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Exchange Rate Pass-Through to Domestic Prices in the European Transition Economies

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Abstract

Vulnerability of exchange rates to the external price shocks as well as their absorption capabilities represents one of the most discussed area in the fixed versus flexible exchange rate dilemma. Ability of exchange rates to serve as a traditional vehicle for a transmission of external shocks to domestic prices is affected by exchange rate arrangement adopted by monetary authorities. As a result, exchange rate volatility determines the overall dynamics of pass-through effects and associated absorption capability of exchange rate. Ability of exchange rates to transmit external (price) shocks to the national economy represents one of the most discussed areas relating to the current stage of the monetary integration in the European single market. The problem is even more crucial when examining crisis related redistributive effects. In the paper we analyze exchange rate pass-through to domestic prices in the European transition economies. We estimate VAR model to investigate (1) responsiveness of exchange rate to the exogenous price shock to examine the dynamics (volatility) in the exchange rate leading path followed by the unexpected oil price shock and (2) effect of the unexpected exchange rate shift to domestic price indexes to examine its distribution along the internal pricing chain. Our results indicate that there are different patterns of exchange rate pass-through to domestic prices according to the baseline period as well as the exchange rate regime diversity.

JEL-Classification: C32, E31, F41

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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).

Ability of the exchange rate to transfer external shocks to the national economy remains one of the most discussed areas relating to the current stage of the monetary integration process in the European single market. New European Union (EU) member countries that accepted the obligation to adopt euro have to consider many positive and negative aspects of the euro adoption especially in the view of time they need for the implementation of all necessary actions to be ready to give up their monetary sovereignty. We do not want to speculate about the approximate date of the future European Monetary Union (EMU) enlargement especially due to increased uncertainty of the economy agents in the time of the global financial and economic crisis that also worsen the macroeconomic stability in the EMU candidate countries as well as their ability to meet the Maastricht convergence criteria. On the other hand it is still convenient to analyze the wide spectrum of effects related to giving up the relative flexibility of the national exchange rates after the euro adoption. While the exchange rates of majority of the EMU candidate countries are strongly affected by the euro exchange rate development on the international markets there is still room for them to float partially reflecting changes in the domestic economic development.

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 exchange rate pass-through to domestic prices in the European transition economies. Approach we employed consists of two stages. In the first stage we investigate the responsiveness of exchange rate to the exogenous price shock to examine the dynamics (volatility) in the exchange rate leading path followed by the unexpected oil price shock. By doing so we investigate a capability of exchange rate 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 domestic price indexes to examine its distribution along the internal pricing chain (Choudhri, Faruqee and Hakura, 2005). Our results contribute to understand the key features of the exchange rate transmission of the external price shifts based inflation pressures across different domestic price measures. We estimate vector autoregression (VAR) model. True shocks are identified by the Cholesky decomposition of innovations. From employed VAR model we estimate (1) responses of exchange rates in each individual country to the positive one standard deviation oil price shock and (2) responses of different domestic price indexes to the positive one standard deviation exchange rate shock. To provide more rigorous insight into the problem of exchange rate pass-through to the domestic prices in countries with different exchange rate arrangements we estimate models for each particular country employing data for two subsequent periods 2000–2007 (pre-crisis period) and 2000–2014 (extended period). This approach should be helpful to examine specific features of external inflation pressures transmission to the domestic prices according to the differences in the exchange rate commitments of monetary authorities. We suggest that comparison of results for models with different time period is crucial to understand spurious effects of the economic crisis in both exchange rate responsiveness to the external price shocks as well as pass-through effects to different domestic price measures.

Following the introduction, in Section 2 we provide brief overview of exchange rate pass-through effect. The topic is then discussed from the prospective of the fixed versus flexible exchange rate dilemma to highlight its specific features under fixed and flexible exchange rate arrangements. In Section 3 we provide an overview of the exchange rate regime evolution in the European transition economies during the period of last two decades. In Section 4 we summarize the current empirical evidence about exchange rate pass-through. While the empirical evidence about exchange rate pass-through seems to be reach, comparison of relevant studies provides results for individual countries or group of countries that we can conventionally divide in three groups – advanced, advancing and emerging markets. However, recent studies provide mixed results according to the exchange rate regimes as a crucial initial assumption or are not even taken into the account. In Section 5 we provide a brief overview of the VAR model (recursive Cholesky decomposition is applied to identify structural shocks) that we employ to examine exchange rate pass-through to domestic prices in two stages. In Section 6 we discuss main results.

2 Exchange Rate Pass-through under Different Exchange Rate Arrangements

Responsiveness of exchange rates to external price shocks as well as their ability to serve as a traditional vehicle for a transmission of these shocks to domestic prices is affected by exchange rate arrangement adopted by monetary authorities. As a result, exchange rate volatility determines the overall dynamics of pass-through effects to domestic prices and associated absorption capability of exchange rate. Ability of exchange rates to transmit external (price) shocks to the national economy represents one of the most discussed areas relating to the current stage of the monetary integration in the European single market. The problem is even more crucial when examining crisis related redistributive effects associated with relative price changes.

Effects of the exchange rate volatility on inflation, as a part of the fixed versus flexible exchange rates dilemma, refer to relative changes in prices of exports and imports and associated price effects on the aggregate price level. Under fixed exchange rate arrangement, credible nominal anchor (i.e. sound foreign currency of a country with a low and stable inflation) provides very efficient tool in fighting high inflation while helping to stabilize inflation expectations. As a result, country with fixed exchange rate should experience successful periods of disinflation (provided that a decision to adopt fixed exchange rate originated from high inflation pressures). Ability of the country to achieve price stability (and maintain low inflation differentials) within a reasonable period of time seems to be crucial for fixed exchange rate sustainability. It seems that stable inflation expectations anchored by fixed exchange rate to credible foreign currency represent a crucial role for understanding price effects of the sudden exchange rate shifts. Exchange rate volatility under fixed exchange rate arrangement originated in anchoring foreign currency instability 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.

On the other hand, price stability in countries with flexible exchange rate arrangement obviously suffers even more in the short period due to absence of credible nominal anchor provided that the monetary policy strategy of the central bank is based on either inflation targeting or interest rate transmission channel. Low levels of inflation targeted by the monetary authority are obviously more sensitive to exogenous price shocks originated in the sudden and unexpected exchange rate shifts. Price effects of exchange rate volatility in countries with flexible exchange rate arrangements may be even strengthened by corresponding effects of real output or its components to unexpected movements of exchange rate on domestic price level as a part

of the exchange rate adjustment process. As a result, exchange rate fluctuations in countries with flexible exchange rate arrangements are usually associated with more intensive a durable adjustment in price level.

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).

Effects of exchange rate volatility on the price level in countries with different exchange rate regime may be even strengthened during the crisis period. Excessive price adjustments due to uncertainty and lower predictability of the exchange rate leading path under flexible exchange rate arrangement, regardless of the sources and intensity of exchange rate instability, reflects the absence of a nominal anchor to stabilize inflation expectations. At the same time, inflation expectations anchored by the credible foreign currency, provides more fundamentally appropriate framework to preserve and sustain price stability.

Exchange rate flexibility (i.e. exchange rate depreciation as a result of economic growth cool down) serves as a convenient vehicle for exchange rate based recovery (i.e. automatic adjustment process) through increased competitiveness of domestic production on markets home and abroad provided there are flexible adjustments to price incentives on the markets. On the other hand, exchange rates shifts (under fixed exchange rate regime) associated with volatility of main reference currency serving as the nominal anchor are usually not originated by changes in domestic economy (i.e. real output fluctuations during the business cycle turnovers in country with fixed exchange rate) and thus may act as unexpected and destabilizing shock reducing its price effects on demand. As a result we suggest that the exchange rate downward flexibility

may provide wide range of incentives stimulating overall demand and thus accelerate economic growth in the recession. Exchange rate rigidity under fixed exchange rate arrangement may stabilize exchange rate expectations with positive contributions to the overall macroeconomic stability. Sudden shifts in exchange rate of the reference currency may cause a fixed exchange rate of domestic currency to become volatile. Moreover, exchange rate based adjustments of real output will not work provided that price incentives may be associated with false signals and spurious effects on expected short-term exchange rate leading path.

3 Overview of Exchange Rate Regime Evolution in the European Transition Economies

Macroeconomic stability, fast recovery from deep and sudden transition shock and real output growth stimulation represents one of the most challenging objectives for the European transition economies in the early 1990s. Consistent choice as well as flexible adjustments of monetary policy framework and exchange rate regime accompanied key crucial economic policy decisions in this process. Associated changes in monetary-policy strategy reflected wide range of macroeconomic aspects underlying sustainability of appropriate exchange rate regime choice.

Among key determinants of the exchange rate regime choice in the European transition economies at the beginning of the 1990s we may consider an effort to regain macroeconomic stability, foreign exchange reserves requirements and availability, overall external economic (trade and financial) openness, etc. At the later stages of transition process we emphasize the role of massive foreign capital inflows, sustainability of real economic growth, institutional adjustments according to perspectives of ERM2 entry.

Initial transition shock followed by the sharp real output decline associated with intensive inflation pressures (caused by rapid exchange rate devaluations, price liberalization and deregulation, tax reforms, fiscal imbalances, etc.) emphasized a crucial importance of strong nominal anchor for monetary authorities in restoring a macroeconomic stability and confidence as well as positive expectations of economic agents. However immediate exchange rate based stabilization became an appropriate strategy only for countries with adequate foreign exchange reserves while being able to significantly reduce inflation pressures in adequate (short) time period to prevent undesired rapid overvaluation. As a result it seems to be convenient to divide the European transition economies in two groups (so called “peggers” and “floaters”) considering initial exchange rate regime framework.

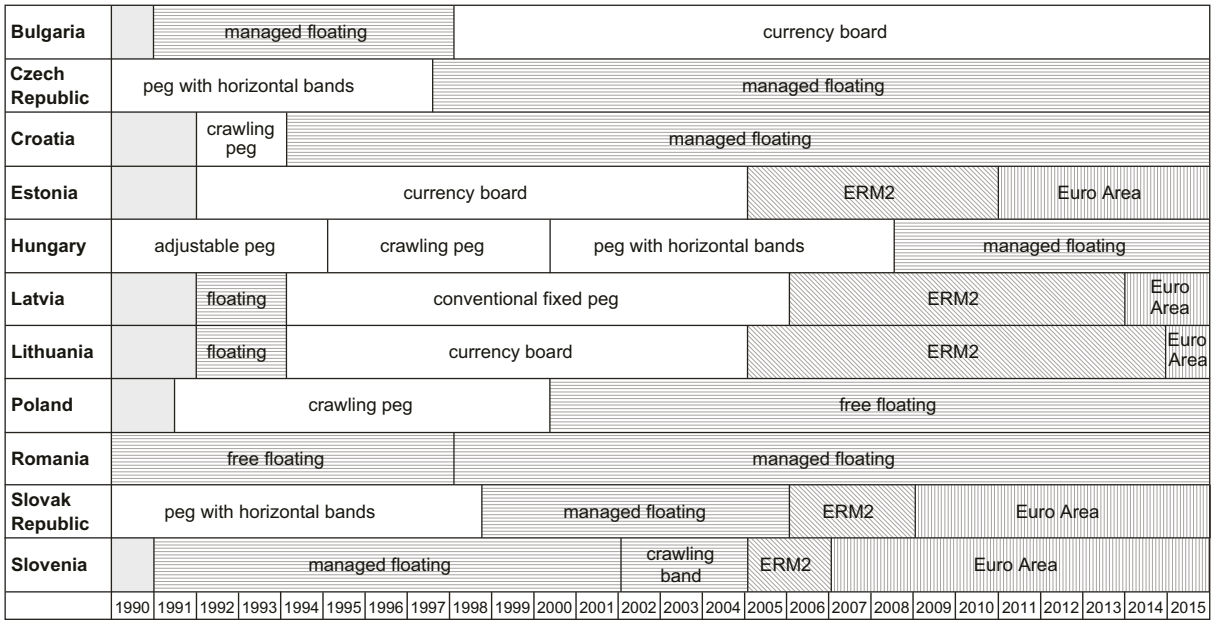
Relative diversity in exchange rate regimes in the European transition economies revealed uncertain and spurious conclusions about the exchange rate regime choice during the last two decades (Calvo and Reinhart, 2002). Moreover, Euro Area membership perspective (de jure pegging to euro) has highlighted uncertain consequences of the exchange rate regime switching especially in the countries with large economies and flexible exchange rate arrangements.

Successful anti-inflationary policy associated with stabilization of inflation expectations in the European transition economies at the end of 1990s significantly increased the role of short-term interest rates in the monetary policy strategies. At the same time, so called qualitative approach to the monetary policy decision-making performed in the low inflation environment,

gradually enhanced the role of real interest rates expectations in the process of nominal interest rates determination. However, economic crisis increased uncertainty on the markets and thus worsen expectations (inflation expectations including) of agents.

Eurozone member countries as well as global economy are currently exposed to the negative effects of the economic and debt crisis. To alleviate recession and support economic recovery, monetary authorities dramatically reduced key interest rates. Low interest rates together with quantitative easing, however, should not necessarily increase supply of loans due to prudential credit policy of commercial banks reflecting increased uncertainty on the markets. As a result, policy of low interest rates seems to be inefficient.

Table 1: Exchange Rate Regimes in the European Transition Economies



Note: Exchange rate regime evolution in the New EU member countries (based of IMF de jure classification): Bulgaria – since 1991 floating (pegged exchange rate regime undesirable due to possible low credibility), currency board since 1997 (after 1996 – 1997 financial crisis – public debt, bad commercial banks loans). Czech Republic – exchange rate pegged to currency basket with narrow but continuously widen horizontal bands, since May 1997 after currency attacks switch to managed floating with no predetermined path for the exchange rate with DEM (EUR) as reference currency. Croatia – crawling peg since March 1992 till October 1993, since October 1993 tightly managed floating with no predetermined path for the exchange rate with DEM (EUR) as reference currency. Estonia – currency board since 1992 till 2011 (euro adoption), plan to adopt in 2008 but delayed due high inflation, since 2011 Eurozone membership. Hungary – managed floating till February 1995, since March 1995 till the end of 1999 crawling peg with continuously decreased rate of periodical devaluation and widen horizontal bands, since January 2000 exchange rate pegged to euro combined with wide horizontal bands (since May 2001), since May 2008 managed floating with EUR as reference currency. Latvia – since February 1994 exchange rate pegged to SDR (fixing the exchange rate to a basket of currencies (SDR) instead of a single currency serves to promote long-term stability) (since January 2005 pegged to EUR), since 2014 Eurozone membership. Lithuania – since April 1994 currency board (exchange rate pegged to USD, in February 2002 pegging switched to EUR), since 2015 Eurozone membership. Poland – since the end of 1991 crawling peg with continuously decreased rate of periodical devaluation and widen horizontal bands, since April 2000 free floating. Romania – free floating, since 1998 exchange rate arrangement reclassified as managed floating. Slovak Republic – exchange rate pegged to currency basket with narrow but continuously widen horizontal bands, since October 1998 after currency attacks switch to managed floating with no predetermined path for the exchange rate with DEM (EUR) as reference currency, since 2009 Eurozone membership. Slovenia – managed floating with no predetermined path for the exchange rate (since February 2002 crawling band – the monetary authority manages the float of the domestic currency within certain fluctuating margins around a depreciating path – a heavily-managed crawling band with pragmatic monetary, real, external and financial indicators). ERM2 – June 2004 – Estonia (left in January 2011 after euro adoption), Lithuania (left in January 2015 after euro adoption), Slovenia (left in January 2007 after euro adoption); – May 2005 – Latvia (left in January 2014 after euro adoption); – November 2005 – Slovak Republic (left in January 2009 after euro adoption).

Source: IMF AREAER 1990-2014, author's processing.

Exchange rate policy evolution represents one of the key parts of crucial economic policy decisions at the beginning of the transition process in countries from the region of Central and Eastern Europe in the early 1990s. Despite its complexity and particularity there seems to be some similar features at the starting point of transition process in all European transition economies such as recession followed by initial transition shock and common vision of European union and Economic and Monetary union membership.

Macroeconomic stability as one of the primary objectives in the initial phase of the transition process affected exchange rate regime choice in the European transition economies. However, low credibility of monetary institutions, lack of foreign exchange reserves and high inflation differentials represented real constraints and difficulties related to the sustainability of pegged exchange rate regimes. Brief overview of the exchange rate regimes evolution in the European transition economies provides table 1.

The European transition economies did not follow common practice in the process of the exchange rate regime choice at the beginning of the 1990s. Small Baltic countries adopted currency board regime (Estonia and Lithuania) eventually conventional fixed peg regime (Latvia). Hungary adopted crawling peg regime (after few years of adjustable peg in place) together with Poland. Czech Republic and Slovak Republic adopted pegged regime with horizontal bands. Despite high inflation rates Bulgaria, Croatia, Romania and Slovenia adopted floating exchange rate regime due to low level of reserves and lack of credibility though Bulgaria switched to currency board after 1996–97 financial crisis. It seems to be clear that most of the European transition economies enjoyed disinflationary and credibility benefits of so called hard or soft exchange rate regimes (Frait and Komárek, 2001). Fixed exchange rates as the nominal anchor significantly contributed to the successful disinflationary process at the end of the 1990s.

Till the end of the decade many countries from the group switched to more flexible exchange rate regimes (Czech Republic in 1997, Slovak Republic in 1998 and Poland in 2000). Similarly Hungary switched to intermediate regime by widening horizontal bands. Although Hungary stacked to exchange rate pegged to euro, by employing wide horizontal bands de facto followed the same trend as previous group of countries.

Exchange rate regime choice also affected corresponding monetary policy strategy framework. Countries with exchange rate as nominal anchor (hard pegs or soft pegs with narrow horizontal bands) successfully implemented exchange rage targeting. Countries with soft pegs (pegs with wide horizontal bands or crawling pegs) and floating regimes employed monetary targets as intermediate criteria of monetary policy (monetary targeting).

Overall success of disinflationary process represents one of the key milestones on the road to stable macroeconomic environment with crucial role of low and stable inflation expectations. Low inflation combined with stable inflation expectations is considered to be a substantial condition for switching from quantitative (money supply) to qualitative (interest rates) approach in monetary policy decision-making. This adjustment in monetary policy strategies seems to be obvious in the European transition economies since the end of 1990s as a part of prevailing trend in weakening of relationship between money and inflation. Increased role of inflation expectations together with raising credibility of monetary authorities resulted in adoption of direct (explicit) inflation targeting strategy in many European transition economies – Czech Republic (1998), Poland (1999), Hungary (2001), Slovenia (2002), Romania (2005) and Slovak Republic (2005).

European transition economies challenged a decision of a euro adoption and Euro Area membership several years before the economic crisis arises (Hedija, 2013). Disputable policy implications of sacrificing monetary sovereignty had risen as a crucial assumption affecting the main features as well as durability of preparation phase timetable in countries with the flexible exchange rate regimes (Czech Republic, Croatia, Poland, Romania, Slovak Republic and Slovenia). Among a variety of determinants and aspects we emphasize the role of decisions inevitably associated with a "proper" scheduling of the Euro Area entry. Some countries from the group of new EU member countries already entered the Euro Area (Slovenia – 2007, Slovak Republic – 2009, Estonia – 2011, Latvia – 2014, Lithuania – 2015) followed by participation of their currencies in ERM2 (Estonia – June 2004, Lithuania – June 2004, Slovenia – June 2004, Latvia – May 2005, Slovak Republic – November 2005).

The loss from sacrificing exchange rates flexibility in the Eurozone candidate countries became directly confronted with benefits related to exchange rate stability associated with sacrificing monetary autonomy. Despite plausible advantages of pegging exchange rates of candidate countries to euro followed by the euro adoption it seems to be clear that risks associated with potential effects of breakdown in mutual interconnections between macroeconomic development and flexible exchange rates leading path seem to be of a minor interest in current empirical literature.

The economic theory provides clear suggestions in a fixed versus flexible exchange rates dilemma in terms of the exchange rate based adjustments in the external competitiveness as well as external and internal shocks absorption capabilities of the exchange rate. From the perspective of a macroeconomic stabilization, the costs or benefits of giving up the flexible exchange rate depends on the types of asymmetric shocks hitting the economy and the ability of the exchange rate to act as a shock absorber. Borghijs and Kuijs (2004) argue that flexible exchange rates are useful in absorbing asymmetric real shocks but unhelpful in the case of monetary and financial shocks.

Even before Euro Area establishment some authors (Bayoumi and Eichengreen, 1992) had argued that structural shocks are significantly idiosyncratic across EU countries suggesting difficulties in operating a monetary union. Moreover, the existing heterogeneity among Euro Area members operating under the fixed exchange rates is still being associated with the asynchronous real exchange rates adjustments based on price (wage) differentials affecting their equilibrium levels in the long-run (Égert, Halpern and MacDonald, 2005). Among the key lessons learned from the latest economic crisis is an increased dynamic in the real exchange rate volatility among the Euro Area member countries as well as non-member countries (Berka, Devereux and Engel, 2012) recognized as a side effect of waves of internal devaluations (Angelini, Dieppe and Pierluigi, 2015). Central banks and governments, especially under the fixed exchange rate anchor, may tend to internally devaluate currencies in times when a low interest rates policy associated with a quantitative easing does not provide correct and sufficient incentives to boost domestic demand. At the same time, incentives to increase external demand during the crisis period may start an unfavourable spiral of competitive devaluations. Finally, the crisis period has affected responsiveness patterns of the real exchange rates to underlying shocks in both Euro Area member and non-member countries (Grossmann, Love and Orlov, 2014). As a result, our motivation to examine the role of real exchange rates as a shock absorber or source of underlying shocks (Artis and Ehrman, 2000) under the fixed and flexible nominal exchange rates involves the effects of the crisis period as well.

4 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.

5 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 exchange rate pass-through to domestic prices in the European transition economies. 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.

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. 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 European transition economies 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:

$$AX_t = B(L)X_{t-1} + B\varepsilon_t \tag{1}$$

where X_t represents n x 1 a vector including endogenous variables of the model, $B(L)$ is a n x 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, each of A and B represent n x n matrices which coefficients will be specified later, ε_t is n x 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):

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

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

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

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

where $C(L)$ is the polynomial of matrices with coefficients representing the relationship among variables on lagged values and e_t is a n x 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):

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

Relationship between reduced-form VAR residuals (e_t) and structural shocks (ε_t) can be expressed as follows:

$$e_t = A^{-1} B \varepsilon_t \text{ or } A e_t = B \varepsilon_t \tag{5}$$

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:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} e_{y_r,t} \\ e_{m,t} \\ e_{p,t} \\ e_{ir_n,t} \\ e_{er_r,t} \\ e_{cu,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{y_r,t} \\ \varepsilon_{m,t} \\ \varepsilon_{p,t} \\ \varepsilon_{ir,t} \\ \varepsilon_{er_r,t} \\ \varepsilon_{cu,t} \end{bmatrix} \tag{6}$$

Correct identification of exogenous structural shocks reflecting Cholesky ordering of variables denotes following assumptions (Alexius and Post, 2005; Rogers, 1999):

- 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:

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

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 European transition economies. 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 exchange rate pass-through to the different domestic price indexes in the European transition economies.

Investigation of the exchange rate responsiveness to the unexpected exogenous price shock in countries with different exchange rate arrangements (“peggers” versus “floaters”) reveals substantial implications of exchange rate anchoring as well as rigorous commitment of monetary authority to maintain fixed exchange rate according to the exchange rate external shock absorption capabilities. Limited exchange rate volatility thus clearly reduces exchange rate exposure to the external price shock while it clearly simplifies its transmission to the domestic

prices. At the same time, external price shocks under flexible exchange rate arrangements should be followed by exchange rate appreciation. Exchange rate flexibility thus increases exchange rate exposure to the unexpected external shocks. Flexible adjustment in the exchange rate leading path thereby serves as shock absorber provided that it is associated with corresponding improvement (decrease) in the domestic price level and thus eliminates the negative effect of the external price shock. However, while the overall effect of the external price shock to the domestic prices may be neutralized, relative prices remain changed.

6 Data and Results

To investigate exchange rate pass-through to domestic prices in the European transition economies we employed monthly data for period 2000M1-2007M12 (model A) consisting of 96 observations and for period 2000M1-2014M12 (model B) consisting of 180 observations for the following endogenous variables – oil prices, nominal exchange rate (nominal effective exchange rate), money supply (monetary aggregate M2), industrial production[1] (nominal volume of the industrial product deflated by averaged PPI) and inflation (index of import prices, producer price index and consumer price index). Time series for all endogenous variables were collected from IMF database.

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. Tests of 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 (i.e. all eigenvalues of A have modulus less than one). As a result, if $\mathbf{X}_t$ has an invertible moving average representation, it also has a stable VAR structure. 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.

[1] Time series for monthly industrial production were employed due to absence of data on the same basis for real output (GDP).

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 ten European transition economies. 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.

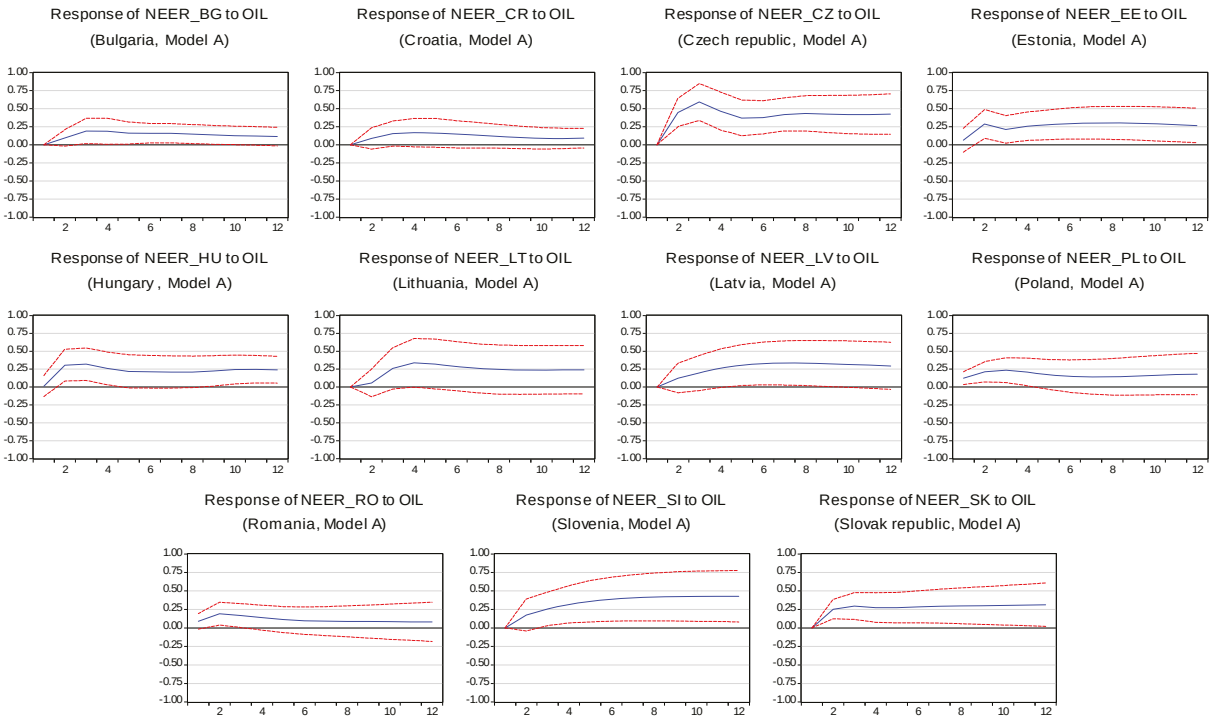
We also observe effects of the crisis period on the both exchange rate responses to oil price shock and domestic prices responses to the exchange rate shock in the European transition economies by comparing results for estimated models using time series for two different periods – model A (2000M1-2007M12) 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

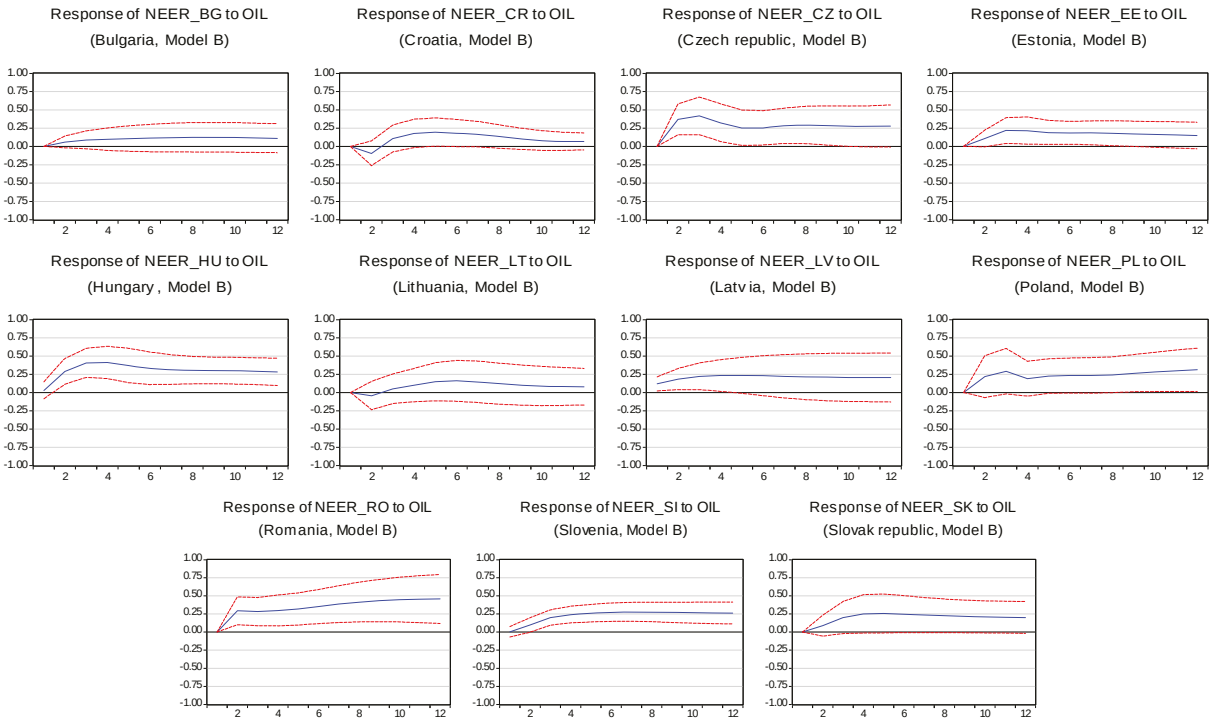
Investigation of the first stage in exchange rate pass-through includes estimation of exchange rates responses to the positive one standard deviation oil price shock employing monthly data for two subsequent periods 2000–2007 (model A) and 2000–2014 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

Figure 1: Responses of Exchange Rates to Oil Price Shock

(Model A) (2000M1-2007M12)



(Model B) (2000M1-2014M12)



Note: Curves represent responses (changes in percentage) of exchange rates (NEER) to the positive one standard deviation oil price (OIL) shock in each country from the group of the European transition economies. All shocks are standardized to one-percent shocks. Horizontal axis depict months.

Source: Author's calculation.

In the figure 1 we summarize results of impulse-response functions of the exchange rate to the positive (increase in) oil price shocks in both models in the European transition economies. Estimates of the exchange rate responsiveness to the Cholesky positive one standard deviation oil price shock revealed interesting implications of the exchange rate regime choice as well as particular role of the size of the economy in the model with time series for a pre-crisis period. 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 countries. Oil price shock caused a moderate and less dynamic increase in the exchange rate in countries ("peggers") with rigid exchange rate regimes. Positive effect of the shock culminated within first four months and then steadily died out. As a result, an exchange rate increase seems to be just a temporary and the overall effect of the oil price shock is neutral in the long-run period (its effect died out completely till the end of the third year since the shock).

Responses of exchange rates in countries ("floaters") with flexible exchange rate arrangements followed slightly different patterns. We observed more dynamic immediate response of exchange rates (except for Croatia). Appreciation of exchange rates seems to be also more persisting over time. As a result, the overall dynamics of the exchange rate response leading path in countries from the group of "floaters" was generally higher. At the same time, the positive effect of the oil price shock seems to be persisting and thus permanent in the long run (however, we found no long-run cointegrating relationship between both variables).

Exchange rate responsiveness to the external price (oil) shock in countries with large and less opened economies (Poland and Romania) seems be to less dynamic in comparison with the rest of countries from the group of "floaters".

Summary of results for exchange rate responses followed by the oil price shock in the model A revealed interesting implications of the exchange rate regime relevancy for examination of the first stage in exchange rate pass-through in the European transition economies. Our results confirmed expected lower vulnerability of exchange rates in countries with nominal exchange rate anchoring to the external price shocks.

Lower 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 exchange rate pass-through. Reduced exchange rate responsiveness to the external price shocks increases the transmission of the price effect to the domestic prices. As a result, exchange rates in countries with reduced exchange rate flexibility operate more as an external price shock transmitters. Imported inflation is clear implication of the exchange rate rigidity in such cases and it is also a contrary 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 countries with flexible exchange rate arrangements reduces the transmission of the price effect to the domestic prices and thus contributes to offset the expected inflation pressures originated in the negative external price shock. As a result, exchange rates in countries with exchange rate flexibility operate more as an external price shock absorber. Assumptions about expected transmission or absorption capabilities of exchange rates under different exchange rate arrangements will be comprehensively evaluated by assessing the second stage in exchange rate pass-through the various domestic price indexes.

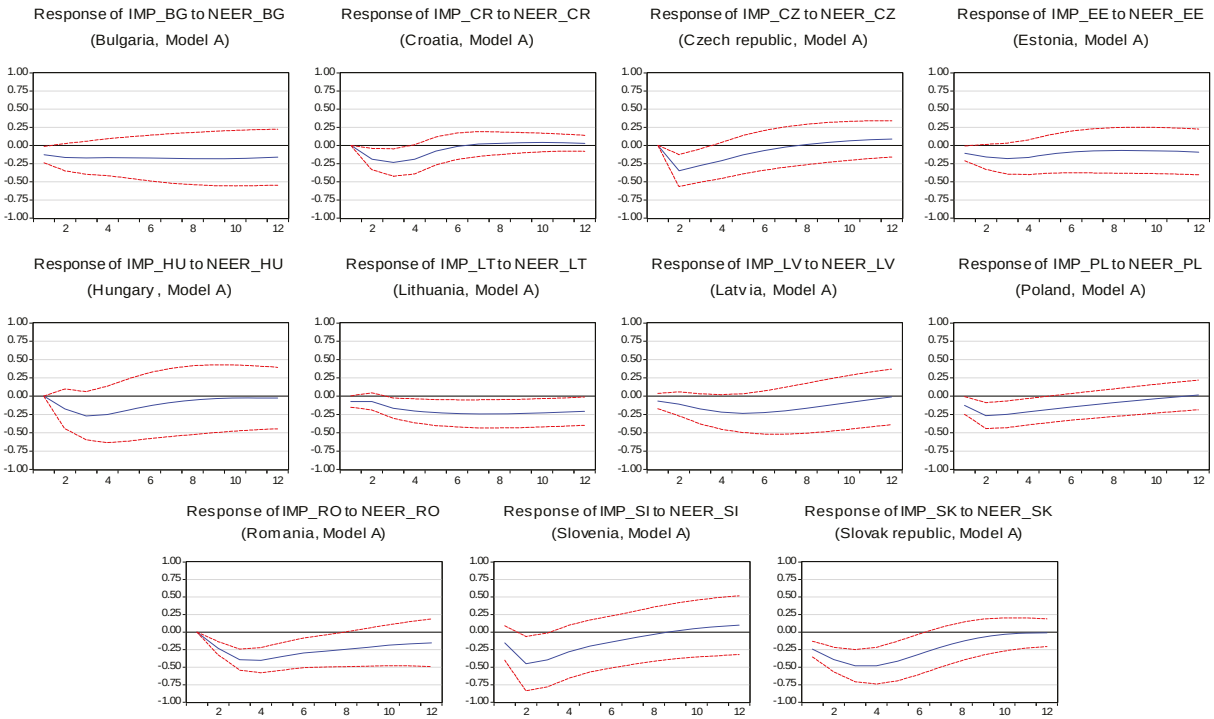
Crisis period affected short-term responsiveness of exchange rates to the positive one standard deviation oil price shock in both groups of countries. Examination of the loading phase in the exchange rate responses revealed slightly reduced immediate and short-term dynamics in the response patterns of exchange rates in countries with nominal exchange rate anchoring. Overall durability of the exchange rate appreciation followed by the oil price shock decreased too. It seems that the overall exposure of exchange rates in countries from the group of "peggers" to the unexpected external price shocks decreased during the crisis period. Reduced vulnerability of rigid exchange rate to the oil price shock intensifies the transmission of the inflation pressure to domestic prices.

Response patterns of exchange rates to oil price shock during the crisis period also changed in countries with flexible exchange rate arrangements. We observed a slight increase in the immediate exchange rate response in this group of countries. Permanent effect of the oil price shock to the long-run exchange rate leading path was also slightly intensified. However, we investigated a moderate decrease in immediate as well as long-term responsiveness of exchange rates in the Slovak republic and Slovenia. Both countries enjoyed effects of the euro adoption during the crisis period that seems to affect their nominal effective exchange rate responsiveness to the external price shock. As a result, the crisis period generally increased the overall exposure of exchange rates to the oil price shocks in countries from the group of "floaters". Ability of flexible exchange rate to offset external inflation pressure originated in the oil price shock during the crisis period rose suggesting its increased absorption capabilities. However, euro adoption in countries with former flexible exchange rate arrangements (the Slovak republic and Slovenia) clearly reduced exchange rate absorption capabilities revealing negative implications of the nominal exchange rate rigidity associated with the external inflation pressure transmission to the domestic prices.

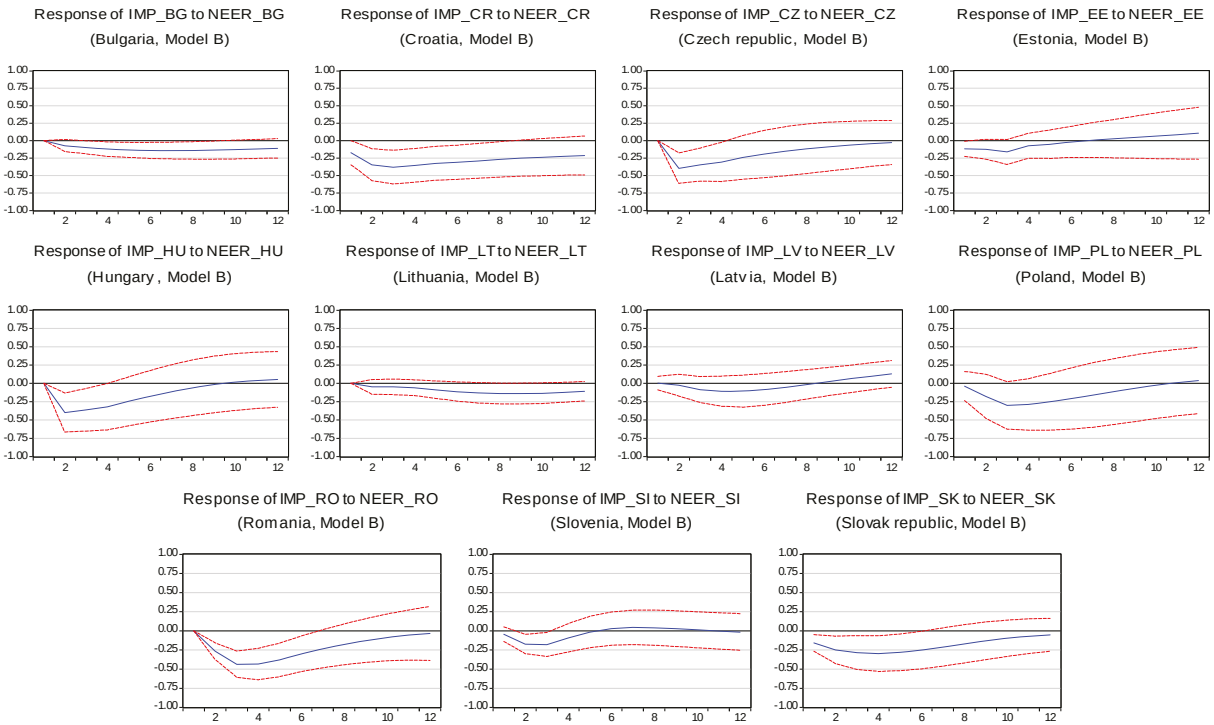
Investigation of the second stage in exchange rate pass-through includes estimation of (a) import prices responses to the positive one standard deviation exchange rate shock employing monthly data for two subsequent periods 2000–2007 (model A) and 2000–2014 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

Figure 2: Responses of Import Prices to Exchange Rate Shock

(Model A) (2000M1-2007M12)



(Model B) (2000M1-2014M12)



Note: Curves represent responses (changes in percentage) of import prices (IMP) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the European transition economies. All shocks are standardized to one-percent shocks. Horizontal axis depict months.

Source: Author's calculation.

In the figure 2 we summarize results of impulse-response functions of the import prices to the positive (increase in) exchange rate shocks in both models in the European transition economies. Unexpected exchange rate appreciation was followed by the drop in import prices though we have observed some different response patterns among individual countries. It seems that results are also sensitive to the exchange rate regime choice. In countries with pegged exchange rate regimes we have observed only moderate decrease in import prices followed by the positive one standard deviation exchange rate shock. At the same time, the initial loading phase of the import price divergence was fairly gradual though with a different intensity in each individual country. While the effect of the shock culminated within first four-six months in all countries from the group, its durability seems to be quite different. The length of the import prices path toward the pre-shock equilibrium lasted from eleven months (Latvia) till twenty months (Estonia) and nearly twenty four months (Bulgaria and Lithuania). In general, the overall effect of the exchange rate shock to the import prices was just a temporary, revealing its long-run neutrality in countries from the group of "peggers".

On the other hand, the leading path of import prices resulted from the positive one standard deviation exchange rate shock followed different response patterns in countries with flexible exchange rate arrangements. Immediate response of import prices in the group of "floaters" was clearly more dynamic in comparison with previous group of countries. Import prices response culminated within first three months since the shock. However, the dynamics of the convergence process of import prices toward the pre-shock equilibrium notably differs among countries. Due to observed differences in adjustment processes the overall effect of the exchange rate shock died out within eleventh and twentieth month since the shock revealing its long-run neutrality in the group of floaters too.

Summary of results for import prices responses followed by the oil price shock in the model A revealed interesting implications of the exchange rate regime relevancy for examination of the second stage in exchange rate pass-through in the European transition economies. Our results confirmed expected lower dynamics of the exchange rates pass-through effect to import prices in countries with rigid exchange rate regimes. At the same time it seems that exchange flexibility is a crucial assumption for more dynamic exchange rate pass-through to import prices.

Higher responsiveness of import prices to the exchange rate shock in countries with flexible exchange rate regimes reveals more dynamic exchange rate pass-through under volatile exchange rates. High degree of exchange rate pass-through to import prices contributes to offset inflationary effects of the external price shock provided high exchange rate vulnerability to this shock (see our results for the first stage in exchange rate pass-through). Volatility of exchange rate increases its price related absorption capabilities against negative inflationary effects originated in sudden external price shifts. On the other hand, low vulnerability of import prices to the exchange rate shock reduces absorption capabilities of exchange rate in situations when exchange rate volatility is caused by external price shocks.

Finally, the degree of the exchange rate pass-through and its price related effects to domestic price indexes should be examined according to the source of exchange rate volatility. Low exchange rate exposure to the external shocks under rigid (flexible) exchange rate arrangements contributes to domestic price (in)stability by reducing (accelerating) inflationary or disinflationary effects on domestic prices provided that the external source of the exchange rate volatility has non-price related origin (i.e. external supply or demand shocks). However, when the exchange rate volatility is caused by external price shocks (i.e. oil price shock) then the low (high) exchange rate exposure contributes to the transmission (absorption) of external price shock to import prices.

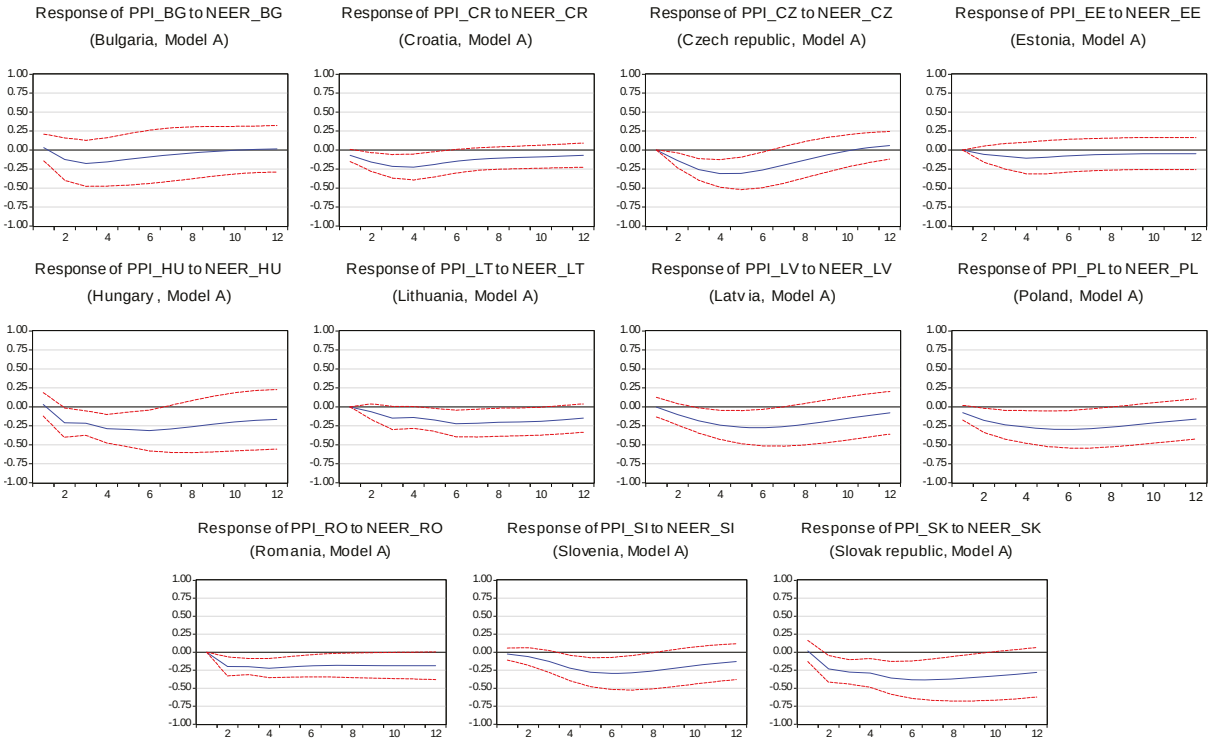
Crisis period affected responsiveness of import prices to the positive one standard deviation exchange rate shock in all countries. In general, the overall durability of the import prices convergence path toward the pre-shock equilibrium was reduced in all countries but Hungary while we observed some differences in the short-term vulnerability of import prices and associated dynamics in the import-prices responsiveness to the unexpected exchange rate shock. Immediate response of import prices in countries with pegged exchange rate regimes was reduced in all countries but Latvia (effect of the exchange rate shock in Latvia culminated earlier though its dynamics in the peak was comparable with pre-crisis levels). As a result, crisis period clearly reduced exchange rate pass-through in countries with nominal exchange rate anchoring and thus increased transmission of external price shock to import prices.

On the other hand, we observed an increase in the overall dynamics of the short-term response patterns of import prices in countries with flexible exchange rate arrangements. Increased responsiveness of import prices is clear especially in countries with higher external (trade) openness (Czech republic and Hungary). However, reduced exchange rate flexibility (due to euro adoption) decreased exposure of import prices to the unexpected exchange rate shock in the Slovak republic and Slovenia. Exchange rate flexibility seems to be a convenient vehicle to reduce distortionary effects of external price shock to import prices through the intensified pass-through effect. It seems that exchange rate regime shift toward pegged exchange rate (i.e. euro adoption) may have negative impact on the price stability when sudden shifts in exogenously determined exchange rate originates in negative external price shock that is easily transmitted into import prices due to reduced absorption capabilities of exchange rate. However, reduced transmission of external price shock (i.e. drop in oil prices) under flexible exchange rates in bad times (crisis period) may reduce its disinflationary effects and associated price related incentives for a demand driven recovery.

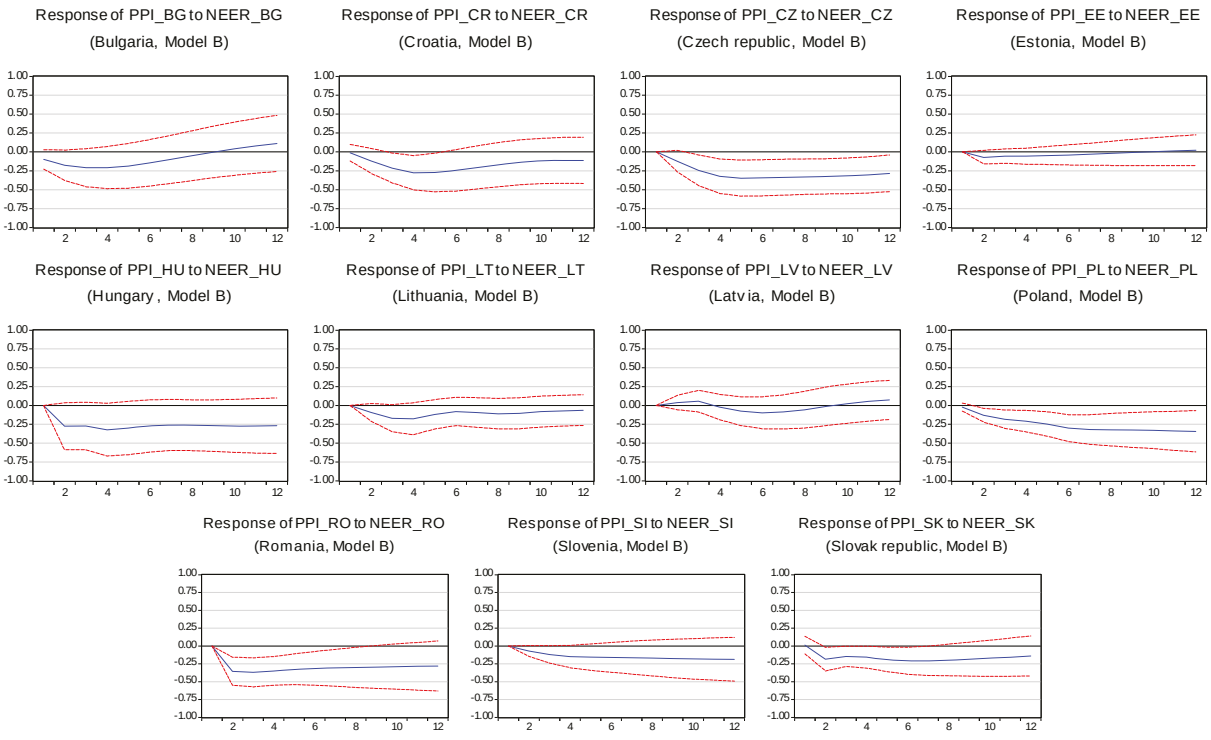
Investigation of the second stage in exchange rate pass-through includes estimation of (b) producer prices responses to the positive one standard deviation exchange rate shock employing monthly data for two subsequent periods 2000–2007 (model A) and 2000–2014 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

Figure 3: Responses of Producer Prices to Exchange Rate Shock

(Model A) (2000M1-2007M12)



(Model B) (2000M1-2014M12)



Note: Curves represent responses (changes in percentage) of producer prices (PPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the European transition economies. All shocks are standardized to one-percent shocks. Horizontal axis depict months.

Source: Author's calculation.

In the figure 3 we summarize results of impulse-response functions of the producer prices to the positive (increase in) exchange rate shocks in both models in the European transition economies. Exchange rate appreciation caused decrease in producer prices in all countries though we observed some differences in the response patterns between both groups of "peggers" and "floaters". Similarly to our results of the import prices responsiveness, responses of producer prices seem to be sensitive to the exchange rate regime diversity. Positive exchange rate shock was followed by a moderate decrease in producer prices in countries with nominal exchange rate anchoring. However, loading phase and dynamics of the producer prices immediate response seems to vary across individual countries. Least dynamic response of producer prices was observed in Estonia (effect of the shock culminated during the third month) while producer prices reacted with most dynamics in Latvia (effect of the shock culminated during the sixth month). Similarly different was the overall durability of the producer prices decrease followed by the exchange rate shock though the overall effect was just a temporary and thus neutral in the long run.

Leading path of producer prices followed by the exchange rate shock in countries with flexible exchange rate regimes followed different response patterns. General decreasing trend in the producer prices response seems to be more dynamic and culminated within first six months since the shock. In comparison with previous group of countries it seems that a decrease in producer prices was more durable though the overall effect of the exchange rate shock was generally neutral in the long-run.

Summary of results for producer prices responses followed by the exchange rate shock in the model for pre-crisis period revealed interesting implications of the exchange rate regime diversity for examination of the second stage in exchange rate pass-through along its pricing chain in the European transition economies. Our results confirmed expected lower dynamics of the exchange rates pass-through effect from import prices to producer prices in countries with nominal exchange rate anchoring. At the same time it seems that countries with flexible exchange rate arrangements experienced more dynamic and durable exchange rate pass-through to producer prices.

Crisis period affected responsiveness of producer prices to the positive one standard deviation exchange rate shock in all countries. In countries with pegged exchange rate regimes we observed a slight reduction in the loading phase as well as the overall dynamics of the producer prices responses. At the same time, the overall durability of the producer prices convergence path toward the pre-shock equilibrium was reduced in all countries from the group. As a result, crisis period reduced producer prices exposure to the exchange rate shock in the group of "peggers" that is why we suggest that the exchange rate pass-through in countries with nominal exchange rate anchoring decreased as well and thus increased transmission of external price shock to producer prices.

Response patterns of producer prices in countries with flexible exchange rate arrangements seem to be also affected by the crisis period. We observed increased dynamics in the initial load of the producer prices responses in most countries (especially in those with smaller and more opened economies). Moreover, the overall durability of the producer prices response path not only increased but the producer prices decrease became even permanent. However, we observed different response patterns of producer prices in countries from the group of "floaters" with reduced exchange rate flexibility during the crisis period. We suggest that euro adoption reduced durability of the producer prices response in the Slovak republic and the dynamics of the initial response in Slovenia. In both countries the overall effect of the exchange rate shock on producer prices seems to be just a temporary.

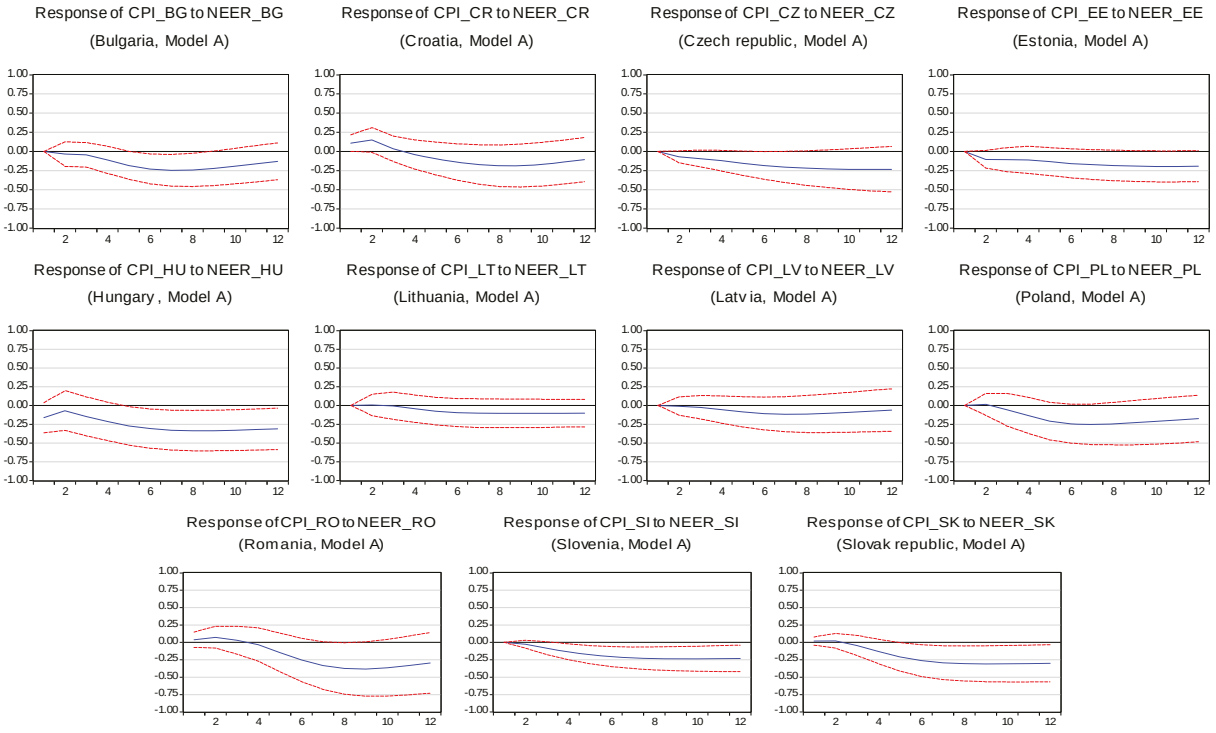
Examination of the exchange rate pass-through along the internal pricing chain in the group of "peggers" revealed slightly reduced extent of transmission of the exchange rate shock from import prices to producer prices. Initial load, intensity as well as durability of the producer prices response to the exchange rate shock were generally reduced. Crisis period clearly reduced the extent of transmission of exchange rate shock across these price indexes. As a results, decrease in the exchange rate pass-through reduced absorption capabilities of exchange rates in countries with rigid exchange rate arrangements.

Investigation of the exchange rate pass-through along the internal pricing chain in the group of "floaters" revealed reduced immediate intensity of price effect transmission from import prices to producer prices though the overall dynamics of the response remained mostly unchanged and the durability of the price effect clearly increased. Crisis period even identified key patterns in the internal pricing chain of the pass-through effect. Despite reduced immediate responsiveness, our results suggest an increasing dynamics in the medium-term exchange rate pass-through revealing (from import prices to producer prices) increased absorption capabilities of exchange rates in countries with flexible exchange rate arrangements.

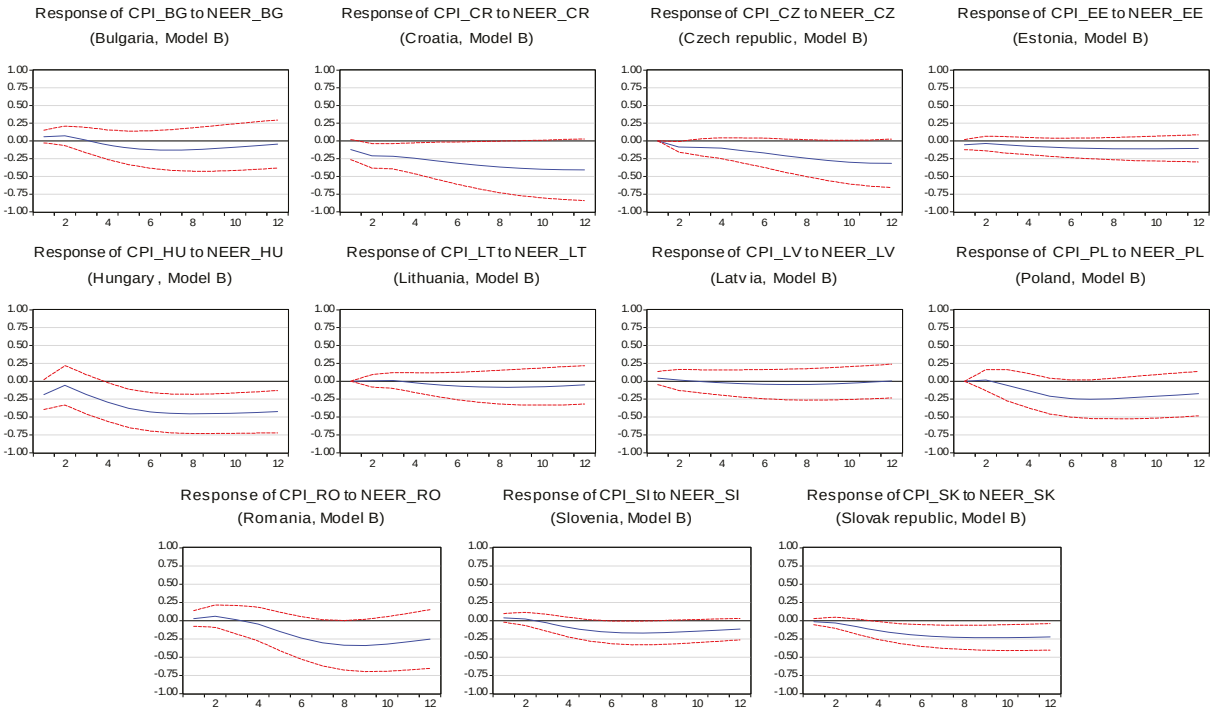
Investigation of the second stage in exchange rate pass-through includes estimation of (c) consumer prices responses to the positive one standard deviation exchange rate shock employing monthly data for two subsequent periods 2000–2007 (model A) and 2000–2014 (model B). Results seem to be sensitive to the exchange rate arrangements diversity in individual countries.

Figure 4: Responses of Consumer Prices to Exchange Rate Shock

(Model A) (2000M1-2007M12)



(Model B) (2000M1-2014M12)



Note: Curves represent responses (changes in percentage) of consumer prices (CPI) to the positive one standard deviation exchange rate (NEER) shock in each country from the group of the European transition economies. All shocks are standardized to one-percent shocks. Horizontal axis depict months.

Source: Author's calculation.

In the figure 4 we summarize results of impulse-response functions of the consumer prices to the positive (increase in) exchange rate shocks in both models in the European transition economies. Similarly to our results from the figure 4 we observed that the exchange rate appreciation was followed by a decrease in consumer prices in all countries though we observed some differences in the response patterns between both groups of "peggers" and "floaters". Here again we investigated some crucial implications of the exchange rate arrangement diversity on the consumer prices responsiveness. Positive exchange rate shock was followed by mostly lagged decrease in consumer prices in all countries though the length of the lag differs among individual countries. The overall dynamics as well as durability (from twelve to twenty months) of the consumer prices response in countries with pegged exchange rate regimes was generally lower.

Responsiveness of consumer prices to the unexpected exchange rate shock in countries from the group of "floaters" followed different patterns according to the dynamics and durability. While generally lagged, consumer prices response to the exchange rate shock in this group of countries was clearly more dynamic revealing higher medium-term exposure of consumer prices to the unexpected exchange rate shifts. At the same time, in most countries we observed permanent effect of the exchange rate shock to the consumer prices response path.

Summary of results for consumer prices responses followed by the exchange rate shock in the model for pre-crisis period revealed interesting implications of the exchange rate regime diversity for examination of the second stage in exchange rate pass-through along its pricing chain in the European transition economies. However, our results did not confirm expected decreasing trend in the exchange rates pass-through effect along the pricing chain (from producer prices to consumer prices) in both groups of countries. While a decrease in consumer prices followed by the exchange rate shock clearly lagged behind the drop in producer prices, its dynamics was higher in Bulgaria, Estonia and all countries from the group of "floaters" but lower in Lithuania and Latvia. At the same time, countries from both groups experienced more durable exchange rate pass-through to producer prices in comparison with producer prices.

Crisis period affected responsiveness of consumer prices to the positive one standard deviation exchange rate shock in countries from both groups. In countries with rigid exchange rate arrangements we observed a slight increase in the lag length of the consumer prices response as well as its reduced dynamics. Overall durability of the consumer prices convergence path toward the pre-shock equilibrium during the crisis period was reduced in all countries from the group of "peggers" but Bulgaria. As a result, crisis period reduced consumer prices vulnerability to the exchange rate shock in this group of countries that is why we suggest that the exchange rate pass-through in countries with nominal exchange rate anchoring decreased as well (with the exception of Bulgaria) and thus increased transmission of external (oil) price shock to consumer prices.

Response patterns of consumer prices in countries with flexible exchange rate regimes were also affected by the crisis period. While the length of the initial lag of the consumer prices response loading phase did not significantly change, we investigated clear increase in their medium-term responsiveness. Similarly we observed an increase in the durability of the consumer prices response path. However, similarly to our results from the figure 4 (impulse-response functions for producer prices) we observed different response patterns of consumer prices in countries from the group of "floaters" with reduced exchange rate flexibility during the crisis period. We suggest that euro adoption reduced durability of the consumer prices response in the Slovak republic and Slovenia. In both countries the overall effect of the exchange rate shock on producer prices seems to be just a temporary.

Investigation of the exchange rate pass-through along the internal pricing chain in the group of "peggers" provided mixed results. Despite generally lagged response of consumer prices to the unexpected exchange rate shock, its dynamics was higher in Bulgaria and Estonia but lower in Lithuania and Latvia. Exchange rate pass-through to consumer prices in fist two countries was intensified but in the last two countries reduced. Our results thus provide biased information about absorption capabilities of exchange rates in countries with rigid exchange rate arrangements according to the exchange rate pass-through to consumer prices.

Investigation of the exchange rate pass-through along the internal pricing chain in the group of "floaters" revealed lagged though generally more dynamic transmission of price effect from producer prices to consumer prices while the overall durability of the price effect clearly increased. Crisis period even identified crucial patterns in the internal pricing chain of the pass-through effect. Despite lagged overall responsiveness, our results highlight an increasing dynamics in the medium-term exchange rate pass-through (from producer prices to consumer prices) revealing increased absorption capabilities of exchange rates in countries with flexible exchange rate arrangements.

7 Conclusion

In the paper we have analyzed exchange rate pass-through to domestic prices in the European transition economies. We have employed a multivariate VAR model for each individual country 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. To meet the objective we have analyzed (1) a capability of exchange rate to transmit or absorb the external inflation pressure originated in the oil price shock to domestic prices followed by examination of (2) effects of the unexpected exchange rate shift to domestic price indexes to examine its distribution along the internal pricing chain. We suggest that our results contribute to understand the key features of the exchange rate transmission of the external price shifts based inflation pressures across different domestic price measures.

Our results confirmed expected lower vulnerability of exchange rates in countries with nominal exchange rate anchoring ("peggers") to the external price shocks (this effect was even strengthened during the crisis period). Reduced exchange rate responsiveness to the external price shocks increased the transmission of the price effect to the domestic prices. This idea was supported by investigated lower dynamics of the exchange rates pass-through effect to import prices and producer prices (though not to consumer prices) in countries with pegged exchange rate regimes in comparison with "floaters" (results for the crisis period mostly highlighted empirical results from the pre-crisis period). Intensity of the price effect along the internal pricing chain revealed its reduction from import prices to producer prices though results for consumer prices were mixed. As a result, exchange rates in countries with reduced exchange rate flexibility operated more as the external price shock transmitters.

On the other hand, higher and durable responsiveness of exchange rates to the oil price shock in countries with flexible exchange rate arrangements (this effect was even strengthened during the crisis period) reduced the transmission of the price effect to the domestic prices and thus contributes to offset the expected inflation pressures originated in the negative external price shock. This idea was supported by investigated higher dynamics of the exchange rates pass-through effect to import prices, producer prices as well as consumer prices in countries with flexible exchange rate regimes in comparison with "peggers" (results for the crisis period mostly highlighted empirical results from the pre-crisis period). Intensity of the price effect along the internal pricing chain revealed its reduction from import prices to producer prices though results for consumer prices revealed its increase. As a result, exchange rates in countries with exchange rate flexibility operated more as the external price shock absorber.

Low exchange rate exposure to the external shocks under rigid (flexible) exchange rate arrangements contributes to domestic price (in)stability by reducing (accelerating) inflationary or disinflationary effects on domestic prices provided that the external source of the exchange rate volatility has non-price related origin (i.e. external supply or demand shocks). However, when exchange rate volatility is caused by external price shocks (i.e. oil price shock) then the low (high) degree of exchange rate pass-through to import prices/producer prices/consumer prices contributes to the transmission (absorption) of external price shock to import prices/producer prices/consumer prices following the price shock distribution along the internal pricing chain.

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