FIW – Working Paper

FIW Working Paper N° 171
April 2016

Exchange Rate Pass-Through in the Euro Area

Rajmund Mirdala[1]

Abstract

Time-varying exchange rate pass-through effects to domestic prices under fixed euro exchange rate perspective represent one of the most challenging implications of the common currency. The problem is even more crucial when examining crisis related redistributive effects associated with relative price changes. The degree of the exchange rate pass-through to domestic prices reveals its role as the external price shocks absorber especially in the situation when the leading path of exchange rates is less vulnerable to the changes in the foreign prices. Adjustments in domestic prices followed by exchange rate shifts induced by sudden external price shocks are associated with changes in the relative competitiveness among member countries of the currency area. In the paper we examine exchange rate pass-through to domestic prices in the Euro Area member countries to examine crucial implications of the nominal exchange rate rigidity. Our results indicate that absorption capabilities of nominal effective exchange rates clearly differ in individual countries. As a result, an increased exposure of domestic prices to the external price shocks in some countries represents a substantial trade-off of the nominal exchange rate stability.

JEL: C32, E31, F41
Keywords: exchange rate pass-through, inflation, Euro Area, VAR, impulse-response function

The author

1 Rajmund Mirdala, Associate Professor and Head of Department of Economics at the, Faculty of Economics, Technical University of Kosice, Nemcovej 32, 04001 Kosice, Slovak Republic. E-mail: rajmund.mirdala@tuke.sk

Exchange Rate Pass-Through in the Euro Area

Rajmund Mirdala[1]
Faculty of Economics, Technical University of Kosice

Abstract

Time-varying exchange rate pass-through effects to domestic prices under fixed euro exchange rate perspective represent one of the most challenging implications of the common currency. The problem is even more crucial when examining crisis related redistributive effects associated with relative price changes. The degree of the exchange rate pass-through to domestic prices reveals its role as the external price shocks absorber especially in the situation when the leading path of exchange rates is less vulnerable to the changes in the foreign prices. Adjustments in domestic prices followed by exchange rate shifts induced by sudden external price shocks are associated with changes in the relative competitiveness among member countries of the currency area. In the paper we examine exchange rate pass-through to domestic prices in the Euro Area member countries to examine crucial implications of the nominal exchange rate rigidity. Our results indicate that absorption capabilities of nominal effective exchange rates clearly differ in individual countries. As a result, an increased exposure of domestic prices to the external price shocks in some countries represents a substantial trade-off of the nominal exchange rate stability.

Keywords: exchange rate pass-through, inflation, Euro Area, VAR, impulse-response function

JEL Classification: C32, E31, F41

[1] Rajmund Mirdala, Associate Professor and Head of Department of Economics at the, Faculty of Economics, Technical University of Kosice, Nemcovej 32, 04001 Kosice, Slovak Republic. E-mail: rajmund.mirdala@tuke.sk

1. Introduction

Exchange rate pass-through to domestic prices represents one of the most discussed topics in the recent literature dealing with a wide area of effects associated with exchange rate flexibility. The establishment of the Euro Area and introduction of the euro represent a crucial milestone in the ongoing discussions highlighting positive and negative implications of the nominal exchange rate rigidity. On the other hand, we suggest that it is still convenient to analyze the wide spectrum of effects related to the abortion of the relative flexibility of the national exchange rates after the euro adoption (Barhoumi, 2006).

Among many of impulses that the exchange rate transmits from the external environment to the domestic market we highlight price related effects associated with sudden changes in the foreign prices and related responsiveness of the domestic price indexes. The degree of the exchange rate pass-through to domestic prices reveals its role as the external price shocks absorber especially in the situation when the leading path of exchange rates is less vulnerable to the changes in the foreign nominal variables (Campa, Goldberg and González-Mínguez, 2005).

In the paper we analyze the exchange rate pass-through to domestic prices in the Euro Area member countries. Our motivation follows an idea (Bussière, 2013) of asymmetric exchange rate pass-through to domestic prices across internal price chain. Our methodology consists of two partial stages. In the first stage we examine the responsiveness of nominal effective exchange rates to the exogenous price shock to observe the dynamics (volatility) in the exchange rate leading path followed by the unexpected exogenous oil price shock. By doing so we investigate a capability of exchange rates to transmit or absorb the external inflation pressure to domestic prices (Corsetti, Dedola and Leduc, 2008). In the second stage we investigate effects of the unexpected exchange rate shift to the domestic price indexes (import prices, producer prices, consumer prices) to examine its distribution across the internal pricing chain (Choudhri, Faruqee and Hakura, 2005). Our results contribute to understand the key features of the exchange rate transmission of the inflation pressures initiated by external price shifts and related responses of the domestic price indexes. We employ a vector autoregression (VAR) model. True shocks are identified by the Cholesky decomposition of innovations. From estimated VAR model we compute (1) responses of exchange rates in each individual country to the positive one standard deviation oil price shock and (2) responses of import

prices, producer prices and consumer prices to the positive one standard deviation exchange rate shock. To provide more rigorous insight into the problem of the exchange rate pass-through to domestic prices in we estimate models for each particular country employing monthly data for two subsequent periods 2000-2007 (pre-crisis period) and 2000-2014 (extended period). This approach should be helpful to examine country specific features of the transmission of external inflation pressures to the domestic prices. We suggest that comparison of results for models with different time periods is crucial to understand spurious effects of the economic crisis in both exchange rate responsiveness to the external price shocks as well as associated pass-through pass-through effects to domestic price measures.

2. Exchange Rate Pass-through in the Euro Area

Euro Area member countries are still suffering from lagging recession. While internal devaluation in countries with nominal exchange rate anchor may improve price competitiveness and boost both internal and external demand, risk of deflationary pressures substantially reduce vital growth incentives (Hetzel, 2015). Moreover, ECB by inflating its monetary base fueled by another wave of quantitative easing does not primarily follow idea of economic recovery (Christensen and Gillan, 2015). Low interest rate environment may be followed by euro depreciation improving competitiveness of European producers on the foreign markets. However, as the most of transactions on the EU single market are conducted in euro among its member countries, Euro Area seeks common reasonable automatic mechanisms that would help to improve its internal competitiveness (Peersman, 2011).

There are still many opened issues according to the suitability of the common monetary policy in the Euro Area provided a relative heterogeneity of the single market (Micossi, 2015). Time-varying exchange rate pass-through effects to domestic prices under fixed euro exchange rate perspective represent one of the most challenging implications of the common currency (Bussière, 2013). The problem is even more crucial when examining crisis related redistributive effects associated with relative price changes. The degree of the exchange rate pass-through to domestic prices reveals its role as the external price shocks absorber especially in the situation when the leading path of exchange rates is less vulnerable to the changes in the foreign nominal variables (Campa, Goldberg and González-Mínguez, 2005). Resulted adjustments in domestic prices followed by exchange rate shifts induced by sudden

external price shocks are associated with changes in the relative competitiveness among member countries of the currency area (Team of the Working Group on Econometric Modelling of the ESCB, 2012). Moreover, distribution of the exogenous price shock across the internal pricing chain may be biased by country specific conditions and cross-country distortionary effects induced by the recent economic crisis.

Fixed exchange rate environment represented by credible nominal anchor (i.e. sound foreign currency of a country with a low and stable inflation) or common currency in the currency union provides very efficient tool in fighting high inflation while helping to stabilize inflation expectations (Calvo and Reinhart, 2002). As a result, countries with fixed exchange rate benefit from disinflationary periods provided that a decision to adopt fixed exchange rate originated from high inflation pressures in the past. On the other hand, countries in the common currency area obviously experience intensified price level convergence due to higher price transparency that may result in the increased inflation rates over the medium-term period. However, stable inflation expectations anchored by fixed exchange rate and common monetary policy following explicit inflation target obviously induces price stability (Wehinger, 2000). On the other hand, increased volatility of exchange rate of the common currency may cause domestic price level to adjust accordingly in the short period, though persisting inflation or disinflation pressures are not expected. It is especially due to positive effects of stable inflation expectations that (we suggest) do not seem to be affected for longer period of time.

Quite specific seems to be a situation in countries with common currency that serves as a local or global currency widely used in foreign transactions. Price effects of increased volatility in such a common currency may be reduced provided that a large number of trading partners are also participating on the common currency. Even when the large portion of mutual foreign transactions in member countries of the common currency area are immune to the exchange rate volatility, remaining transactions are still exposed to the unexpected shifts in the common currency exchange rate against other currencies (Hahn, 2003). On the other hand, sudden shifts in the real exchange rate are not exclusively caused by the nominal exchange rate volatility. Increased intensity of price adjustments associated with crisis related effects on real output are usually followed by accelerated deviations of real exchange rates from their equilibrium leading path especially in the short period. This

scenario is even more biased provided that crisis period induced diverse effects on the price level dynamics in the heterogeneous group of countries (Choudhri and Hakura, 2012).

3. Overview of the Literature

Vulnerability of the exchange rates to the exogenous shocks came to the center of an academic discussion shortly after a break-down of a Bretton Woods system of fixed exchange rates at the beginning of the 1970s. Uncertainty on the foreign exchange markets together with higher volatility of exchange rates increased a sensitivity of domestic economies to the foreign partners' economic development as well as to the world leading economies' exchange rate movements. Exchange rate pass-through as the relationship between exchange rate movement and price adjustments of traded goods came to the center in academic and policy circles (Lian, 2007). Toshitaka (2006) estimated exchange rate pass-through of six major industrial countries using a time-varying parameter with stochastic volatility model. Author divided an analysis into impacts of exchange rate fluctuations to import prices and those of import price movements to consumer prices. Takatoshi et al. (2005) examined the pass-through effects of exchange rate changes on the domestic prices among the East Asian countries using the conventional pass-through equation and a VAR analysis. In order to identify the VAR model authors used a Cholesky decomposition to identify structural shocks and to examine the pass-through of the exchange rate shock to the domestic price inflation. They conclude that while the degree of exchange rate pass-through to import prices is quite high in the crisis-hit countries, the pass-through to CPI is generally low. Takatoshi and Kiyotaka (2006) estimated five and seven variable VAR model (including all three price variables to check the robustness and to investigate directly the pass-through effect across the prices.) in order to examine the pass-through effects of exchange rate changes on the domestic prices. Cortinhas (2007) also tested the sensitivity of results from the VAR models using several alternative ordering of the variables with mixed results. Ca' Zorzi et al. (2007) on the sample 12 emerging markets in Asia, Latin America, and Central and Eastern Europe investigated that exchange rate pass-through declines across the pricing chain, i.e. it is lower on consumer prices than on import prices. Choudhri and Hakura (2012) analyzed exchange rate pass-through to import prices and export prices employing

both regression- and VAR-based estimates considering local currency pricing and producer currency pricing assumptions. Authors suggest that exchange rate pass-through to import prices for a large number of countries is incomplete and larger than the pass-through to export prices. McCarthy (2007) investigated the impact of exchange rates and import prices on the domestic PPI and CPI in selected industrialized economies by employing VAR model. His Impulse-response analysis indicates that exchange rates have a modest effect on domestic price inflation while import prices have a stronger effect. He suggests that pass-through is larger in countries with a larger import share and more persistent exchange rates and import prices. Bussière and Peltonen (2008) estimated export and import price equations for a large number of countries. Their results indicate, inter alia, that exchange rate pass-through to import prices in advanced countries is falling over time indicating the increased role of emerging economies in the world economy. Campa, Goldberg and González-Mínguez (2005) analyzed the transmission rates from exchange rates movements to import prices, across countries and product categories, in the Euro Area during 1990s. Their results show that the transmission of exchange rate changes to import prices in the short run is high, although incomplete, and that it differs across industries and countries; in the long run, exchange rate pass-through is higher and close to one. Anderton (2003) employed both time series and panel estimation techniques to investigate exchange rate pass-through for euro. His results points to the relatively high degree of the pass-through changes in the effective exchange rate of the euro to the price of extra-Euro Area imports of manufacturers. Bergin and Feenstra (2007) studied how a rise in China's share of U.S. imports could lower pass-through of exchange rates to U.S. import prices. Barhoumi (2006) investigated exchange rate pass-through into import prices in a sample of 24 developing countries over the period from 1980 to 2003. His analysis revealed differences in exchange rate pass-through in his sample of developing countries explained by three macroeconomics determinants: exchange rate regimes, trade distortions and inflation regimes. Shambaugh (2008) examined the relationship between exchange rates and prices. He employed long-run restrictions VAR to identify shocks and explore the way domestic prices, import prices and exchange rates react to a variety of shocks. He suggests that consumer price pass-through is nearly complete in response to some shocks, but low in response to others. Alternatively, import prices

and exchange rates typically respond in the same direction, and pass-through seems quick.

4. Econometric Model

VAR models represent dynamic systems of equations in which the current level of each variable depends on past movements of that variable and all other variables involved in the system. Residuals of vector ε_t represent unexplained movements in variables (effects of exogenous shocks hitting the model); however as complex functions of structural shocks effects they have no economic interpretation. Structural shocks can be still recovered using transformation of the true form representation into the reduced-form by imposing a number of identifying restrictions. Applied restrictions should reflect some general assumptions about the underlying structure of the economy and they are obviously derived from economic theory. There are two general (most used) approaches to identify VAR models. (I) Cholesky decomposition of innovations implies the contemporaneous interactions between exogenous shocks and the endogenous variables are characterized by a Wald causal chain. Ordering of endogenous variables then reflects expected particular economy structure following general economic theory assumptions. However, the lack of reasonable guidance for appropriate ordering led to the development of more sophisticated and flexible identification methods - (II) structural VAR (SVAR) models. Identifying restrictions implemented in SVAR models reflect theoretical assumptions about the economy structure more precisely. However, restrictions based on the theoretical assumptions employed in both identifying schemes should be empirically tested to avoid shocks identification bias and imprecisions associated with endogenous variables responses to the shocks.

We employ a VAR methodology to investigate the exchange rate pass-through to domestic prices in the Euro Area member countries. Cholesky decomposition of variance-covariance matrix of reduced-form VAR residuals is implemented to examine responsiveness of (1) exchange rate to the unexpected oil price shock followed by (2) investigation of responses of different domestic price indexes to the unexpected exchange rate shock (Takatoshi and Kiyotaka, 2006).

First stage in exchange rate pass-through reveals ability of exchange rate to absorb or accelerate the transmission of external price shock (positive one standard deviation oil price shock). The overall dynamics in the exchange rates response

patterns provide crucial information about the exposure of exchange rate to the price related external shock in each particular country from the group (McCarthy, 2007). At the same time it reveals vital features of the exchange rate leading path toward pre-shock equilibrium and associated volatility patterns followed by the initial exogenous price shock.

Second stage in exchange rate pass-through highlights effects of the unexpected exchange rate shifts (positive one standard deviation exchange rate shock) on domestic price indexes and thus reveals the responsiveness of prices at different stages of the pricing chain (import prices, producer prices, consumer prices). At the same time it allows to investigate a distribution channel of the external price shock along the internal pricing chain. This approach is helpful for understanding the responsiveness patterns of domestic price indexes following principles of the pricing chain mechanism across different price measures.

Examination of the two stage exchange rate pass-through employing a multivariate VAR for each individual country from the group of the Euro Area member countries follows the side objective of the paper to investigate possible implications of different exchange rate arrangements on estimated results and thus to contribute to the fixed versus flexible exchange rates dilemma from the prospective of the transmission of the external inflation pressures to the domestic price inflation associated with the exchange rate conditional variability.

True model is represented by the following infinite moving average representation:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} = \sum_{i=0}^{\infty} A_i L^i\varepsilon_t = A(L)\varepsilon_t \qquad (1)$$

where X_t represents $n \times 1$ a vector including endogenous variables of the model, $A(L)$ is a $n \times n$ polynomial consisting of the matrices of coefficients to be estimated in the lag operator L representing the relationship among variables on the lagged values, ε_t is $n \times 1$ vector of identically normally distributed, serially uncorrelated and mutually orthogonal errors (white noise disturbances that represent the unexplained movements in the variables, reflecting the influence of exogenous shocks):

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t\varepsilon_t') = \Sigma_\varepsilon = \mathrm{I}, \quad E(\varepsilon_t\varepsilon_s') = [0] \quad \forall t \neq s \qquad (2)$$

Vector X_t in our baseline model similar to those by Takatoshi and Liyotaka (2006) consists of five endogenous variables - oil prices $(p_{oil,t})$, nominal exchange

rate $\left(er_{n,t}\right)$, money supply $\left(m_t\right)$, real output $\left(y_{r,t}\right)$, domestic price index $\left(p_t\right)$. In the five-variable VAR model $\left(X_t = \left[p_{oil,t}, er_{n,t}, m_t, y_{r,t}, p_t\right]\right)$ we assume five exogenous shocks that contemporaneously affect endogenous variables - external (oil) price shock $\left(\varepsilon_{p_{oil},t}\right)$, nominal exchange rate shock $\left(\varepsilon_{er_n,t}\right)$, liquidity shock $\left(\varepsilon_{m,t}\right)$, demand shock $\left(\varepsilon_{y_d,t}\right)$ and internal price shock $\left(\varepsilon_{p,t}\right)$.

Structural exogenous shocks from equation (1) are not directly observable due to the complexity of information included in true form VAR residuals. As a result, structural shocks cannot by correctly identified. It is then necessary to transform true model into following reduced form

$$X_t = C(L)X_{t-1} + e_t \tag{3}$$

where $C(L)$ is the polynomial of matrices with coefficients representing the relationship among variables on lagged values and e_t is a $n \times 1$ vector of normally distributed errors (shocks in reduced form) that are serially uncorrelated but not necessarily orthogonal (shocks in the reduced form can be contemporaneously correlated with each other):

$$E\left(e_t\right) = 0, \quad \Sigma_u = E\left(e_t e_t'\right) = A_0 E\left(e_t e_t'\right) A_0' = A_0 A_0', \quad E\left(e_t e_s'\right) = [0] \quad \forall t \neq s \tag{4}$$

Relationship between reduced-form VAR residuals $\left(e_t\right)$ and structural shocks $\left(\varepsilon_t\right)$ can be expressed as follows:

$$e_t = A_0 \varepsilon_t \tag{5}$$

As we have already noted at the beginning of the section we implement a Cholesky identification scheme to correctly identify structural shocks. In order to identify our model there must be exactly $n^2 - \left[\left(n^2 - n\right)/2\right]$ relationships among endogenous variables of the model, where *n* represents a number of variables. We have to impose $\left(n^2 - n\right)/2$ restrictions on the matrix A_0 based on the Cholesky decomposition of the reduced-form VAR residual matrix that define matrix A_0 as a lower triangular matrix. The lower triangularity of A_0 (all elements above the diagonal are zero) implies a recursive scheme (structural shocks are identified through the reduced-form VAR residuals) among variables (the Wald chain scheme)

that has clear economic implications and has to be empirically tested as any other relationship. Identification scheme of the matrix A_0 implies that particular contemporaneous interactions between some exogenous shocks and some endogenous variables are restricted reflecting causal (distribution) chain of interaction transmission. It is clear that the Wald causal chain is incorporated via convenient ordering of variables.

Considering lower triangularity of a matrix A_0 the equation (5) can be rewritten as follows:

$$\begin{bmatrix} e_{p_{oil},t} \\ e_{er_n,t} \\ e_{m,t} \\ e_{y_r,t} \\ e_{p,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{p_{oil},t} \\ \varepsilon_{er_n,t} \\ \varepsilon_{m,t} \\ \varepsilon_{y_r,t} \\ \varepsilon_{p,t} \end{bmatrix} \quad (6)$$

Correct identification of exogenous structural shocks reflecting Cholesky ordering of variables denotes following assumptions:

- Oil prices do not contemporaneously respond to the shock from any other endogenous variable of the model.
- Exchange rate doesn't contemporaneously respond to liquidity, demand and internal price shocks, while it is contemporaneously affected only by the external price shock.
- Money supply doesn't contemporaneously respond to demand and internal price shocks, while it is contemporaneously affected by external price and exchange rate shocks.
- Real output doesn't contemporaneously respond to the internal price shock, while it is contemporaneously affected by external price, exchange rate and liquidity shocks.
- Domestic price index is contemporaneously affected by the shocks from all of the endogenous variables of the model.

After initial period endogenous variables may interact freely without any restrictions.

Ordering of variables is crucial not only for a correct identification of structural shocks but also to reveal a convenient transmission mechanism of the external price shock into the domestic price level as well as a suitable distribution chain of the price effect across various domestic price indexes. However, the overall accuracy and robustness of the empirical results may be tested by examining the effects of the changed ordering of endogenous variables to exchange rate pass-through to the domestic prices.

To investigate the pass-through effect of the exchange rate shock to domestic price indexes at particular stages of distribution we include three different types of domestic prices (import prices, producer prices, consumer prices). All three types of internal price indexes are included in one model to examine a distribution channel of the external price shock along the internal pricing chain. As a result, the equation (6) is rewritten as follows:

$$\begin{bmatrix} e_{p_{oil},t} \\ e_{er_n,t} \\ e_{m,t} \\ e_{y_r,t} \\ e_{p_{imp},t} \\ e_{p_{ppi},t} \\ e_{p_{cpi},t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 & 0 \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{p_{oil},t} \\ \varepsilon_{er_n,t} \\ \varepsilon_{m,t} \\ \varepsilon_{y_r,t} \\ \varepsilon_{p_{imp},t} \\ \varepsilon_{p_{ppi},t} \\ \varepsilon_{p_{cpi},t} \end{bmatrix} \quad (7)$$

Following theoretical assumptions as well as empirical results we expect that the highest degree of exchange rate pass-through would be identified for import prices and lowest for consumer prices. We suggest that the initial effect of the external price shock will be reduced during its transmission along the internal price distribution channel.

Estimated VAR model is employed to compute impulse response functions to analyze (1) the responses of the exchange rate to the positive one standard deviation external (oil) price shock and (2) responses of particular internal price indexes to the positive one standard deviation exchange rate shock in the Euro Area member countries (Lian and Wang, 2012). To check the robustness of empirical results we estimate the model considering different ordering of the endogenous

variables in models and thus employing different identifying restrictions resulting from the recursive Cholesky decomposition of the reduced form VAR residuals:

- model A1, B1 $\left(X_t = \left[p_{oil,t}, er_{n,t}, m_t, y_{r,t}, p_{imp,t}, p_{ppi,t}, p_{cpi,t}\right]\right)$
- model A2, B2 $\left(X_t = \left[p_{oil,t}, m_t, er_{n,t}, y_{r,t}, p_{imp,t}, p_{ppi,t}, p_{cpi,t}\right]\right)$
- model A3, B3 $\left(X_t = \left[p_{oil,t}, y_{r,t}, er_{n,t}, m_t, p_{imp,t}, p_{ppi,t}, p_{cpi,t}\right]\right)$

Different ordering of variables enables us to examine exchange rate pass-through via alternative distribution channels of external inflation pressures transmission to the domestic prices assuming that different ordering of variables follows the economic logic of the chain of pricing and the structure of the economy. It also allows us to compare results with those of other studies. Additionally, if estimated results from the impulse-response analysis confirm the model is not very sensitive to the endogenous variables ordering than the Cholesky decomposition of the reduced-form VAR residuals with the initial ordering of variables provides significant and robust results.

Following the main objective of the paper we also estimate VAR models employing time series for two different periods (pre-crisis period (model A, 2000M1-2007M12) and extended period (model B, 2000M1-2014M12)) to examine effects of the crisis period on the exchange rate pass-through to import prices, producer prices and consumer prices in the Euro Area member countries.

Investigation of the exchange rate responsiveness to the unexpected exogenous price shock in countries with de-facto fixed exchange rates reveals substantial implications of exchange rate rigidity according to the absorption capabilities of exchange rates (Hahn, 2003). We expect that limited exchange rate volatility in terms of its vulnerability to the country specific determinants should reduce exchange rate exposure to the external price shock while it should simplify its transmission to the domestic prices.

5. Data and Results

To investigate the exchange rate pass-through to domestic prices in the Euro Area member countries we employed monthly data for period 2000M1-2007M12 (model A) consisting of 96 observations and for period 2000M1-2014M12 (model B) consisting of 168 observations for the following endogenous variables - oil prices, nominal exchange rate (nominal effective exchange rate), money supply (monetary

aggregate M2), industrial production (nominal volume of the industrial product deflated by averaged PPI) and inflation (import prices index, producer prices index, consumer prices index).

A. Testing Procedures

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were computed to test endogenous variables for the unit roots presence. Both ADF and PP tests indicate that most of variables are non-stationary on values so that the null hypothesis of a unit root presence cannot be rejected for any of time series. Testing variables on first differences indicates that time series are stationary. We may conclude that variables are integrated of order 1 I(1).

Because there are endogenous variables with a unit root on values it is necessary to test time series for cointegration using the Johansen and Juselius cointegration test (we found reasonable to include variables I(0) for testing purposes following economic logic of expected results). The test for the cointegration was computed using three lags as recommended by the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion).

Results of Johansen cointegration tests confirmed our results of unit root tests. Both trace statistics and maximum eigenvalue statistics (both at 0.05 level) indicate that there is no cointegration among endogenous variables of the model.

To test the stability of VAR models we also employed a number of diagnostic tests. We found no evidence of serial correlation, heteroskedasticity and autoregressive conditional heteroskedasticity effect in disturbances. The model also passes the Jarque-Bera normality test, so that errors seem to be normally distributed. VAR models seem to be stable also because inverted roots of the model for each country lie inside the unit circle. Detailed results of time series testing procedures are not reported here to save space. Like any other results, they are available upon request from the author.

Following results of the unit root and cointegration tests we estimated the model using variables in first differences so that we can calculate impulse-response functions for all nineteen Euro Area member countries. Following the main objective of the paper we focus on interpretation of responses of the (1) exchange rate to the positive one standard deviation oil price shock and (2) domestic price indexes

(import prices, producer prices and consumer prices) to the positive one standard deviation exchange rate shock.

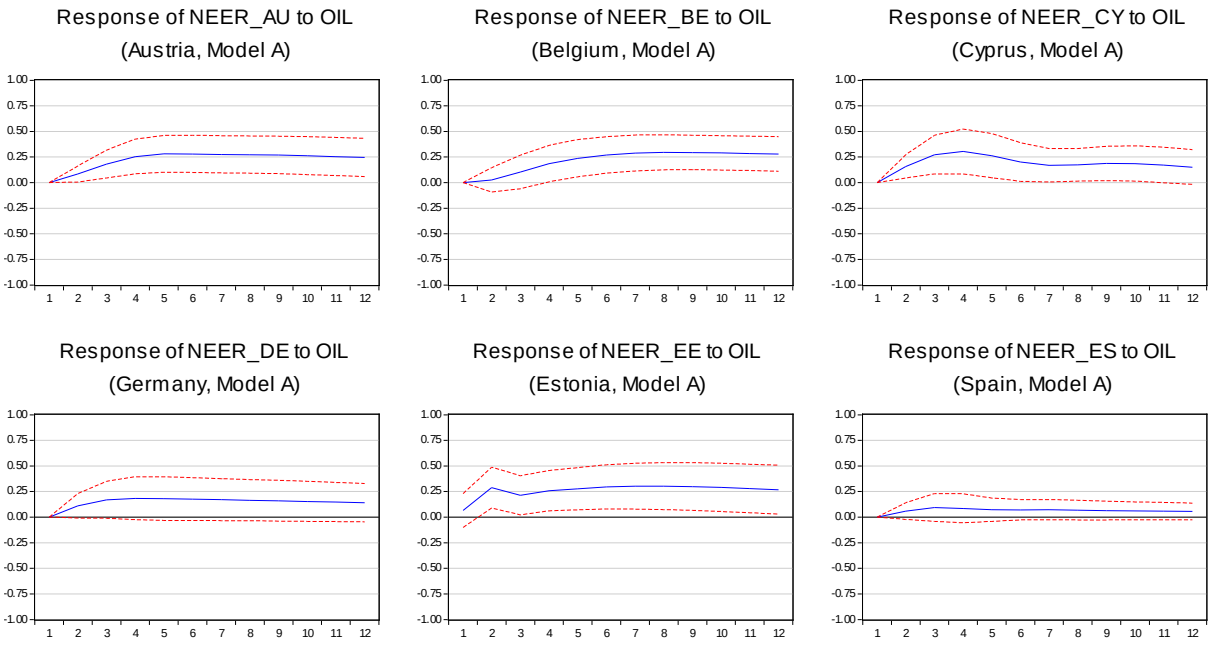
We also observe effects of the crisis period on the both exchange rate responses to oil price shock and domestic prices responses to the exchange rate shock in the Euro Area member countries by comparing results for estimated models using time series for two different periods - model A (2000M1-2007M12) and model B (2000M1-2014M12). Changed ordering of variables didn't seem to affect results of the analysis. Considering that impulse-response functions are not very sensitive to the ordering of endogenous variables we present results of both models (model A1 and B1) with default ordering of endogenous variables (detailed results for models A2, A3, B2, B3 are available upon request from the author).

B. Impulse-Response Functions

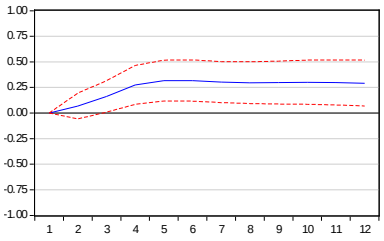
Examination of the first stage in the exchange rate pass-through includes estimation of exchange rates responses to the positive one standard deviation oil price shock employing monthly data for two subsequent periods 2000-2007 (model A) and 2000-2014 (model B).

Figure 1 Responses of Exchange Rates to Oil Price Shock

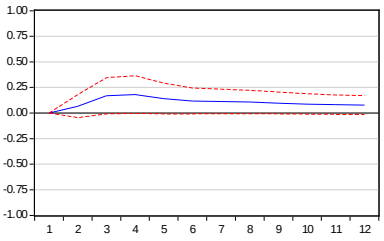
(Model A) (2000M1-2007M12)



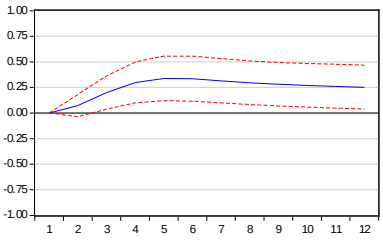
Response of NEER_FI to OIL
(Finland, Model A)



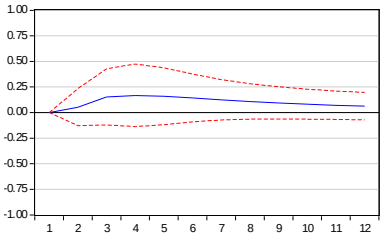
Response of NEER_FR to OIL
(France, Model A)



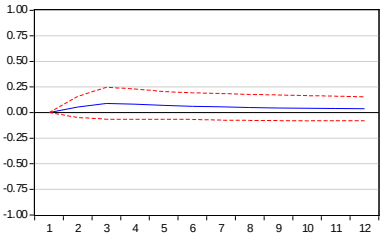
Response of NEER_GR to OIL
(Greece, Model A)



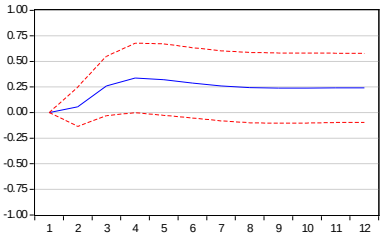
Response of NEER_IR to OIL
(Ireland, Model A)



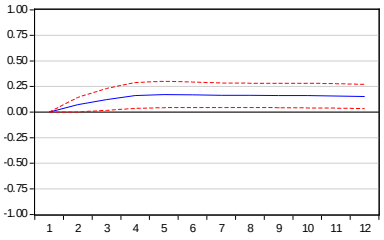
Response of NEER_IT to OIL
(Italy, Model A)



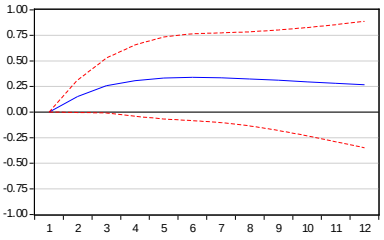
Response of NEER_LT to OIL
(Lithuania, Model A)



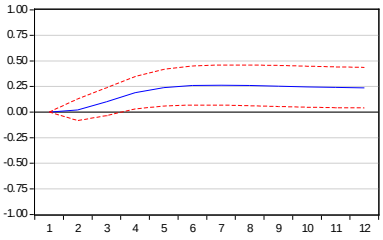
Response of NEER_LU to OIL
(Luxemburg, Model A)



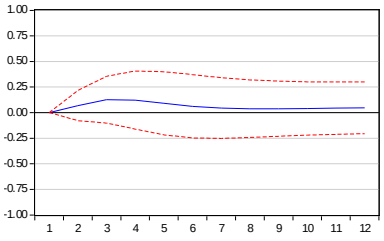
Response of NEER_LV to OIL
(Latvia, Model A)



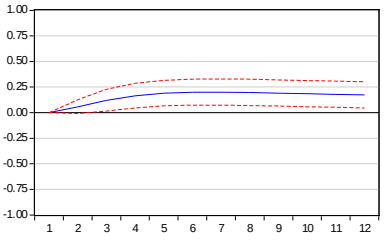
Response of NEER_MT to OIL
(Malta, Model A)



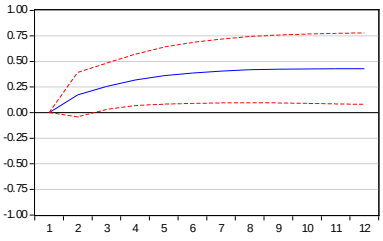
Response of NEER_NE to OIL
(Nederland, Model A)



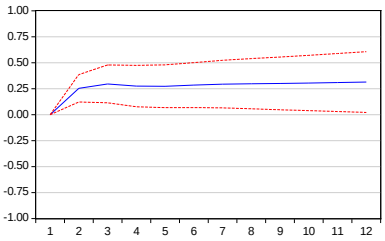
Response of NEER_PT to OIL
(Portugal, Model A)



Response of NEER_SI to OIL
(Slovenia, Model A)



Response of NEER_SK to OIL
(Slovak republic, Model A)



Note: Curves represent responses of exchange rates (NEER) to the positive one standard deviation oil price (OIL) shock in each country from the group of the Euro Area member countries.

Source: Author's calculations.

In the Figure 1 we summarize results of impulse-response functions of exchange rates to the positive (increase in) oil price shocks in both models in Euro Area member countries. Estimations of the exchange rates responsiveness to the Cholesky positive one standard deviation oil price shocks revealed interesting implications of the relative heterogeneity of the Euro Area. Unexpected increase in the oil price was followed by the exchange rate appreciation in all countries from the group. However, we have observed different patterns in the exchange rate responsiveness among individual countries. Oil price shock caused a moderate and less dynamic increase in the exchange rate in large economies (Germany, Spain, France, Italy), countries of Benelux (except for Belgium) and Portugal. Exchange rate responsiveness to the external price (oil) shock in countries with large and less opened economies seems be to less dynamic in comparison with the rest of countries from the Euro Area. Reduced responsiveness of NEER in sizeable economies corresponds with theoretical assumptions about low exposure of exchange rates to exogenous shocks in less opened economies. In Luxemburg, Nederland and Portugal our results indicate reduced absorption capabilities associated with price related effects of unexpected oil price shock.

In the rest of countries we observed more dynamic initial response of NEER to the positive oil price shock. Higher absorption capability of exchange rates in these countries reduces inflation pressures associated with external price shock and its transmission to domestic prices.

Our results also indicate different durability of the effect of the external price shock on NEER in the Euro Area member countries. In large economies and Euro Area outliers the overall positive effect of the oil price shock clearly died out earlier in comparison with the rest of countries from the group. While generally temporary in most of countries, NEER appreciation seems to be permanent in just three economies (Finland, Slovenia and Slovak republic[2]).

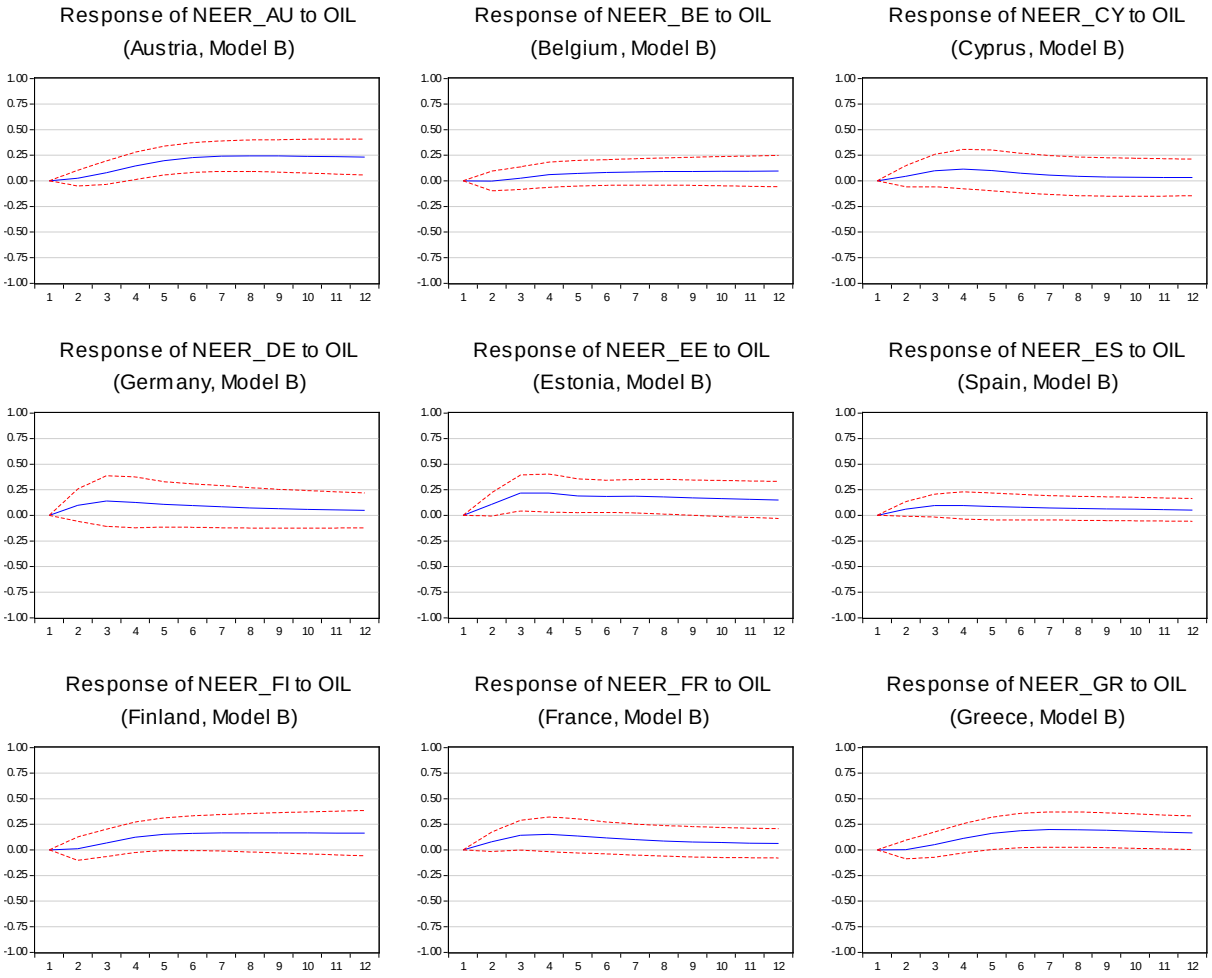
Low exposure of the exchange rate to the oil price shock reduces its absorption capabilities. We expect that this feature of exchange rates will be crucial consideration in examining the second stage in the exchange rate pass-through. Reduced exchange rate responsiveness to the external price shocks increases the transmission of the price effect to the domestic prices. Imported inflation is clear implication of the exchange rate rigidity in such cases and it is also a contrary

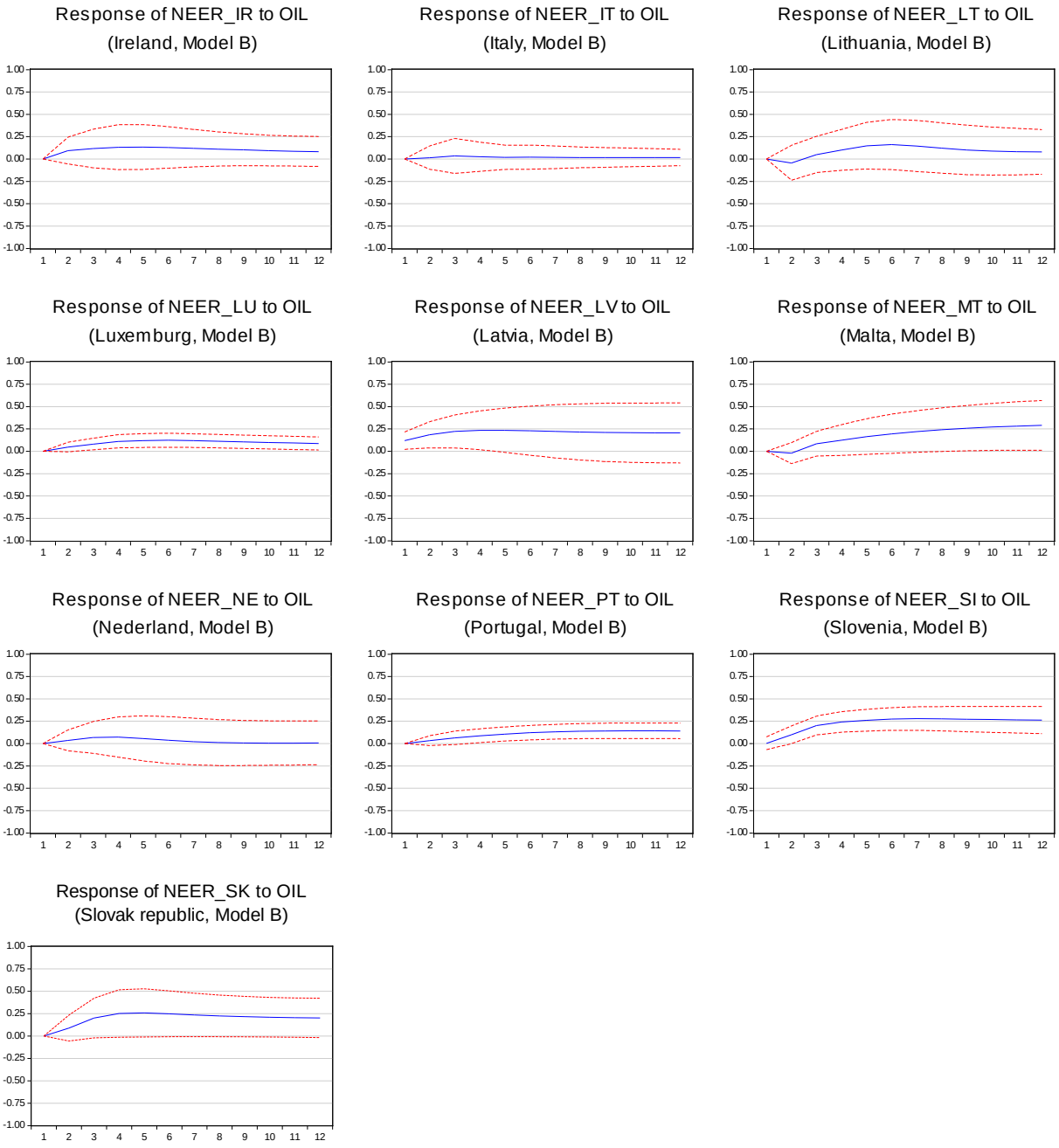
[2] It is necessary to note that Slovenia and Slovakia operated during the most of the pre-crisis period outside the Eurozone.

example to the traditional views emphasizing positive effects of the (fixed) exchange rate based stabilization economic policies. On the other hand, higher and durable responsiveness of exchange rates to the oil price shock in the second group of countries reduces the transmission of the price effect to domestic prices and thus contributes to offset the expected inflation pressures originated in the negative external price shock. As a result, exchange rates in these countries operate more as an external price shock absorber. Assumptions about expected transmission or absorption capabilities of exchange rates in both groups of countries will be comprehensively evaluated by assessing the second stage in the exchange rate pass-through to import prices, producer prices and consumer prices.

Figure 2 Responses of Exchange Rates to Oil Price Shock

(Model B) (2000M1-2014M12)





Note: Curves represent responses of exchange rates (NEER) to the positive one standard deviation oil price (OIL) shock in each country from the group of the Euro Area member countries.

Source: Author's calculations.

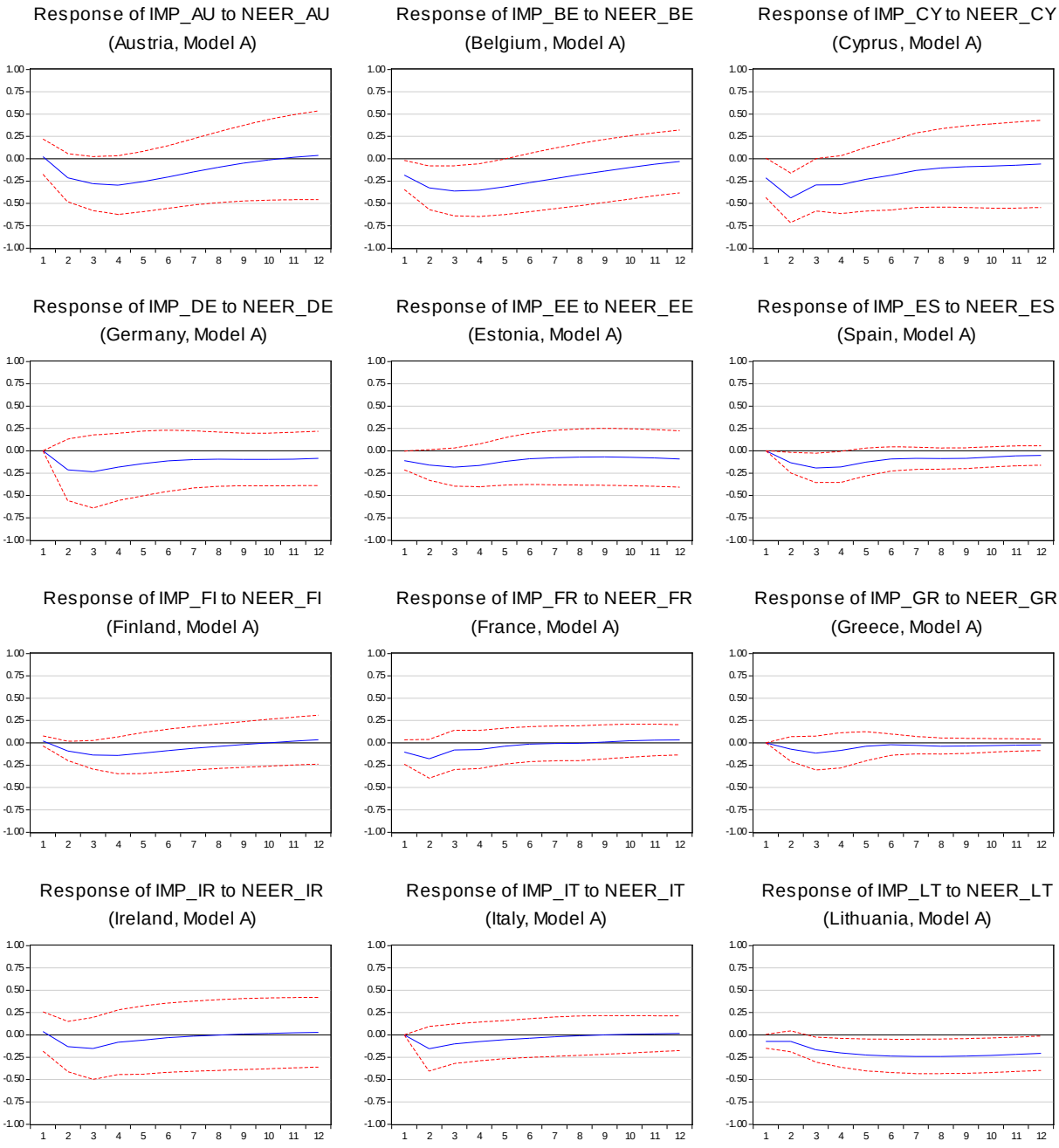
Crisis period affected short-term responsiveness of exchange rates to the positive one standard deviation oil price shock in all Euro Area member countries (Figure 2). In general, the NEER response during the extended period followed slightly lagged, less intensive and less durable path toward its long-run pre-shock equilibrium in all countries. Permanent feature in the NEER response was preserved in Slovenia and Slovak republic. Generally lower responsiveness of NEER to the exogenous price shocks during the extended period indicates reduced absorption capabilities of

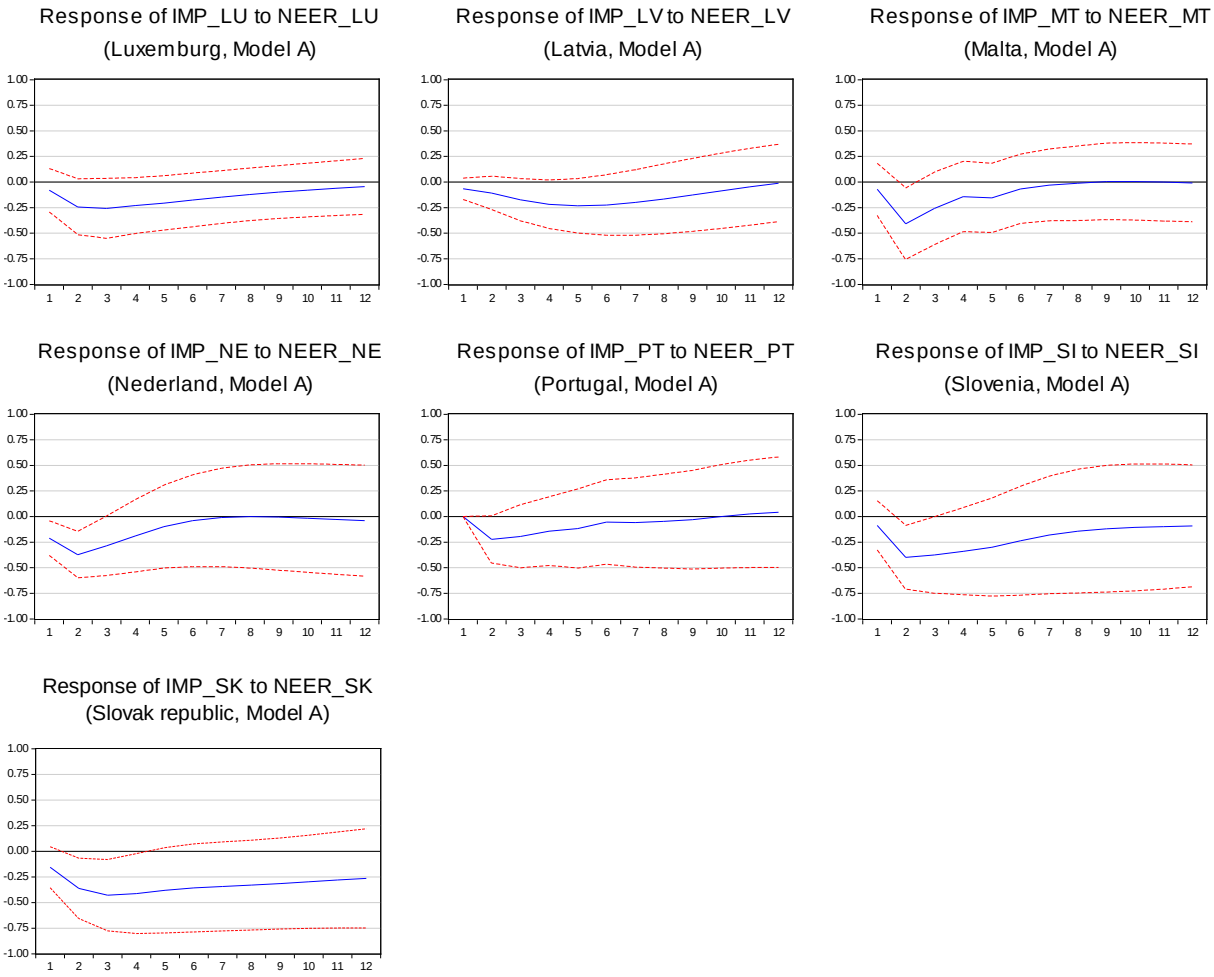
exchange rate due to crisis related effects. As a result, the crisis period increased the overall vulnerability of the Euro Area member countries to the external price shocks.

Examination of the second stage in the exchange rate pass-through includes estimation of the import prices, producer prices and consumer prices responses to the positive one standard deviation exchange rate shock (unexpected exchange rate appreciation) employing monthly data for two subsequent periods 2000-2007 (model A) and 2000-2014 (model B).

Figure 3 Responses of Import Prices to Exchange Rate Shock

(Model A) (2000M1-2007M12)





Note: Curves represent responses of import prices (IMP) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the Euro Area member countries

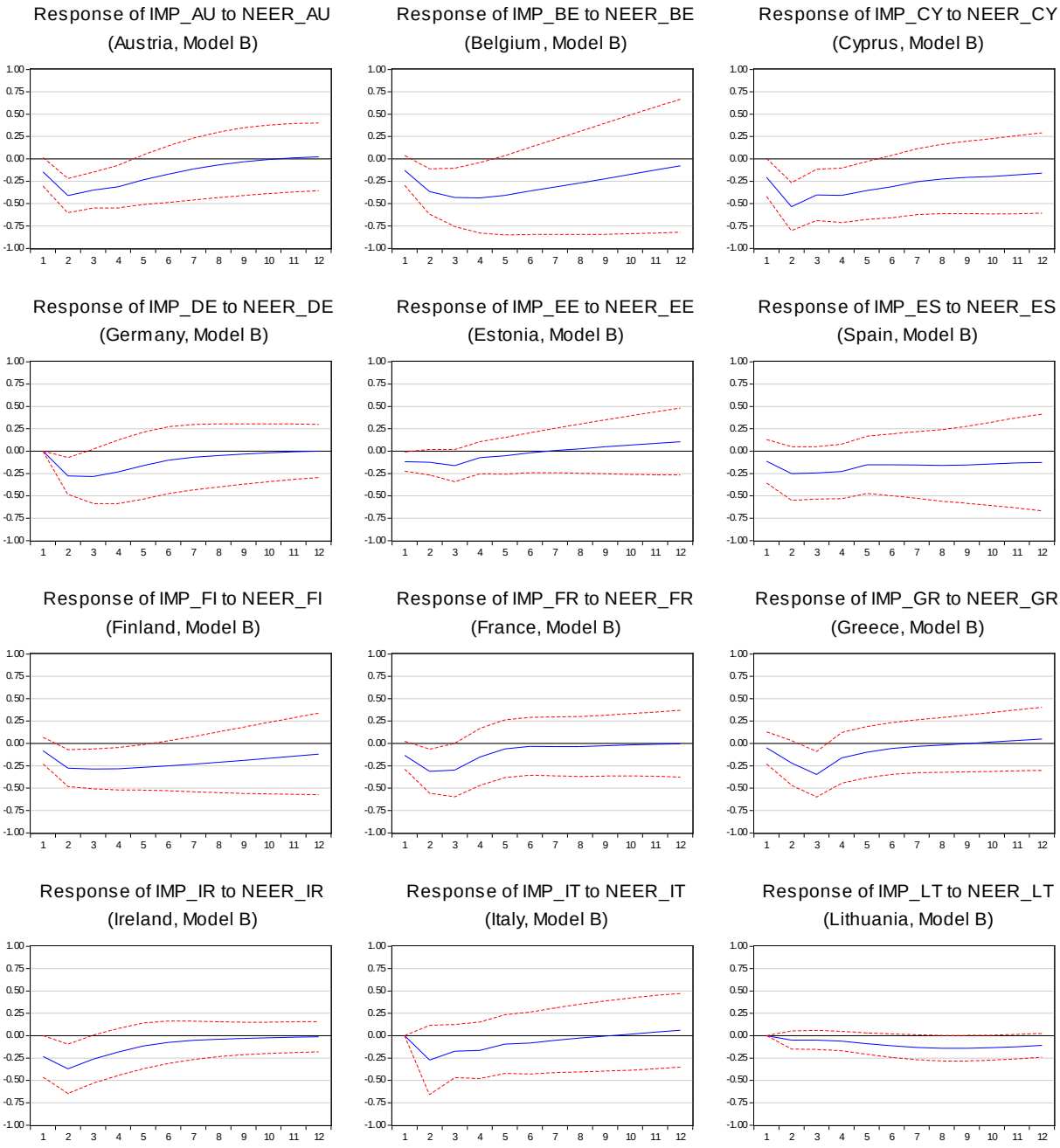
Source: Author's calculation.

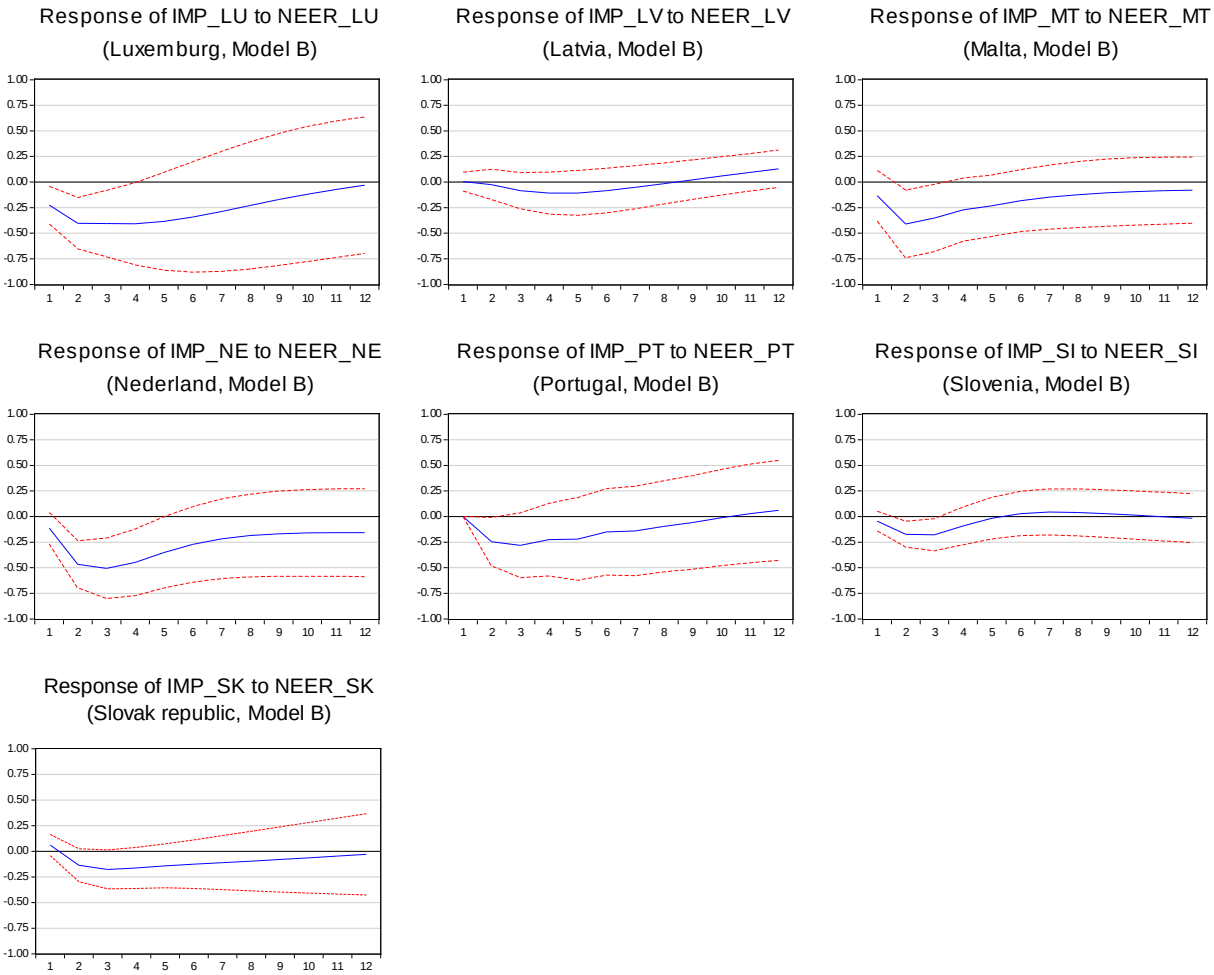
In the figure 3 we summarize results of impulse-response functions of the import prices to the positive (increase in) exchange rate shocks in both models in the Euro Area member countries. While we observed some similar patterns in the import prices responsiveness in the whole group of countries there are still some differences than need to be discussed. Most of the initial effect of the exchange rate shock affected import prices in all countries within first 2-3 months and then steadily decreased. Only exception we observed in Latvia and Lithuania where import prices decreased with a reduced intensity. Effect of the exchange rate shock on import prices seems to be neutral in the long run in all countries. Moreover, smaller and more opened economies experienced more dynamic initial decrease in import prices followed by the exchange rate shock. Increased vulnerability of import prices contributed to higher absorption capabilities of NEER in these countries. Moreover, import prices, as the first element in the internal price chain, initiated impulse that will spread across

remaining two price indexes (producer prices and import prices). Responsiveness of the latest two indexes to the unexpected exchange rate shock may provide crucial information about efficiency of the transmission mechanism of the external price shock across internal price chain in individual countries.

Figure 4 Responses of Import Prices to Exchange Rate Shock

(Model B) (2000M1-2014M12)





Note: Curves represent responses of import prices (IMP) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the Euro Area member countries

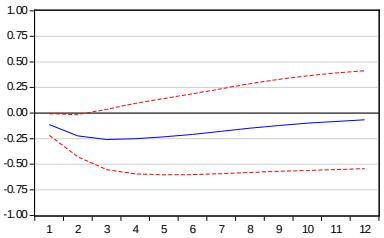
Source: Author's calculation.

Crisis period affected responsiveness of import prices to the positive one standard deviation exchange rate shock in the Euro Area member countries though we observed some differences that need to be discussed (Figure 4). In general, all Euro Area member countries except for new members (Baltic countries, Slovakia and Slovenia) experienced increased short term vulnerability of import price to the unexpected NEER shock. Similarly to the results for the pre-crisis period, negative effect (decrease in prices) of the shock culminated within first three months (except for Lithuania) and was neutral in the long run as its effect completely died out mostly within one year since the shock. Higher short-term sensitivity of the import prices to the exchange rate shock induces increased absorption capabilities of NEER in most of the Euro Area member countries. However, our results for producer prices and consumer prices did not confirm the idea of the transmission of the exchange rate absorption capabilities across the internal price chain.

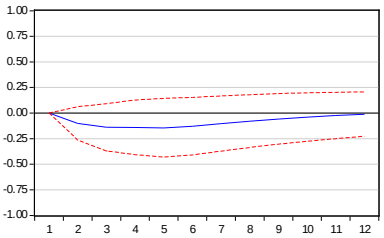
Figure 5 Responses of Producer Prices to Exchange Rate Shock

(Model A) (2000M1-2007M12)

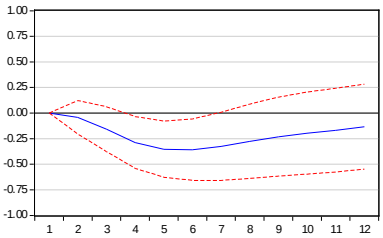
Response of PPI_AU to NEER_AU
(Austria, Model A)



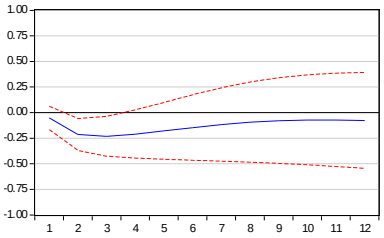
Response of PPI_BE to NEER_BE
(Belgium, Model A)



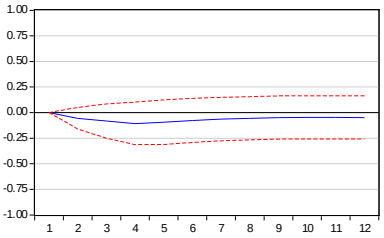
Response of PPI_CY to NEER_CY
(Cyprus, Model A)



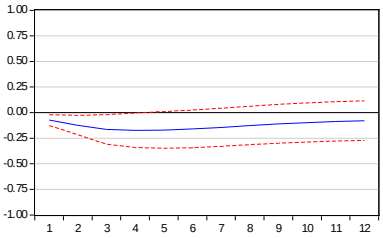
Response of PPI_DE to NEER_DE
(Germany, Model A)



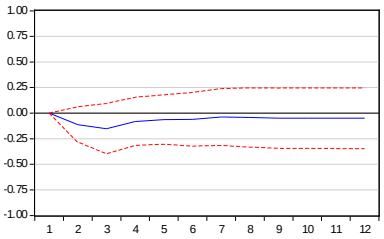
Response of PPI_EE to NEER_EE
(Estonia, Model A)



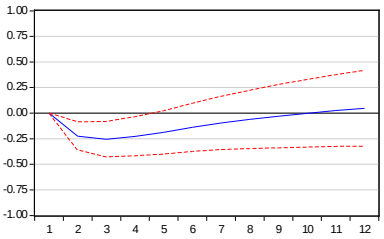
Response of PPI_ES to NEER_ES
(Spain, Model A)



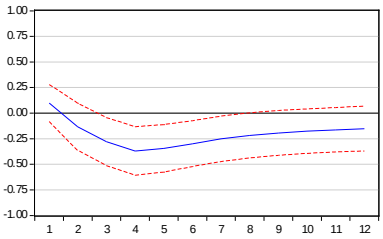
Response of PPI_FI to NEER_FI
(Finland, Model A)



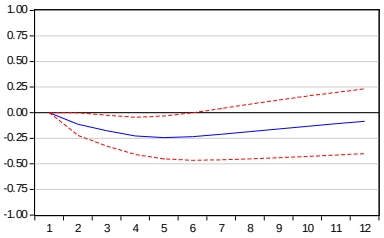
Response of PPI_FR to NEER_FR
(France, Model A)



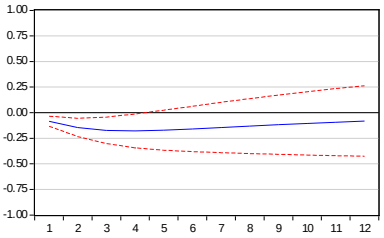
Response of PPI_GR to NEER_GR
(Greece, Model A)



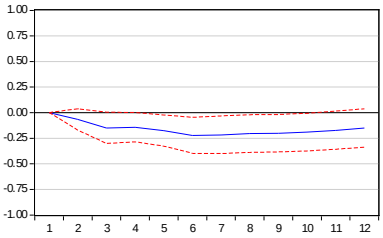
Response of PPI_IR to NEER_IR
(Ireland, Model A)



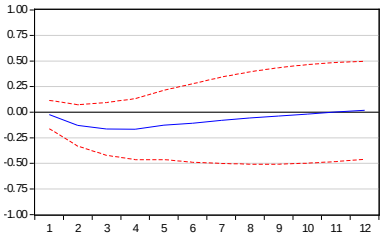
Response of PPI_IT to NEER_IT
(Italy, Model A)



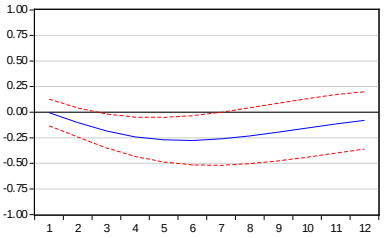
Response of PPI_LT to NEER_LT
(Lithuania, Model A)



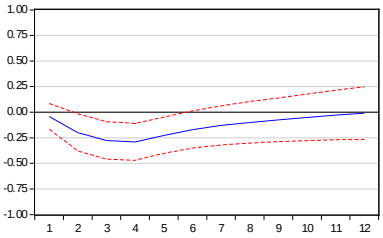
Response of PPI_LU to NEER_LU
(Luxemburg, Model A)

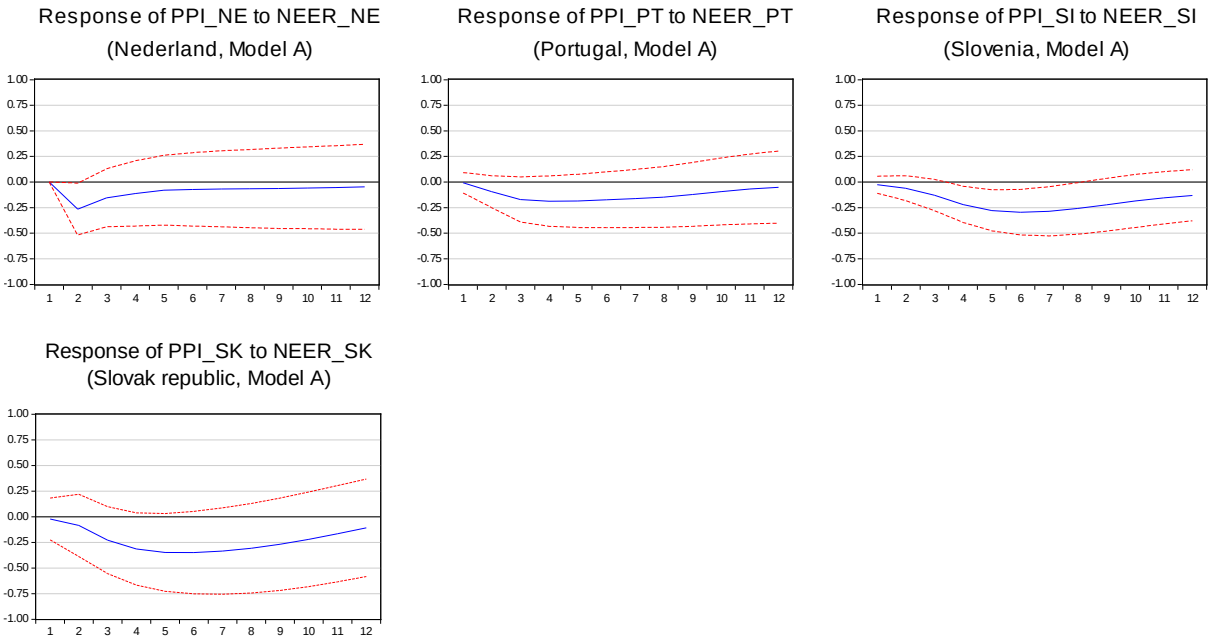


Response of PPI_LV to NEER_LV
(Latvia, Model A)



Response of PPI_MT to NEER_MT
(Malta, Model A)





Note: Curves represent responses of producer prices (PPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the Euro Area member countries.

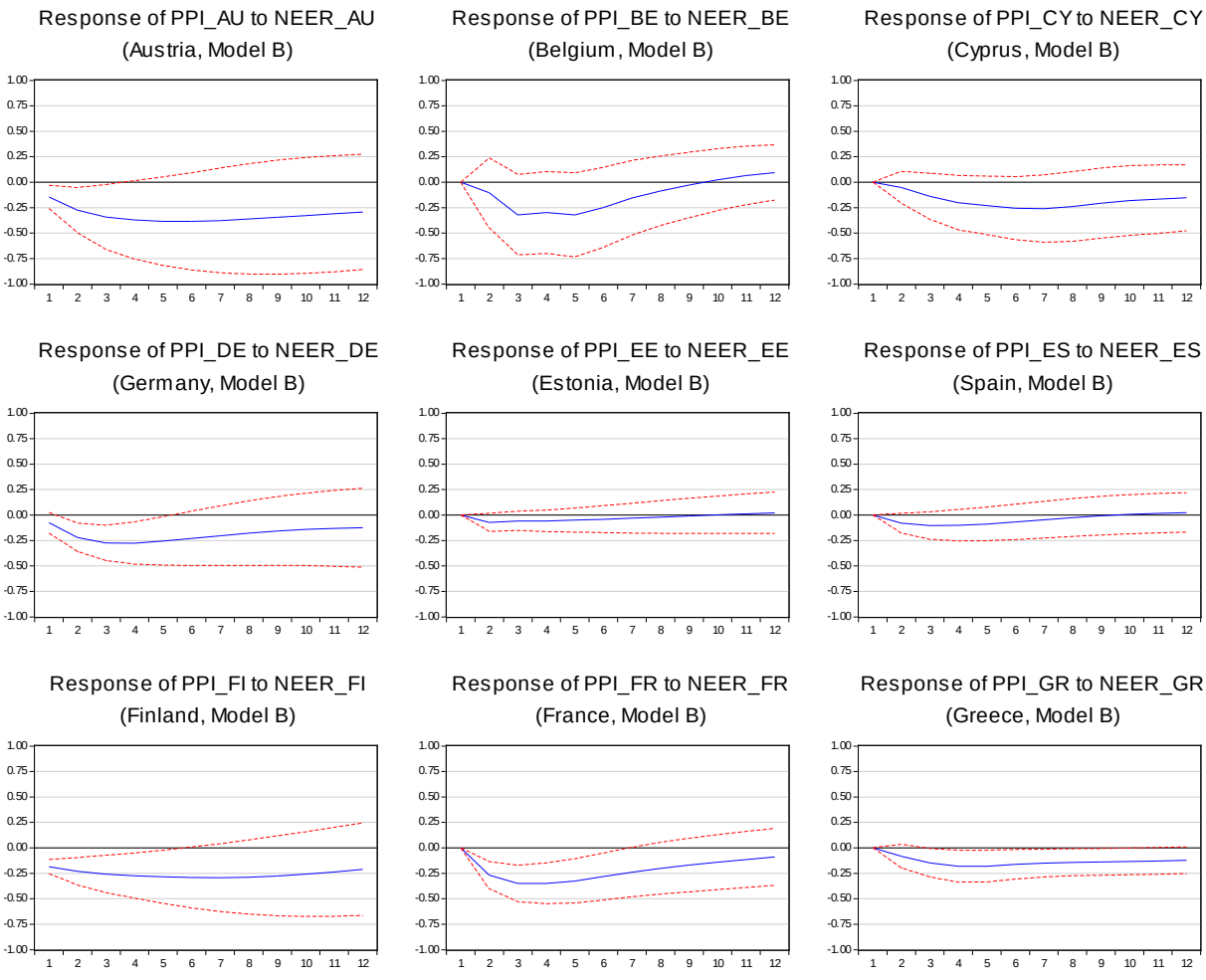
Source: Author's calculation.

In the Figure 5 we summarize results of impulse-response functions of the producer prices to the positive (increase in) exchange rate shocks in both models in the Euro Area member countries. Exchange rate appreciation, in models with time series for the pre-crisis period, was followed by a drop in producer prices in all nineteen economies. However, while the positive effect of the shock culminated within first six months, the response pattern of producer prices in individual countries followed unique leading path to its pre-shock equilibrium. New Euro Area member countries from past Eastern bloc (except for Estonia) experienced more dynamic and more lagged decrease in producer prices in comparison with the rest of the Euro Area. Similar response patterns (more dynamic and durable) were observed in Cyprus and Greece. In remaining countries we observed mostly less dynamic and less durable responsiveness of producer prices. Overall effect of the shock in all countries seems to be just a temporary and thus neutral in the long run. Finally, in most of the less performing countries (mostly periphery economies) we observed higher dynamics in the responsiveness pattern of producer prices in comparison with responsiveness of import prices. Overreaction of producer prices combined with low responsiveness of NEER to the external price shock may refer to reduced efficiency of the transmission mechanism across the internal price chain.

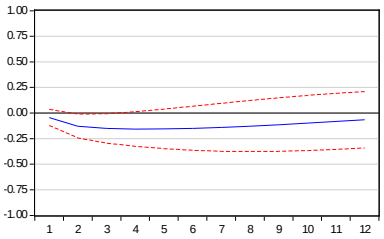
Examination of the exchange rate pass-through to producer prices revealed interesting differences in the absorption capabilities of the common currency among member countries of the Euro Area. Generally higher responsiveness of producer prices in the new Euro Area member countries from the past Eastern bloc (together with Cyprus and Greece) indicates better transmission of the asymmetric effect of the external price shock from exchange rate (appreciation) to producer prices (decrease) in the short-run period. As a result, higher flexibility of the exchange rate pass-through in these countries reduces their vulnerability to the exogenous price shocks. At the same time, less dynamic response of producer prices in the most of the Euro Area member countries increase their exposure to the unexpected external price shocks.

Figure 6 Responses of Producer Prices to Exchange Rate Shock

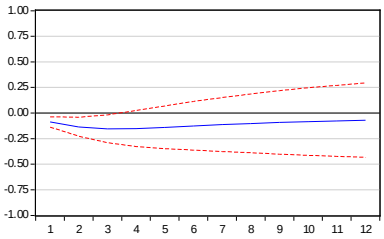
(Model B) (2000M1-2014M12)



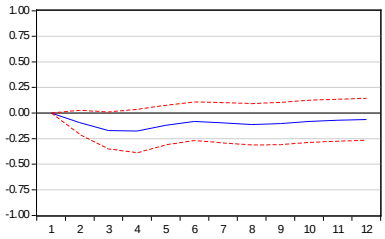
Response of PPI_IR to NEER_IR
(Ireland, Model B)



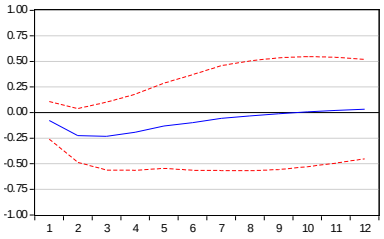
Response of PPI_IT to NEER_IT
(Italy, Model B)



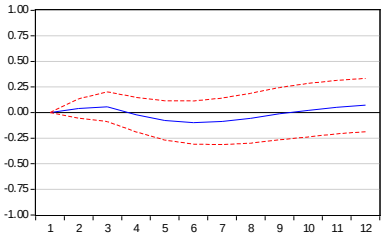
Response of PPI_LT to NEER_LT
(Lithuania, Model B)



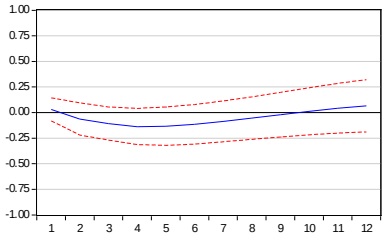
Response of PPI_LU to NEER_LU
(Luxemburg, Model B)



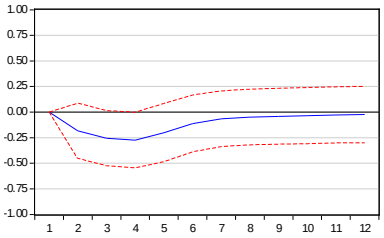
Response of PPI_LV to NEER_LV
(Latvia, Model B)



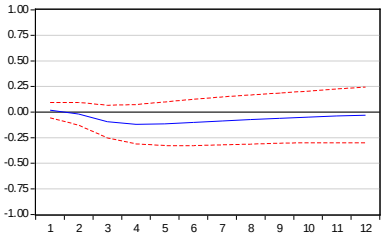
Response of PPI_MT to NEER_MT
(Malta, Model B)



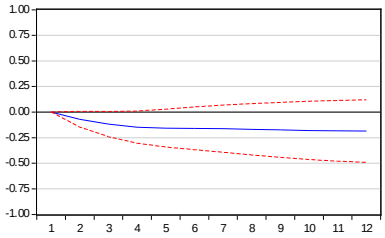
Response of PPI_NE to NEER_NE
(Nederland, Model B)



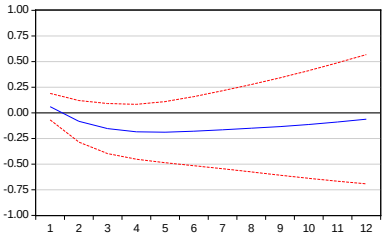
Response of PPI_PT to NEER_PT
(Portugal, Model B)



Response of PPI_SI to NEER_SI
(Slovenia, Model B)



Response of PPI_SK to NEER_SK
(Slovak republic, Model B)



Note: Curves represent responses of producer prices (PPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the Euro Area member countries

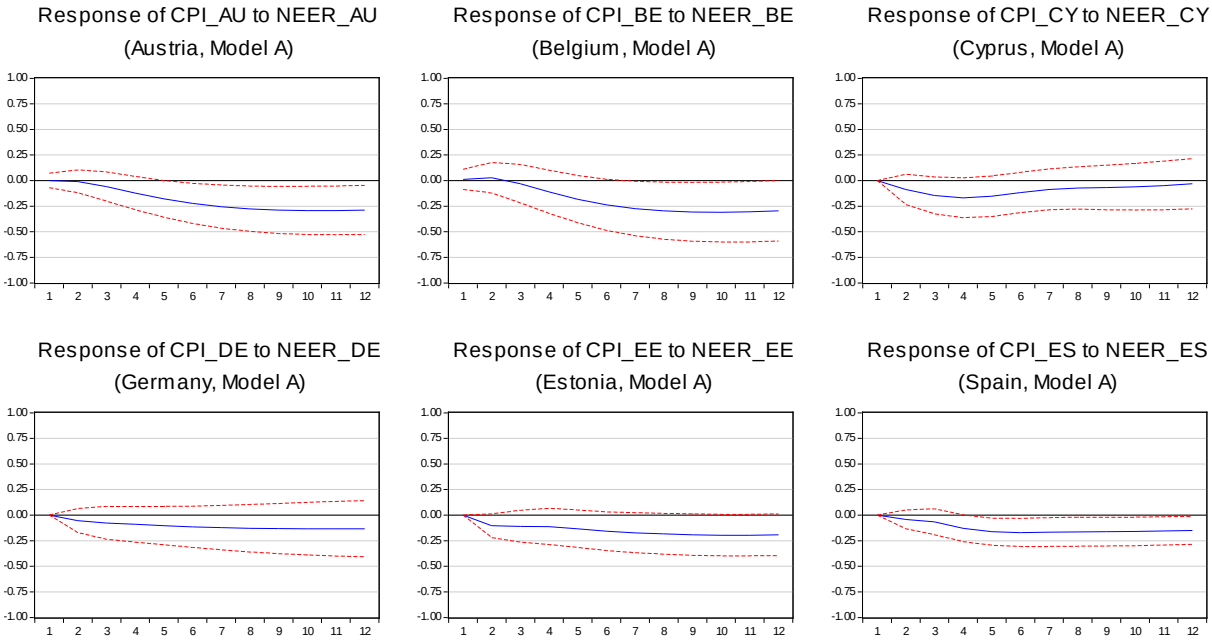
Source: Author's calculation.

Crisis period affected responsiveness of producer prices to the positive one standard deviation exchange rate shock in our group of countries though we have recognized some differences that need to be discussed (Figure 6). NEER appreciation was followed by general decrease in producer prices. However, crisis period reduced responsiveness of producer prices (mostly in terms of dynamics and in some cases also in the speed of adjustment) to the unexpected exchange rate shock in group consisting of the new Euro Area member countries (Baltic countries,

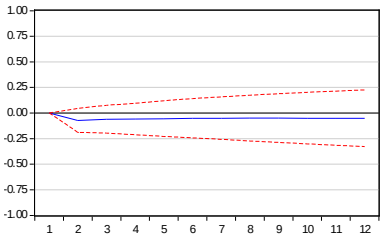
Slovakia and Slovenia) and the less performing core Euro Area members represented by periphery countries (PIGS), Cyprus, Ireland and Malta. We suggest that these countries experienced a reduction in efficiency of the exchange rate pass-through to producer prices that increased their vulnerability to external price shocks due to reduced absorption capabilities of their NEER. Moreover, remaining countries from the core of the Euro Area experienced an increased dynamics in the response pattern of their producer prices to the unexpected exchange rate shock. It seems that generally better macroeconomic conditions in these countries resulted in the overall improvement of the exchange rate pass-through to producer prices. As a result, absorption capabilities of NEER in the core countries were improved and the vulnerability and exposure of the core countries to the external price shocks was generally reduced. We suggest that less performing economies of the Euro Area seem to be more vulnerable to the external price shocks and thus more prone to deflationary pressures driven by external shocks.

Figure 7 Responses of Consumer Prices to Exchange Rate Shock

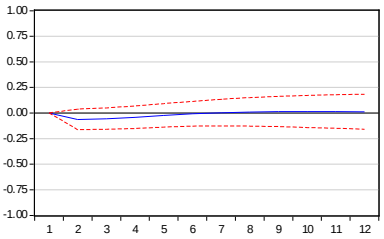
(Model A) (2000M1-2007M12)



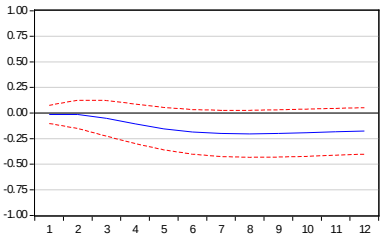
Response of CPI_FI to NEER_FI
(Finland, Model A)



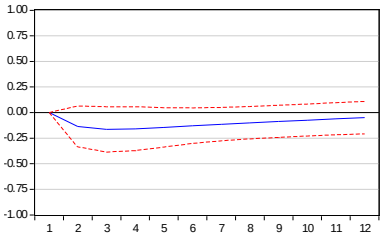
Response of CPI_FR to NEER_FR
(France, Model A)



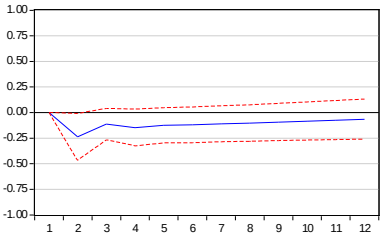
Response of CPI_GR to NEER_GR
(Greece, Model A)



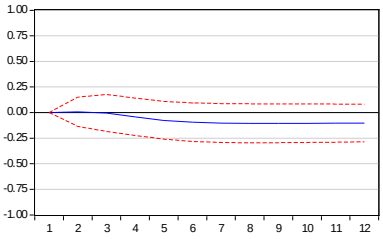
Response of CPI_IR to NEER_IR
(Ireland, Model A)



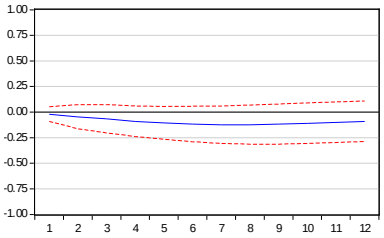
Response of CPI_IT to NEER_IT
(Italy, Model A)



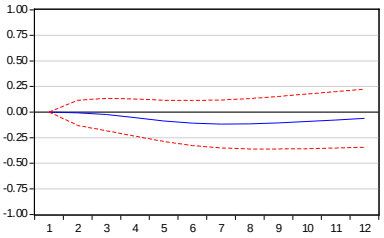
Response of CPI_LT to NEER_LT
(Lithuania, Model A)



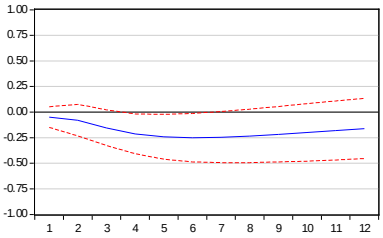
Response of CPI_LU to NEER_LU
(Luxemburg, Model A)



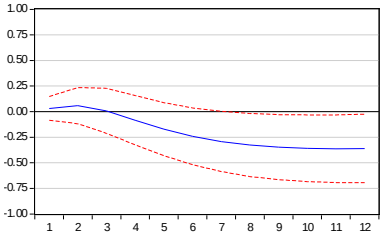
Response of CPI_LV to NEER_LV
(Latvia, Model A)



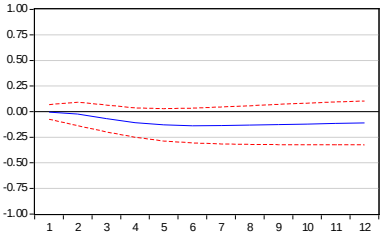
Response of CPI_MT to NEER_MT
(Malta, Model A)



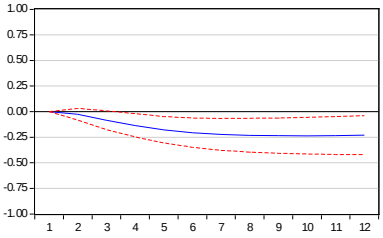
Response of CPI_NE to NEER_NE
(Nederland, Model A)



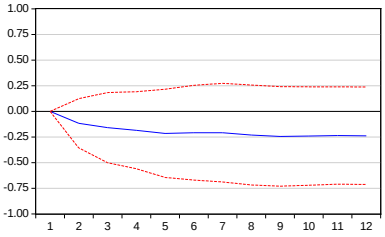
Response of CPI_PT to NEER_PT
(Portugal, Model A)



Response of CPI_SI to NEER_SI
(Slovenia, Model A)



Response of CPI_SK to NEER_SK
(Slovak republic, Model A)



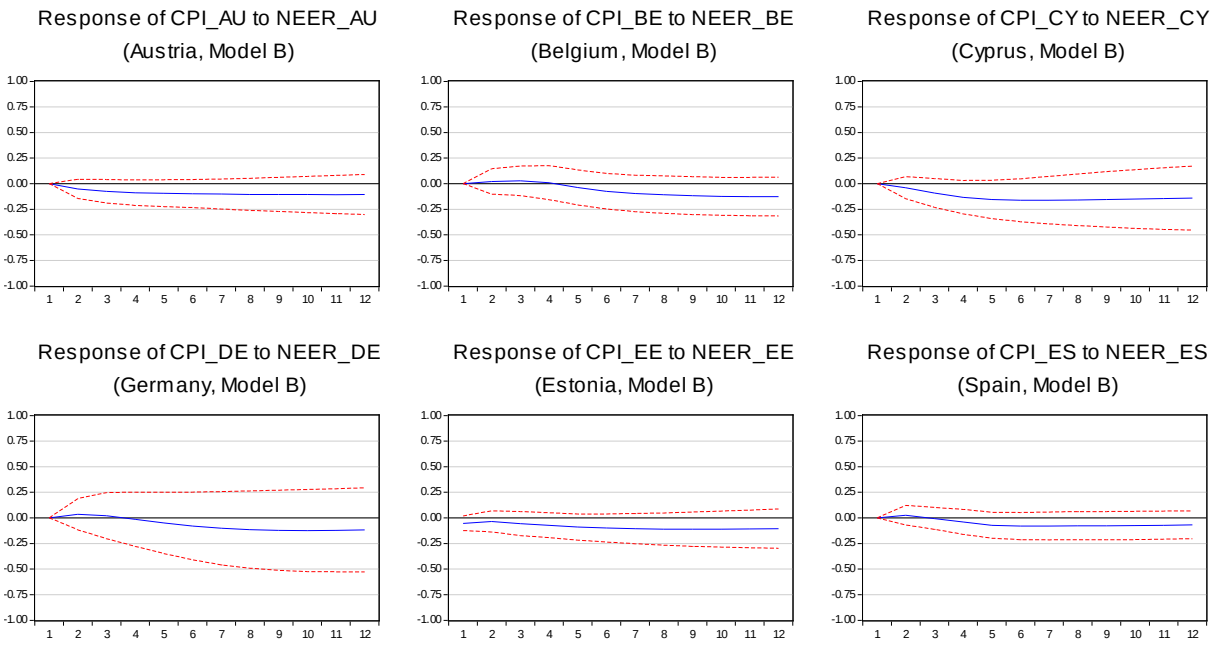
Note: Curves represent responses of consumer prices (CPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the Euro Area member countries.

Source: Author's calculation.

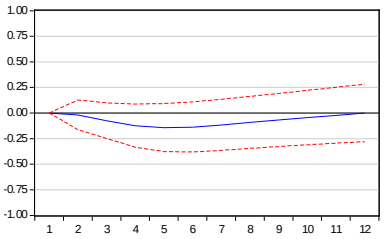
In the Figure 7 we summarize results of impulse-response functions of the consumer prices to the positive (increase in) exchange rate shocks in both models in the Euro Area member countries. We observed that unexpected exchange rate appreciation was followed by a decrease in consumer prices in all countries though we observed some differences in the response patterns of domestic prices. Large economies and most of outliers experienced lagged and moderate decrease in consumer prices followed by the positive NEER shock. Effect of the shock in this group of countries seems to be just a temporary and gradually died out in the long run. Cyprus, Finland and Ireland experienced only small and short-term decrease in consumer prices. The rest of countries experienced lagged though more dynamic decrease in consumer prices followed by the exchange rate shock. Effect of the shock seems to be just a temporary and thus neutral in the long run in all countries but Estonia and Slovenia. Finally, in some economies (Belgium, Estonia, Spain, Ireland, Italy, Malta, and Nederland) we observed increased dynamics in the responsiveness pattern of consumer prices in comparison with responsiveness of producer prices. Overreaction of producer prices combined with low responsiveness of import prices to the NEER shock indicates reduced efficiency of the transmission mechanism across the internal price chain.

Figure 8 Responses of Consumer Prices to Exchange Rate Shock

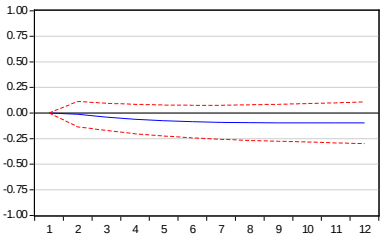
(Model B) (2000M1-2014M12)



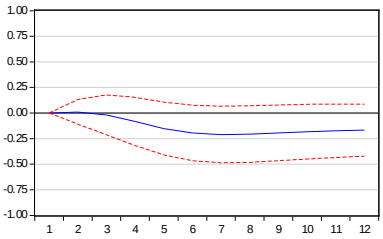
Response of CPI_FI to NEER_FI
(Finland, Model B)



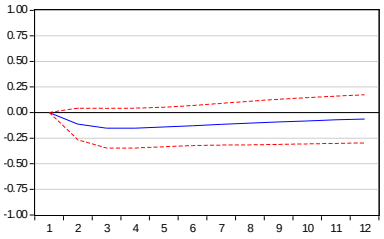
Response of CPI_FR to NEER_FR
(France, Model B)



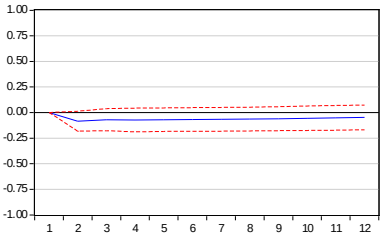
Response of CPI_GR to NEER_GR
(Greece, Model B)



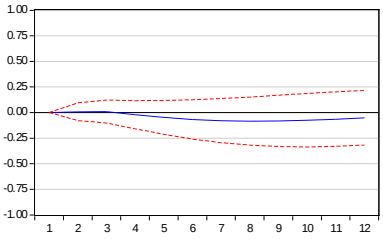
Response of CPI_IR to NEER_IR
(Ireland, Model B)



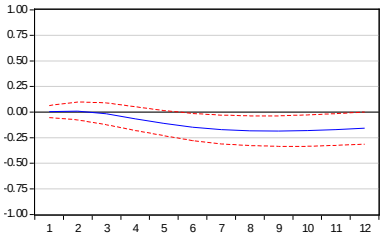
Response of CPI_IT to NEER_IT
(Italy, Model B)



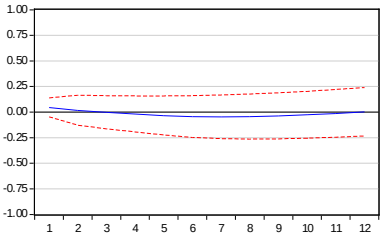
Response of CPI_LT to NEER_LT
(Lithuania, Model B)



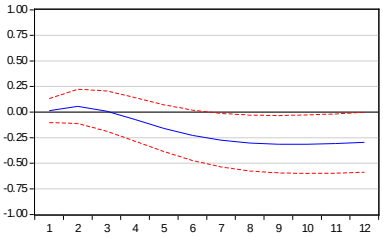
Response of CPI_LU to NEER_LU
(Luxemburg, Model B)



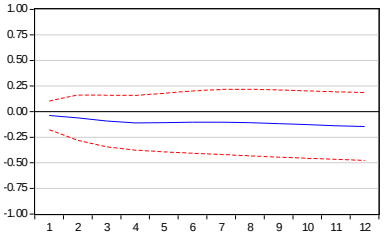
Response of CPI_LV to NEER_LV
(Latvia, Model B)



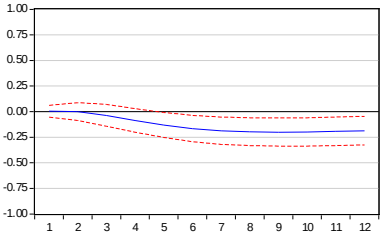
Response of CPI_MT to NEER_MT
(Malta, Model B)



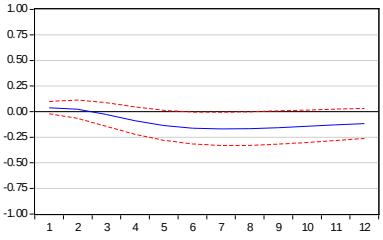
Response of CPI_NE to NEER_NE
(Nederland, Model B)



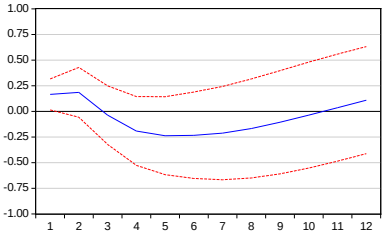
Response of CPI_PT to NEER_PT
(Portugal, Model B)



Response of CPI_SI to NEER_SI
(Slovenia, Model B)



Response of CPI_SK to NEER_SK
(Slovak republic, Model B)



Note: Curves represent responses of consumer prices (CPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the Euro Area member countries.

Source: Author's calculation.

Crisis period affected responsiveness of consumer prices to the positive one standard deviation exchange rate shock in the Euro Area member countries though we observed some differences that need to be discussed (Figure 8). In general, the overall short-term decrease in consumer prices seems to be reduced and slightly lagged in the most of countries. Higher medium term dynamic in the consumer prices response pattern was observed in Cyprus, France, Luxemburg, Malta and Portugal.

6. Conclusion

Investigation of the first stage in the exchange rate pass-through revealed reduced absorption capabilities of NEER in large economies (Germany, Spain, France, Italy), countries of Benelux (except for Belgium) and Portugal in comparison with the rest of countries from the Euro Area. Reduced exchange rate responsiveness to the external price shocks increases the transmission of the price effect to the domestic prices.

While the examination of the first stage in the exchange rate pass-through during the pre-crisis period generally confirmed higher absorption capabilities of NEER in countries from the past Eastern bloc (due to more dynamic responsiveness of producer prices to the exchange rate shock), reduced absorption capabilities of NEER in Portugal, Italy and Spain indicates increased vulnerability of less performing periphery members of the Euro Area to the external price shocks. Moreover, reduced absorption capabilities of NEER in all countries during the crisis period just highlighted higher exposure of all Euro Area members operating under common currency to the external price shocks. Most of the countries from the core of the Euro Area experienced more dynamic NEER response to the oil price shock. As a result, fixed exchange rate operated more as the external price shock absorber reducing effect of so called imported inflation (or deflation) in these countries.

Second stage of the exchange rate pass-through revealed interesting differences in the absorption capabilities of NEER among the Eurozone member countries. Exchange rate shock was followed by immediate decrease in import prices (within first three months) in all countries but Latvia and Lithuania. As a result, initial effect of the exchange rate shock (followed by oil price shock that appreciated NEER) was adequately transmitted to the import prices. Import prices, as the first element in the internal price chain, initiated impulse that will spread across

remaining two price indexes (producer prices and import prices). Crises period generally increased short-term responsiveness of import prices to the exchange rate shock except for Baltic countries, Slovakia and Slovenia. However, our results for producer prices and consumer prices did not confirm the idea of the transmission of the exchange rate absorption capabilities across the internal price chain.

Higher responsiveness of producer prices in the new Eurozone member countries from the past Eastern bloc (together with Cyprus and Greece) indicates better transmission of the asymmetric effect of the external price shock from exchange rate (appreciation) to producer prices (decrease) in the short-run period. As a result, higher flexibility of the exchange rate pass-through in these countries reduces their vulnerability to the exogenous price shocks. At the same time, less dynamic response of producer prices in the most of the Eurozone member countries increase their exposure to the unexpected external price shocks. Crisis period clearly reduced absorption capabilities of NEER in PIGS countries, Cyprus, Ireland and Malta due to reduced responsiveness of their producer prices to the unexpected exchange rate shock. As a result, these countries experienced increased vulnerability to external price shocks due to reduced absorption capabilities of their NEER while absorption capabilities of NEER in the core countries generally improved and thus reduced their vulnerability to the external price shocks.

Summary of the response patterns to the unexpected positive NEER shock for the last component in the internal price chain, consumer prices, revealed mixed results. Most of the countries experienced lagged and moderate decrease in consumer prices followed by the exchange rate shock. However, combination of low NEER exposure to oil price shock and reduced responsiveness of consumer prices to the NEER shock mostly in less performing economies of the Euro Area intensifies the transmission of the external inflation pressures to domestic prices. As a result, negative external price shocks in the time of crises may operate as a vehicle of imported deflation and contribute to the domestic demand driven deflationary pressures in bad times. On the other hand, most of the remaining countries experiencing more dynamic NEER response to the oil price shock that together with increased responsiveness of consumer prices to the NEER shock reduced the effect of the exchange rate pass-through to domestic prices. Crisis period reduced vulnerability of both NEER and consumer prices to above mentioned unexpected structural shocks. As a result, exchange rate pass-through to domestic prices was

intensified due to crisis related effects reducing external price related absorption capabilities of NEER in the most of the Euro Area member countries.

Finally, analysis of the transmission of the price impulse initiated by the external price shock across the internal price chain revealed interesting implications of the heterogeneity problem in the Euro Area. In most of the Euro Area periphery and less performing countries we examined the pattern of small dynamics in import prices, higher dynamics in producer prices and even higher responsiveness of consumer prices followed by the positive NEER shock. Some sort of overreaction in the internal price chain indicates competitiveness issues in the less performing group of Euro Area member countries. However, while the crisis period mostly reduced the effect of overreaction across the internal price chain (except for the response patterns in import prices), reduced vulnerability of producer prices and consumer prices to the unexpected positive NEER shock clearly reduced absorption capabilities of the exchange rates mostly in the weaker part of the Euro Area resulting in their higher vulnerability to the external price shocks. At the same time, increased differences in response patterns between a) import prices (overreaction) and b) producer prices (reduced responsiveness) and consumer prices (reduced responsiveness) indicates distortionary effects of the crisis period on the price transmission mechanism across internal price chain.

Acknowledgement

This paper was written in connection with scientific project VEGA no. 1/0892/13 and VEGA no. 1/0994/15. Financial support from this Ministry of Education's scheme is also gratefully acknowledged.

References

ANDERTON, R. (2003) Extra-Euro Area Manufacturing Import Prices and Exchange Rate Pass-Through, [ECB Working Paper, no. 219], Frankfurt am Main, European Central Bank, 31 p.

BACCHETTA, P., VAN WINCOOP, E. (2002) Why Do Consumer Prices React Less than Import Prices to Exchange Rates? [NBER Working Paper, no. 9352], Cambridge, National Bureau of Economic Research, 26 p.

BARHOUMI, K. (2006) Differences in Long Run Exchange Rate Pass-Through into Import Prices in Developing Countries: An Empirical Investigation. *Economic Modelling*, 23(6): 926-951

BERGIN, P.R., FEENSTRA, R.C. (2007) Pass-through of Exchange Rates and Competition Between Floaters, [NBER Working Paper, no. 13620], Cambridge, National Bureau of Economic Research, 45 p.

BETTS, C., DEVEREUX, M. (2000) Exchange Rate Dynamics in a Model of Pricing-to-Market, *Journal of International Economics*, 50(1): 215-244

BURSTEIN, A., EICHENBAUM, M., REBELO, S. (2007) Modeling Exchange Rate Pass-Through after Large Devaluations, *Journal of Monetary Economics*, 54(2): 346-368

BUSSIÈRE, M. (2013) Exchange Rate Pass-through to Trade Prices: The Role of Nonlinearities and Asymmetries, *Oxford Bulletin of Economics and Statistics*, 75(5): 731-758.

BUSSIÈRE, M., PELTONEN, T. (2008) Exchange Rate Pass-Through in the Global Economy-The Role of Emerging Market Economies, [ECB Working Paper, no. 951], Frankfurt am Main, European Central Bank, 46 p.

CA' ZORZI, M., HAHN, E., SÁNCHEZ, M. (2007) Exchange Rate Pass-Through in Emerging Markets, [ECB Working Paper, no. 739], Frankfurt am Main, European Central Bank, 31 p.

CALVO, G., REINHART, C. (2002) Fear of Floating, *Quarterly Journal of Economics*, 117(2): 379-408

CAMPA, J.M., GOLDBERG, L.S. (2005) Exchange Rate Pass-Through to Import Prices, *Review of Economics and Statistics*, 87(4): 679-690

CAMPA, J.M., GOLDBERG, L.S., GONZÁLEZ-MÍNGUEZ, J.M. (2005) Exchange Rate Pass-Through to Import Prices in Euro Area, [NBER Working Paper, no. 11632], Cambridge, National Bureau of Economic Research, 49 p.

COOK, D., DEVEREUX, M.B. (2014) Exchange Rate Flexibility under Zero Level Bound, [FRB of Dallas, Working Paper no. 198], Dallas, Federal Reserve Bank of Dallas, 52 p.

CORSETTI, G., DEDOLA, L., LEDUC, S. (2008) High Exchange-Rate Volatility and Low Pass-Through in Business Cycle Models, *Journal of Monetary Economics*, 55(6): 1113-1128

CORTINHAS, C. (2007) Exchange Rate Pass-Through in ASEAN: Implications for the prospects of Monetary Integration in the Region, [NIPE Working Paper, no. 2.], Minho, Universidade do Minho, 31 p.

CHOUDHRI, E.U., FARUQEE, H., HAKURA, D.S. (2005) Explaining the Exchange Rate Pass-Through in Different Prices, *Journal of International Economics*, 65(2): 349-374

CHOUDHRI, E.U., HAKURA, D.S. (2012) The Exchange Rate Pass-Through to Import and Export Prices: The Role of Nominal Rigidities and Currency Choice, [IMF Working Paper, No. 226/2012], Washington D.C., International Monetary Fund, 34 p.

CHRISTENSEN, J.H.E., GILLAN, J.M. (2015) Does Quantitative Easing Affect Market Liquidity?, [FRB of San Francisco, Working Paper no. 26], San Francisco, Federal Reserve Bank of San Francisco, 55 p.

DE BANDT, O., BANERJEE, A., KOZLUK, T. (2007) Measuring Long Run Exchange Rate Pass-Through, *Economics: The Open-Access, Open-Assessment E-Journal*, 2(March): 36 p.

DEVEREUX, M.B., ENGEL, C. (2002) Exchange Rate Pass-Through, Exchange Rate Volatility, and Exchange Rate Disconnect, *Journal of Monetary Economics*, 49, 913-940

DEVEREUX, M.B., ENGEL, C., STORGAARD, P. (2004) Endogenous Pass-Through when Nominal Prices are Set in Advance, *Journal of International Economics*, 63(2): 263-291

DORNBUSCH, R. (1987) Exchange Rates and Prices, *American Economic Review*, 77(1): 93-106

ENGEL, C. (2000) Local-currency Pricing and the Choice of Exchange-rate Regime, *European Economic Review*, 44(8): 1449-1472

FAUST, J., ROGERS, J. (2003) Monetary Policy's Role in Exchange Rate Behavior, *Journal of Monetary Economics*, 50(7): 1403-1424

GAGNON, J.E., IHRIG, J. (2004) Monetary Policy and Exchange Rate Pass-Through, *International Journal of Finance and Economics*, 9(4): 315-338

GAULIER, G., LAHRÈCHE-RÉVIL, A., MÉJEAN, I. (2008) Exchange Rate Pass-through at the Product Level, *Canadian Journal of Economics*, 41(2): 425-449

GHOSH, A., WOLF, H. (2001), Imperfect Exchange Rate Pass-Through: Strategic Pricing and Menu Costs, [CESifo, *Working Paper* No. 436] Munich, CESifo, 27 p.

GOLDBERG, P., KNETTER, M. (1997) Goods Prices and Exchange Rates: What Have We Learned? *Journal of Economic Literature*, 35(3): 1243-1272

GUST, C., LEDUC, S. VIGFUSSON, R. (2010) Trade Integration, Competition, and the Decline in Exchange Rate Pass-Through, *Journal of Monetary Economics*, 57(3): 309-324

HAJEK J., HORVATH R. (2015) Exchange Rate Pass-Through in an Emerging Market: The Case of the Czech Republic, [IES Working Paper, no. 8/2015], Prague, Institute of Economic Studies, 25 p.

HAHN, E. (2003) Pass-Through of External Shocks to Euro Area Inflation, [ECB Working Paper, no. 243], Frankfurt am Main, European Central Bank, 57 p.

HETZEL, R.L. (2015) Should Greece Remain in the Eurozone?, [FRB of Richmond, Working Paper no. 15-04R], Richmond, Federal Reserve Bank of Richmond, 30 p.

KARDASZ, S.W., STOLLERY, K.R. (2001) Exchange Rate Pass-Through and Its Determinants in Canadian Manufacturing Industries, *The Canadian Journal of Economics*, 34(3): 719-738

KENNY, G., MCGETTIGAN, D. (1998) Exchange Rates and Import Prices for a Small Open Economy: The Case of Ireland, *Applied Economics*, 30(9): 1147-1155

KLEIN, M. (1990) Macroeconomic Aspects of Exchange Rate Pass-Through, *Journal of International Money and Finance*, 9(4): 376-387

LIAN, A., WANG, J. (2012) Exchange Rate Pass-through: Evidence Based on the Vector-Autoregression with Sign Restrictions, *Open Economies Review*, 23(2): 359-380

MCCARTHY J. (2007) Pass-through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies, Eastern Economic Journal, 33(4): 511-537

MENON, J. (1995) Exchange Rate Pass-Through, *Journal of Economic Surveys*, 9(2):

197-231

MIRDALA, R. (2013) Exchange Rate Pass-through to Domestic Prices under Different Exchange Rate Regimes, *Journal of Applied Economic Sciences*, 8(4): 466-489

MICOSSI, S. (2015) The Monetary Policy of the European Central Bank (2002-2015), [CEPS Special Report, no. 109], Brussels, Centre for European Policy Studies, 37 p.

OBSTFELD, M., ROGOFF, K. (1995) Exchange Rate Dynamics Redux, *Journal of Political Economy*, 103(3): 624-660

PARSLEY, D C., POPPER, H.A. (1998) Exchange Rates, Domestic Prices, and Central Bank Actions: Recent U.S. Experience, *Southern Economic Journal*, 64(4): 957-972

PEERSMAN, G. (2011) Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area, [ECB Working Paper, no. 1397], Frankfurt am Main, European Central Bank, 33 p.

SHAMBAUGH J (2008) A New Look at Pass-Through, *Journal of International Money and Finance*, 27(4): 560-591

SMETS, F., WOUTERS, R. (2002) Openness, Imperfect Exchange Rate Pass-Through and Monetary Policy, *Journal of Monetary Economics* 49(5): 947-81

TEAM OF THE WORKING GROUP ON ECONOMETRIC MODELLING OF THE ESCB (2012) Competitiveness and External Imbalances within The Euro Area, [ECB Working Paper, no. 139], Frankfurt am Main, European Central Bank, 74 p.

TAKATOSHI, I., SASAKI, Y.N., KIYOTAKA, S. (2005) Pass-Through of Exchange Rate Changes and Macroeconomic Shocks to Domestic Inflation in East Asian Countries, [RIETI Discussion Paper Series 05-E-020], 55 p.

TAKATOSHI, I., KIYOTAKA, S. (2006) Exchange Rate Changes and Inflation in Post-Crisis Asian Economies, [NBER Working Paper, no. 12395], Cambridge, National Bureau of Economic Research, 49 p.

TAKHTAMANOVA, Y.F. (2008) Understanding Changes in Exchange Rate Pass-Through, [Federal Reserve Bank of San Francisco Working Paper, no. 13.], San Francisco, 40 p.

TAYLOR, J.B. (2000) Low Inflation, Pass-Through, and the Pricing Power of Firms, *European Economic Review*, 44(7): 1389-1408

TOSHITAKA, S. (2006) Time-Varying Exchange Rate Pass-Through: Experiences of Some Industrial Countries, [BIS Working Paper, no. 202], Basel, Bank for International Settlements, 34 p.

WEHINGER, G.D. (2000) Causes of Inflation in Europe, the United States and Japan: Some Lessons for Maintaining Price Stability in the EMU from a Structural VAR Approach, *Empirica*, 27(1): 83-107

YANG, J.W. (1997) Exchange Rate Pass-Through in U.S. Manufacturing Industries, *The Review of Economics and Statistics*, 79(1): 95-104