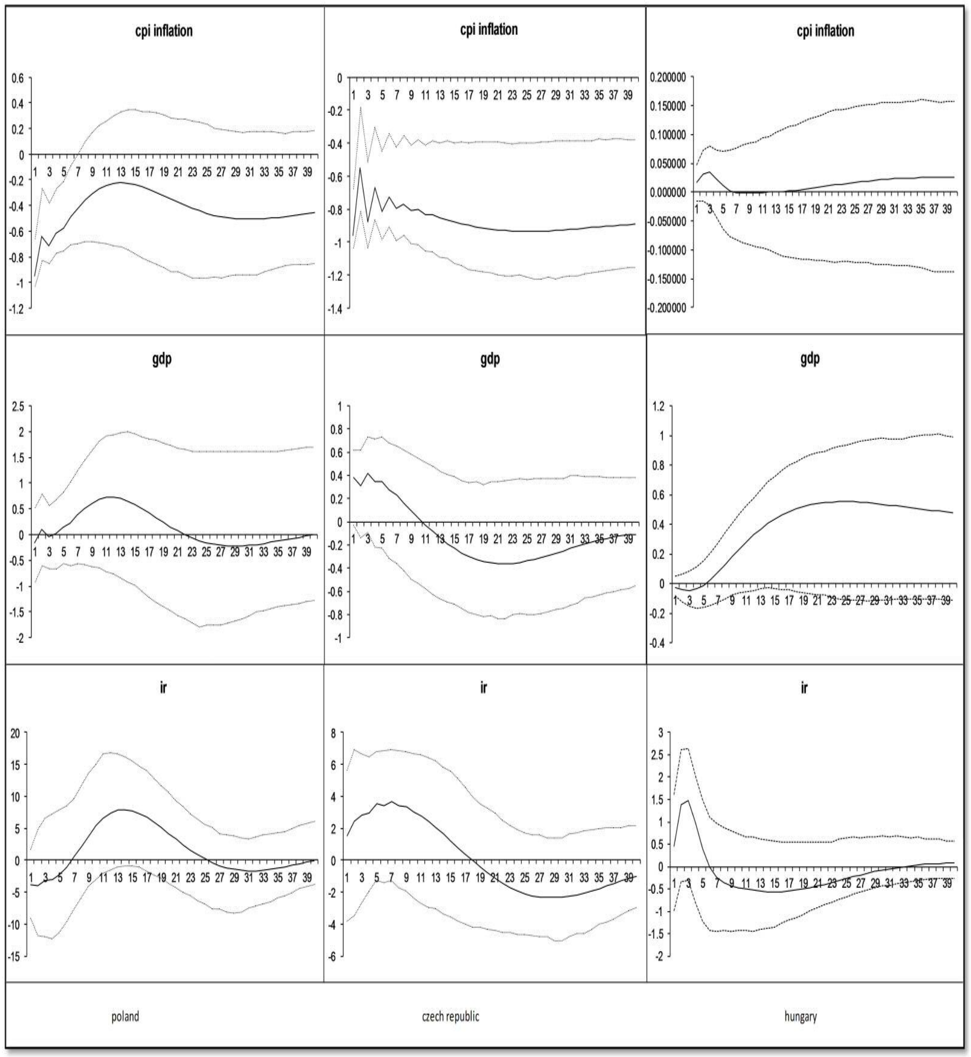

Figure 3: Generalized Impulse Responses to a 1 percent Shock to the Exchange Rate

inflation are straightforwardly connected to the shock in the price differential. In Hungary this is associated with a slight decrease in the interest rate. Further, it

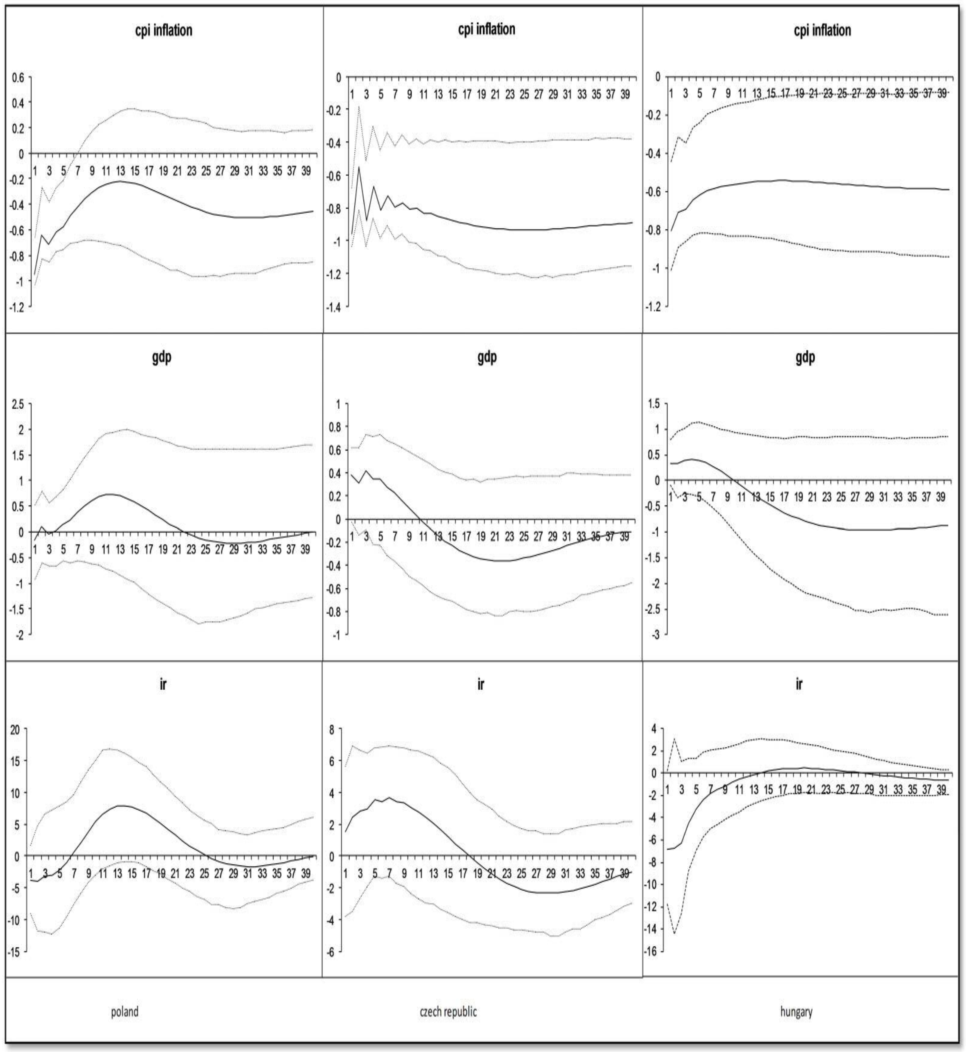

Figure 4: Generalized Impulse Responses to a 1 percent Shock to the Price Differential

is interesting to see that, relying on our model, there is no effect of higher prices in the Euro Area on the GDP of the three Eastern European countries covered in our study.

7 Conclusions

We set forth a structural vector error correction model to assess the effects of shocks on Euro Area GDP and Euro Area interest rates as well as the exchange rate and relative prices between the Euro Area and the Czech Republic, Hungary, and Poland on inflation, GDP, and the interest rates of these countries.

Positive shocks on Euro Area GDP lead to positive short-run effect on the GDP of Hungary only. In Poland and in the Czech Republic the effect on GDP is not significant at the 5% level. We find a transmission of the interest rate shock to the interest rates of Poland and to those of the Czech Republic. In Poland, this effect is furthermore associated with a decrease in consumer prices. A 1% shock in the exchange rate has a significant impact only in the Czech Republic. The depreciation of the Koruna leads to an immediate and permanent increase in consumer prices which remain at a higher level subsequently. Furthermore, GDP decreases in the quarters following the shock, even though this effect is present only in the first four quarters following the shock and might be associated with a J-curve effect.

8 Tables

Table 1: Results of the Unit Root Tests

ADF

	Czech Republic				Hungary				Poland		
	diff=0	diff=1	diff=2		diff=0	diff=1	diff=2		diff=0	diff=1	diff=2
Y_{EA}	0.280	0.000	0.000	Y_{EA}	0.280	0.000	0.000	Y_{EA}	0.919	0.000	0.000
Y_{CZ}	0.676	0.000	0.000	Y_{HU}	0.282	0.014	0.000	Y_{PL}	0.234	0.000	0.000
IR_{EA}	0.243	0.019	0.000	IR_{EA}	0.243	0.019	0.000	IR_{EA}	0.137	0.068	0.000
IR_{CZ}	0.827	0.000	0.000	IR_{HU}	0.318	0.000	0.000	IR_{PL}	0.261	0.008	0.000
PD	0.064	0.000	0.000	PD	0.000	0.000	0.000	PD	0.353	0.000	0.000
Π_{CZ}	0.017	0.000	0.000	Π_{HU}	0.000	0.000	0.000	Π_{PL}	0.237	0.000	0.000
E	0.914	0.000	0.000	E	0.002	0.000	0.000	E	0.213	0.000	0.000
P_{OIL}	0.694	0.000	0.000	P_{OIL}	0.694	0.000	0.000	P_{OIL}	0.053	0.000	0.000

ADF with trend

	Czech Republic				Hungary				Poland		
	diff=0	diff=1	diff=2		diff=0	diff=1	diff=2		diff=0	diff=1	diff=2
Y_{EA}	0.919	0.000	0.000	Y_{EA}	0.919	0.000	0.000	Y_{EA}	0.280	0.000	0.000
Y_{CZ}	0.987	0.000	0.000	Y_{HU}	0.999	0.008	0.000	Y_{PL}	0.655	0.000	0.000
IR_{EA}	0.137	0.068	0.000	IR_{EA}	0.137	0.068	0.000	IR_{EA}	0.243	0.019	0.000
IR_{CZ}	0.715	0.000	0.000	IR_{HU}	0.245	0.000	0.000	IR_{PL}	0.649	0.001	0.000
PD	0.101	0.000	0.000	PD	0.001	0.000	0.000	PD	0.108	0.000	0.000
Π_{CZ}	0.022	0.000	0.000	Π_{HU}	0.000	0.000	0.000	Π_{PL}	0.087	0.000	0.000
E	0.138	0.000	0.000	E	0.039	0.000	0.000	E	0.065	0.000	0.000
P_{OIL}	0.053	0.000	0.000	P_{OIL}	0.053	0.000	0.000	P_{OIL}	0.694	0.000	0.000

Table 2: Lag Selection

	Czech Republic			Hungary			Poland	
	AIC	BIC		AIC	BIC		AIC	BIC
1 LAG	-37.78219	-35.79279	1 LAG	-39.88321	-37.89382	1 LAG	-38.58829	-36.59889
2 LAGS	-38.79161	-35.02809	2 LAGS	-40.40156	-36.63804	2 LAGS	-39.37376	-35.61025
3 LAGS	-39.16881	-33.59909	3 LAGS	-40.56011	-34.99039	3 LAGS	-39.25249	-33.68278
4 LAGS	-40.65097	-33.24209	4 LAGS	-40.99636	-33.58748	4 LAGS	-40.69636	-33.28748
5 LAGS	-42.27073	-32.9888	5 LAGS	-43.11023	-33.8283	5 LAGS	-43.88004	-34.59812

Table 3: Test on the Number of Cointegrating Relations

Data Trend: Test Type	None No Intercept No Trend	None Intercept No Trend	Linear Intercept No Trend	Linear Intercept Trend	Quadratic Intercept Trend
Czech Republic					
Trace	4	4	3	5	7
Max-Eig	4	4	3	3	3
Hungary					
Trace	4	5	3	2	2
Max-Eig	3	3	2	2	2
Poland					
Trace	3	2	2	3	3
Max-Eig	2	2	2	3	3

*Critical values based on MacKinnon-Haug-Michelis (1999)

Table 4: Reduced form error correction specification for the model for the Czech Republic

	$\Delta(Y^{EA})$	$\Delta(IR^{EA})$	$\Delta(\Delta CPI^{CZ})$	$\Delta(IR^{CZ})$	$\Delta(PD)$	$\Delta(E)$	$\Delta(Y^{CZ})$
CointEq1	-0.009688	-0.061575	-0.00258	-0.117927	0.003186	-0.015377	-0.018413
	-0.00331	-0.05072	-0.00349	-0.0569	-0.00348	-0.01295	-0.00531
	[-2.92905]	[-1.21406]	[-0.73886]	[-2.07265]	[0.91664]	[-1.18751]	[-3.46794]
CointEq2	-0.011082	-0.032711	0.005815	0.040297	-0.00506	-0.004603	0.00332
	-0.0029	-0.0445	-0.00306	-0.04992	-0.00305	-0.01136	-0.00466
	[-3.81854]	[-0.73505]	[1.89787]	[0.80719]	[-1.65935]	[-0.40514]	[0.71262]
CointEq3	-0.01471	-0.098981	-0.008514	-1.390043	0.011498	-0.172703	-0.03526
	-0.02429	-0.3724	-0.02564	-0.41776	-0.02552	-0.09508	-0.03898
	[-0.60569]	[-0.26579]	[-0.33206]	[-3.32736]	[0.45056]	[-1.81649]	[-0.90448]
$\Delta(Y^{EA}_{t-1})$	-0.122284	4.33702	0.557229	-1.478386	-0.445362	0.332101	0.236745
	-0.16322	-2.50279	-0.17231	-2.80764	-0.1715	-0.63897	-0.262
	[-0.74919]	[1.73288]	[3.23385]	[-0.52656]	[-2.59679]	[0.51975]	[0.90361]
$\Delta(IR^{EA}_{t-1})$	0.017697	0.499538	-0.016372	0.185108	0.013743	0.036914	0.020824
	-0.00869	-0.13323	-0.00917	-0.14946	-0.00913	-0.03401	-0.01395
	[2.03678]	[3.74938]	[-1.78485]	[1.23851]	[1.50530]	[1.08526]	[1.49307]
$\Delta(\Delta CPI^{CZ}_{t-1})$	0.434815	7.65691	0.096097	18.51412	-0.529008	-3.16552	0.136117
	-0.31849	-4.88355	-0.33622	-5.47839	-0.33465	-1.24678	-0.51122
	[1.36525]	[1.56790]	[0.28581]	[3.37948]	[-1.58079]	[-2.53895]	[0.26626]
$\Delta(IR^{CZ}_{t-1})$	0.008163	0.048597	0.025829	0.157246	-0.025488	-0.074757	0.003669
	-0.00856	-0.1313	-0.00904	-0.14729	-0.009	-0.03352	-0.01374
	[0.95334]	[0.37012]	[2.85729]	[1.06759]	[-2.83282]	[-2.23018]	[0.26695]
$\Delta(PD_{t-1})$	0.434113	6.892599	0.779755	17.50148	-1.18374	-3.293022	0.129864
	-0.33409	-5.12281	-0.35269	-5.74679	-0.35104	-1.30786	-0.53627
	[1.29939]	[1.34547]	[2.21086]	[3.04544]	[-3.37207]	[-2.51786]	[0.24216]
$\Delta(E_{t-1})$	-0.042971	-0.668435	0.12623	-0.352017	-0.110781	0.200287	-0.083389
	-0.03366	-0.5162	-0.03554	-0.57907	-0.03537	-0.13179	-0.05404
	[-1.27645]	[-1.29492]	[3.55187]	[-0.60790]	[-3.13182]	[1.51978]	[-1.54318]
$\Delta(Y^{CZ}_{t-1})$	2.69E-05	1.222114	-0.157565	-0.804459	0.127681	-0.260789	-0.49004
	-0.08578	-1.31525	-0.09055	-1.47545	-0.09013	-0.33579	-0.13768
	[0.00031]	[0.92919]	[-1.74005]	[-0.54523]	[1.41666]	[-0.77665]	[-3.55916]
C	0.003491	-0.046343	-0.000236	-0.008873	-0.000294	-0.00255	0.008449
	-0.00119	-0.01824	-0.00126	-0.02047	-0.00125	-0.00466	-0.00191
	[2.93444]	[-2.54027]	[-0.18764]	[-0.43354]	[-0.23506]	[-0.54751]	[4.42396]
DOIL	0.015819	0.140673	0.004027	-0.095808	0.007531	-0.068171	0.020886
	-0.00603	-0.09243	-0.00636	-0.10369	-0.00633	-0.0236	-0.00968
	[2.62426]	[1.52196]	[0.63291]	[-0.92401]	[1.18910]	[-2.88894]	[2.15862]
Adj. R-squared	0.345459	0.59786	0.54595	0.373036	0.501835	0.229168	0.38183

Table 5: Reduced form error correction specification for the model for Hungary

	$\Delta(Y^{EA})$	$\Delta(IR^{EA})$	$\Delta(\Delta CPI^{HU})$	$\Delta(IR^{HU})$	$\Delta(PD)$	$\Delta(E)$	$\Delta(Y^{HU})$
CointEq1	-0.009551	-0.042024	-0.012199	-0.204057	0.012004	-0.023551	-0.020785
	-0.00664	-0.09568	-0.00379	-0.10636	-0.00401	-0.02775	-0.00657
	[-1.43850]	[-0.43923]	[-3.21865]	[-1.91859]	[2.99056]	[-0.84859]	[-3.16137]
CointEq2	-0.007955	-0.009612	-0.003047	0.032921	0.00356	-0.017363	-0.008626
	-0.00299	-0.04303	-0.0017	-0.04784	-0.00181	-0.01248	-0.00296
	[-2.66354]	[-0.22336]	[-1.78753]	[0.68817]	[1.97206]	[-1.39090]	[-2.91695]
CointEq3	0.017131	-0.240586	-0.000986	0.217368	0.00708	0.027477	0.054933
	-0.025	-0.36025	-0.01427	-0.40046	-0.01511	-0.1045	-0.02476
	[0.68521]	[-0.66783]	[-0.06907]	[0.54279]	[0.46843]	[0.26294]	[2.21904]
$\Delta(Y^{EA}_{t-1})$	-0.118888	2.910022	-0.022042	0.495131	0.114625	0.140534	-0.171663
	-0.17903	-2.5798	-0.10219	-2.86777	-0.10823	-0.74834	-0.17728
	[-0.66406]	[1.12800]	[-0.21570]	[0.17265]	[1.05907]	[0.18780]	[-0.96833]
$\Delta(IR^{EA}_{t-1})$	0.016204	0.449726	0.005012	-0.083835	-0.00875	0.082469	0.015259
	-0.00854	-0.12303	-0.00487	-0.13677	-0.00516	-0.03569	-0.00845
	[1.89786]	[3.65532]	[1.02846]	[-0.61298]	[-1.69511]	[2.31077]	[1.80482]
$\Delta(\Delta CPI^{HU}_{t-1})$	0.457487	4.34265	-0.026705	1.217199	-0.400919	-0.479925	0.268458
	-0.34555	-4.97923	-0.19724	-5.53502	-0.2089	-1.44435	-0.34216
	[1.32395]	[0.87215]	[-0.13539]	[0.21991]	[-1.91923]	[-0.33228]	[0.78460]
$\Delta(IR^{HU}_{t-1})$	0.010102	-0.095173	0.01012	0.295274	-0.006236	-0.068926	-0.000636
	-0.00942	-0.1357	-0.00538	-0.15085	-0.00569	-0.03936	-0.00932
	[1.07271]	[-0.70134]	[1.88264]	[1.95742]	[-1.09528]	[-1.75102]	[-0.06826]
$\Delta(PD_{t-1})$	0.330613	5.578239	0.184375	3.154698	-0.641266	0.06713	0.00973
	-0.32853	-4.73397	-0.18752	-5.26239	-0.19861	-1.37321	-0.3253
	[1.00635]	[1.17834]	[0.98321]	[0.59948]	[-3.22883]	[0.04889]	[0.02991]
$\Delta(E_{t-1})$	-0.027211	-0.252326	0.021351	0.922803	-0.02036	0.34325	-0.018133
	-0.03056	-0.44035	-0.01744	-0.4895	-0.01847	-0.12773	-0.03026
	[-0.89042]	[-0.57301]	[1.22404]	[1.88518]	[-1.10208]	[2.68720]	[-0.59923]
$\Delta(Y^{HU}_{t-1})$	0.053572	4.478915	-0.191878	-0.303475	0.186224	-1.428417	0.255159
	-0.15954	-2.29886	-0.09106	-2.55547	-0.09645	-0.66684	-0.15797
	[0.33580]	[1.94832]	[-2.10707]	[-0.11876]	[1.93088]	[-2.14206]	[1.61523]
C	0.003698	-0.065492	0.000458	-0.027403	-0.00111	0.017219	0.005979
	-0.00149	-0.02149	-0.00085	-0.02388	-0.0009	-0.00623	-0.00148
	[2.47992]	[-3.04809]	[0.53779]	[-1.14731]	[-1.23188]	[2.76266]	[4.04969]
DOIL	0.014711	0.151364	0.003008	-0.160497	0.008708	-0.083642	0.018329
	-0.00608	-0.08754	-0.00347	-0.09731	-0.00367	-0.02539	-0.00602
	[2.42149]	[1.72909]	[0.86756]	[-1.64932]	[2.37099]	[-3.29388]	[3.04696]
Adj. R-squared	0.32674	0.634702	0.136339	0.172966	0.294617	0.345028	0.598909

Table 6: Reduced form error correction specification for the model Poland

	$\Delta(Y^{EA})$	$\Delta(IR^{EA})$	$\Delta(\Delta CPI^{PL})$	$\Delta(IR^{PL})$	$\Delta(PD)$	$\Delta(E)$	$\Delta(Y^{PL})$
CointEq1	-0.009952	-0.092292	0.000455	-0.09699	0.000168	-0.04218	-0.019489
	-0.00363	-0.05843	-0.00308	-0.05185	-0.00295	-0.02707	-0.0066
	[-2.73943]	[-1.57942]	[0.14789]	[-1.87070]	[0.05689]	[-1.55847]	[-2.95180]
CointEq2	-0.007208	-0.002909	0.004707	0.077643	-0.00438	0.01117	0.005706
	-0.00251	-0.04037	-0.00213	-0.03582	-0.00204	-0.0187	-0.00456
	[-2.87227]	[-0.07206]	[2.21511]	[2.16770]	[-2.14665]	[0.59738]	[1.25090]
CointEq3	-0.026458	0.310898	0.02462	-0.943301	-0.02875	-0.481228	0.016523
	-0.04091	-0.65805	-0.03464	-0.58387	-0.03326	-0.30479	-0.07435
	[-0.64674]	[0.47245]	[0.71072]	[-1.61560]	[-0.86446]	[-1.57887]	[0.22222]
$\Delta(Y^{EA}_{t-1})$	-0.14682	3.71859	0.215327	2.87247	-0.117273	-0.962133	0.082497
	-0.14288	-2.29834	-0.12099	-2.03924	-0.11616	-1.06453	-0.25969
	[-1.02756]	[1.61795]	[1.77974]	[1.40860]	[-1.00962]	[-0.90381]	[0.31768]
$\Delta(IR^{EA}_{t-1})$	0.013484	0.445846	-0.007571	-0.149398	0.005876	0.050397	-0.031962
	-0.00925	-0.14873	-0.00783	-0.13196	-0.00752	-0.06889	-0.0168
	[1.45836]	[2.99771]	[-0.96703]	[-1.13213]	[0.78175]	[0.73159]	[-1.90199]
$\Delta(\Delta CPI^{PL}_{t-1})$	0.302641	5.175153	-0.471305	5.83659	0.000552	-1.77686	1.116268
	-0.2727	-4.3865	-0.23091	-3.89199	-0.22169	-2.03171	-0.49562
	[1.10980]	[1.17979]	[-2.04106]	[1.49964]	[0.00249]	[-0.87456]	[2.25225]
$\Delta(IR^{PL}_{t-1})$	0.005046	-0.024976	0.00277	0.514886	-0.002647	-0.124018	0.061092
	-0.01098	-0.17669	-0.0093	-0.15677	-0.00893	-0.08184	-0.01996
	[0.45938]	[-0.14135]	[0.29779]	[3.28431]	[-0.29642]	[-1.51540]	[3.06013]
$\Delta(PD_{t-1})$	0.469789	5.562882	-0.206893	5.422893	-0.228933	-2.81735	1.411179
	-0.30751	-4.94656	-0.26039	-4.38892	-0.24999	-2.29112	-0.5589
	[1.52769]	[1.12460]	[-0.79453]	[1.23559]	[-0.91575]	[-1.22968]	[2.52491]
$\Delta(E_{t-1})$	-0.022802	-0.943903	0.03451	-0.409395	-0.028779	-0.00399	0.012309
	-0.02001	-0.32189	-0.01694	-0.2856	-0.01627	-0.14909	-0.03637
	[-1.13948]	[-2.93237]	[2.03660]	[-1.43344]	[-1.76904]	[-0.02676]	[0.33843]
$\Delta(Y^{PL}_{t-1})$	0.214888	1.06712	0.056994	-0.048254	-0.109645	-0.79494	-0.319337
	-0.07538	-1.2125	-0.06383	-1.07581	-0.06128	-0.5616	-0.137
	[2.85081]	[0.88010]	[0.89294]	[-0.04485]	[-1.78929]	[-1.41550]	[-2.33096]
C	0.0012	-0.044663	-0.002664	-0.02702	0.002449	0.017564	0.015124
	-0.00131	-0.02108	-0.00111	-0.0187	-0.00107	-0.00976	-0.00238
	[0.91593]	[-2.11869]	[-2.40053]	[-1.44462]	[2.29835]	[1.79886]	[6.34962]
DOIL	0.014245	0.125482	0.00681	0.04774	0.005295	-0.107093	-0.009019
	-0.0054	-0.08679	-0.00457	-0.077	-0.00439	-0.0402	-0.00981
	[2.64027]	[1.44588]	[1.49055]	[0.61998]	[1.20717]	[-2.66421]	[-0.91972]
Adj. R-squared	0.479205	0.647877	0.228734	0.392318	0.124169	0.181701	0.228807

Standard errors in ( ) & t-statistics in [ ]

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