Charles University in Prague

Faculty of Social Sciences
Institute of Economic Studies

MASTER THESIS

On the Role of Exogenous Shocks in the Great Recession: the Evidence from Belarus

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently, using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

Prague, July 31, 2014

Signature

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Abstract

In this thesis we provide evidence about the relative importance of foreign (Russian) and domestic monetary policy shocks for Belarusian economy. We employ a ten variable structural VAR model with block exogeneity and a set of dummy variables introduced to deal with instability of the data that corresponds to the periods of crises (2008 and 2011). We find that Belarus is significantly influenced by foreign shocks that account for 20 to 60 percent of fluctuations in domestic variables in the long run. The foreign demand and oil prices for Belarus are the main determinants of the domestic output and net export, while the foreign interest rate strongly affects Belarusian interest rate, money demand and the share of loans in GDP. Regarding the domestic monetary shocks, we find that the exchange rate is the most important channel in the Belarusian monetary transmission mechanism. We conclude that deeper trade integration with Russia could be beneficial for Belarusian economy, while in case of the monetary union creation the conduct of an independent monetary policy in Belarus could be further complicated.

JEL Classification	C13, C51, E52, F41
Keywords	SVAR, Small Open Economy, Monetary Policy Shocks, External Shocks

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Acronyms

BYR	Belarusian Ruble
CEE	Central and Eastern Europe
CIS	Community of Independent States
CPI	Consumer Price Index
CUSUM-SQ	Cumulative Sum Squared
EGLS	Empirical Generalized Least Squares
GDP	Gross Domestic Product
NEER	Nominal Effective Exchange Rate
NBRB	National Bank of the Republic of Belarus
SVAR	Structural Vector Autoregressive
TRAMO	Time Series Regression with ARIMA Noise, Missing Observations and Outliers
VECM	Vector Error Correction Model

Master Thesis Proposal

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Proposed Topic:

On The Role of Exogenous Shocks in The Great Recession: The Evidence from Belarus

Topic Characteristics:

Being one of the fastest growing economies in the CIS, Belarus experienced hardly noticeable effect of the global economic and financial crisis in 2008-2010. In 2011, however, the country fell into a deep recession: national currency was devalued by 187% over the year, annual inflation rate amounted to 108.7% (meaning a more than two-times prices increase), interest rate of the Central Bank rose from 12% to 45%. All these factors negatively influenced real wages and attractiveness of Belarus to foreign investors. A common explanation of the economic hardship was slow-down in the world economic activity in the crisis aftermath and increase in energy prices by Russia. At the same time Belarus had been experiencing long-lasting international trade imbalance, growing foreign debt, and boosted demand caused by expansionary monetary policy before the presidential elections of 2010, all of which, as many scholars argue, were the main reasons for economic recession.

Most of this topic related literature explores the shocks influence on transition EU economies, or groups of CIS countries, paying no attention to Belarus. In the paper we will analyze the relative importance of domestic and external shocks for the movements and volatility of current account balance, inflation, real exchange rate, real wages and GDP in Belarus. Vector autoregression (VAR) model will be employed for the estimation. Based on the results, we will explore and judge the ability of policymakers to apply particular tools for economic policy improvement.

Hypotheses:

1. Belarusian variables are more vulnerable to domestic shocks rather than to foreign shocks.

2. Vulnerability of domestic variables to shocks has changed in post-crisis period compared to the pre-crisis period (by crisis we mean Belarusian crisis of 2011).

3. Oil price shocks played important role in creating economic instability.

Methodology:

The effect of exogenous and endogenous shocks on Belarussian variables will be investigated by SVAR model consisting of foreign and domestic blocks. Impulse response and variance decomposition functions derived from the SVAR model will be used to assess the size and relative importance of foreign shocks. A vector of Belarusian variables will include GDP, measure of aggregate price level, short-term interest rate, money demand, loans-to-GDP ratio, exchange rate and net export. Vector of foreign variables in constrained model will be composed of GDP, oil prices and short-term interest rate. The stability of time series will be analyzed in order to choose a proper estimation method. The result obtained will be compared to theory expectation in order to draw policy conclusions.

Outline:

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1 Introduction

Being one of the fastest growing economies in the CIS, Belarus experienced hardly noticeable effect of the global economic and financial crisis in 2008-2010. In 2011, however, the country fell into a deep recession resulting in an almost triple devaluation of Belarusian ruble, a double prices growth, a significant increase of the Central Bank interest rate that reached its maximum over the last decade. All these factors negatively influenced real wages and attractiveness of Belarus to foreign investors.

Among the explanations to the economic hardship was negative influence of exogenous factors: slow-down in the world economic activity in the crisis aftermath and increase in energy prices by Russia. At the same time, Belarus had been experiencing long-lasting international trade imbalance, growing foreign debt, and boosted demand caused by expansionary monetary policy before the presidential elections of 2010, all of which might have played an important role in inducing the economic recession. Studying the relative importance of foreign and domestic shocks can help to determine to what extent each of them can explain the economic imbalances observed in Belarus during the last decade.

Belarus has signed an agreement on the Eurasian Economic Union creation with Russia and Kazakhstan that will take effect in 2015. Since Belarus is highly exposed to trade with Russia, studying the impact of Russian fluctuations on Belarusian aggregate variables may clear up whether the decision to further deepen the integration with this country is justified. In addition, it may help policymakers to react properly to unexpected shocks in the Russian economy.

Most of this topic related literature explores the foreign shocks influence on developed countries (Kim 2001, Giordani 2004, among others), or emerging economies (Jarociński 2008, Canova 2005, IMF 2014, etc.), paying no attention to Belarus. In the literature about Belarus researches mainly focused on studying the monetary policy transmission in the country using the standard VAR methodology (Kallaur et al. 2006, Horváth and Maino 2006). This thesis attempts to contribute to the discussion in the following ways. First, we apply a structural Vector Autoregression (SVAR) methodology that is very flexible as it can accommodate various relationships

among macroeconomic variables inferred from economic theory, which allows us to identify the foreign shocks and domestic monetary shocks. Second, we concentrate on establishing if there is any empirical evidence of foreign shocks importance for Belarus. We study the size and persistence of the foreign (in addition to domestic) shocks in Belarus, as well as their relative importance in explaining macroeconomic fluctuations in the country.

Our results provide evidence of an important role of external shocks in explaining domestic variables. Compared to the results presented in similar papers on small open economies, the foreign shocks appear to have a higher predicting power of output gap and a lower predicting power of prices in Belarus. The model estimation results also suggest that foreign interest rate shocks are important in predicting the changes of interest rate, money demand and loans over GDP ratio, while Russian demand and oil price shocks account for the largest share of variation in domestic output gap and net export.

The thesis is structured as follows: Chapter 2 reflects the relevant VAR literature. Chapter 3 briefly describes the evolution of the Belarusian policy framework and foreign shocks the country is vulnerable to. Chapter 4 presents the empirical methodology, identifies the shocks and interprets the dataset. Chapter 5 presents empirical results. Chapter 6 checks their robustness. Finally, Section 7 concludes by summarizing our findings.

2 Literature Review

The topical issue for policymakers in small open economies is how much of the macroeconomic variation originates abroad. Evidence on this issue can help to decide how closely to track external developments and which external variables should be included into the models.

The literature about small open economies shows that their economic activity and price movements greatly depend on the dynamics of large economies. We will first make contact with the literature on transition economies in Central and Eastern Europe (CEE). Many authors question the importance of foreign shocks on the aggregate output and price levels since these variables are of central importance in macroeconomics.

Maćkowiak (2005a) estimates a VAR model for the Czech Republic, Hungary and Poland using Bayesian inference. This methodology is especially attractive when dealing with the short periods of data typically available to macroeconomists, when classical methods become unreliable. A careful use of prior information alleviates the problem of over-parameterization and improves the quality of the inference. The author finds support that a sizable fraction of the macroeconomic variation in these countries is attributable to external shocks. The results also suggest that external interest rate shocks play an important role in the transmission mechanism: they explain 50-65% of variations in aggregate prices and more than 30% of variations in real aggregate output in the analyzed countries.

Krznar and Kunovac (2010) estimate a VAR model with block-exogenous restrictions to analyze responses of Croatian consumer and producer prices and GDP to domestic and external shocks. The effects of structural shocks are identified by means of Choleski decomposition. The authors find that changes in the world raw material prices and EU GDP account for the major part of volatility of the Croatian variables and that their effects are significant, unlike the effects of domestic variables. The main channels of external shocks transmission to Croatia are claimed to be the foreign trade channel and the foreign borrowings channel.

A particular attention is paid by researchers to the impact of monetary policy shocks on the CEE countries. Horváth and Rusnák (2008) investigate the impact of

euro area and domestic monetary policy shocks on Slovak economy. For this purpose the authors analyze a VAR model with block-exogeneity restrictions using Choleski decomposition for shocks identification. The foreign shocks appear to be the main source of Slovak price level fluctuations, while changes in Slovak output gap, interest rate and exchange rate are found to be explained mainly by domestic shocks. As for monetary shocks, the authors conclude that foreign interest rate changes explain around 20% of variance in Slovak price level and interest rate, whereas they play a minor role in explaining domestic output gap and exchange rate movements.

Jarociński (2008) compares impulse responses to monetary policy shocks before Euro adoption across the two regions – Central-Eastern and Western Europe. CEE countries are expected to be less affected by monetary policy shocks than Western European countries due to smaller financial systems relative to GDP and shorter track records of Central Banks of the former group. However, impulse responses of output to monetary policy shocks are found to be similar in the West and the East of Europe, while the uncertainty bands for price responses include the possibility of even stronger effects in CEE than in the Western Europe that disproves beliefs of lower efficiency of monetary policy in less financially developed countries.

Later, Jiménez-Rodríguez et al. (2010) investigate the influence of foreign variables on ten transition economies of the CEE. For each country of the study the authors used a VAR model that accounts for possible structural breaks in selected variables. In addition to monetary policy shocks, Jiménez-Rodríguez et al. analyze the role of other foreign shocks, such as commodity price shocks and supply side shocks coming from both the euro area and the US. The shocks are also identified through a standard Cholesky decomposition. The authors come up with results that are not always in line with expectations. A positive foreign supply shock leads to an expected significant increase in industrial production of all the countries, while real exchange rate depreciates, which is against theoretical predictions. A positive world prices shock, as expected, leads to an increase of domestic prices and interest rates, but it also causes an increase in output in 7 out of 10 countries, that is unexpected taking into account high dependence of the countries' industrial outputs on commodities inputs and a supposed decline in their competitiveness after such a shock.

These conclusions of high foreign shocks importance are in line with what other authors have found for emerging markets outside of Europe. Parrado (2001) employs a SVAR approach and concludes that foreign (US) and domestic monetary policy

account for a moderate fraction of domestic variables fluctuations. However, risk premium shocks are found to have significant influence on the domestic interest rate and exchange rate, which suggests that the Chilean economy is more sensitive to changes in emerging markets risks rather than to fluctuations in foreign interest rates.

Canova (2005) identifies the foreign shocks by applying sign restrictions. The author finds that US monetary shocks account for about 20%-50% of domestic variables changes in Latin American countries, while US real demand and supply shocks are found to cause little effect on the analyzed countries. Canova concludes that the interest rate channel is more important than the trade channel for transmission of US monetary disturbances in the analyzed countries. Interestingly, the countries with different exchange rate regimes display the same patterns of foreign monetary shocks transmission.

The estimates of Maćkowiak (2006) attribute to U.S. monetary policy shocks a less important role in fluctuations of East Asia and Latin America relative to other kinds of external shocks. The foreign shocks included in the model account for 50% of exchange rate and the price level change, and more than 30% of real output and interest rate fluctuations. The role of U.S. monetary shocks is limited to less than 10% of variations, although their effect on domestic variables is quick and significant.

The author comes to a different conclusion in his other research. Maćkowiak (2005b) assesses effects of Japanese monetary policy shocks on macroeconomic variation in East Asian transition economies and disproves the belief that expansionary monetary policy in Japan contributed to Asian crisis (no beggar-thy-neighbor effects caused by increase in Japanese interest rate are found). The contribution of Japanese monetary policy shocks to the variation in real GDP and trade balances of Japan's neighbors is found to be about 5% over the previous 40 years. Expansionary monetary policy shock is found to increase net exports of Japan's neighbors in the short-run.

Importance of foreign shocks for small open economies in the developed economies is also widely analyzed. Most researches find evidences that developed countries are as vulnerable to foreign disturbances as emerging markets. Buckle et al. (2002) estimate SVAR of the New Zealand economy to identify the influence of foreign and domestic shocks on it over the past 20 years. The authors found dominating influence of world output, world equities, world interest rates, import prices and export prices on New Zealand's economy. Giordani (2004) focuses on the responses of Canadian variables to the US technology, aggregate demand, consumer prices and

monetary policy shocks. The author finds a several cases of sizable effects of the US shocks: Canadian output reacts strongly on US technology and aggregate demand shocks, exchange rate variability is significantly influenced solely by US technology shocks, Canadian CPI is growing for a few quarters after the real exchange rate changes. In the long-term (after 4 years) the overall importance of the US shocks for Canadian variables is rather high: the mean estimate of exogenous shocks for variation of output is around 70%, for inflation, the interest rate and the exchange rate – around 40%, 60% and 55% after 4 years, respectively. These findings are in line with Cushman and Zha (1995) who found that 75% of Canadian output variations are caused by the foreign shocks. The authors point out the importance of the exchange rate channel in transmission of foreign and domestic monetary policy shock in Canada. Kim (2001), however, does not find support for the view that the spillover effects of US monetary policy shocks on the non-US G-7 countries are sizable.

Several papers have addressed some of the issues related to responses of Belarus to domestic monetary shocks. Kallaur et al. (2006) investigate monetary transmission in Belarusian economy in the period 1996-2004. The authors use several models with different endogenous variables included into them depending on the transmission mechanism under study. First, the authors analyze the credit channel and find it to be important in Belarusian monetary transmission: industrial production is found to be significantly affected by changes in money supply and the share of loans to monetary base. Next, the interest rate channel is analyzed and the industrial output is found to react significantly negatively to interest rate increase. The result appears to be unexpected in the light of undeveloped financial market in Belarus and credit market heavily regulated by the Government. The authors explore and find evidences that monetary transmission happens through changes in saving behavior of population in response to interest rate increase. Finally, the exchange rate channel is also found to be important: Belarusian ruble depreciation causes significant growth of prices and stimulates industrial production. Interestingly, none of the channels leads to significant output gap changes in Belarus, so policy conducted by the NBRB seems to have little effect on the Belarusian GDP. These findings are revised and confirmed by a more recent paper of Komkov and Abakumova (2011) who base their model on the period of 2003-2010. In contrast to the previous research the new model detects a significant effect of money demand on the GDP. This finding is attributed to the progress in the Belarusian financial system development that allowed to improve the monetary transmission to the real economy.

The contribution of this paper is the following. To our knowledge, apart from the mentioned papers, no other research addresses the influence of shocks on economic activity in Belarus. The mentioned literature sources deal primarily with monetary transmission in Belarus and do not explore the role of external factors in fluctuations of domestic variables. The findings of this thesis show that external shocks must be taken into account in domestic economy modelling.

3 The Evolution of Economic Policy Framework in Belarus

The path of transition from the centralized to the market economy makes Belarus different from other countries in the region. While market reform measures were undertaken, the economy remains highly regulated and under predominant state control.[1]

The overriding objective of the economic policies in Belarus is to achieve sustainable growth, while paying key attention to social stability. The main annual macroeconomic goals of the Government and the National Bank of the Republic of Belarus (NBRB) is to reduce the pace of inflation to a given target and to achieve annual GDP growth of a set rate. In this chapter we investigate the changes in the targets of monetary policy and exchange rate regime after the crisis of 2011 compared to the period preceding the crisis, as well as describe the foreign shocks Belarus is vulnerable to.

3.1 The Pre-2011 Belarusian Crisis Period

We start our analysis from the year 2004 – the beginning of the time of relative economic stability in Belarus: after the exchange rate unification the year-on-year CPI inflation declined from 360% in August 1999 (after the country was heavily hit by the Russian crisis) to 25% in December 2003 and continued stabilizing afterwards.

Much attention in policymaking in Belarus is paid to macroeconomic planning. Each year the targets for GDP growth, CPI, exchange rate, refinancing rate and some other indicators are set, and compliance to these targets represents the main task of the Government and the NBRB. In order to not to allow price level to grow higher the planned bounds, the monetary policy of Belarus until 2012 was characterized by multiple targets.

The first target was the exchange rate. After the NBRB shifted to a crawling band exchange rate system in 2000, the Belarusian ruble/Russian ruble exchange rate started to serve as the nominal anchor. After 2004, the national currency was fixed also

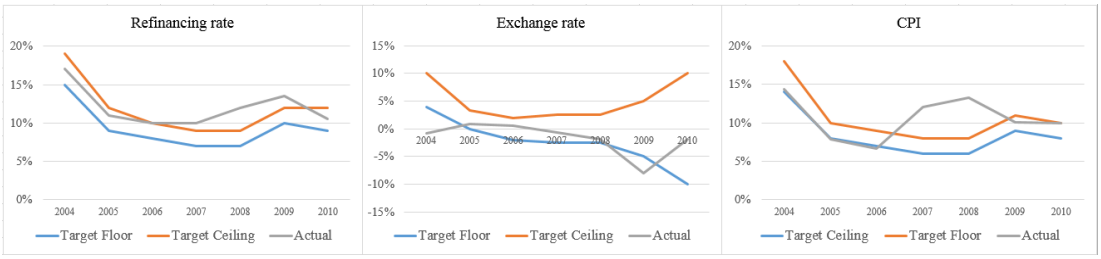
[1] The share of the private sector in GDP was not higher than 25-30% in 2003-2011.

against US dollar, and in 2009-2011 the Belarusian ruble exchange rate was fixed with respect to a basket of currencies: Euro, US dollar, and the Russian ruble. This change was explained by the significant share of US dollar and Euro in the domestic currency market and savings of households, as well as with high proportion of these currencies in foreign trade settlements. The exchange rate was allowed to fluctuate within a fixed corridor.

Another monetary policy target was the interest rate. The NBRB policy instrument is a 1-day interbank interest rate, which is controlled through the management of liquidity. This policy instrument is used to curb inflation and offset pressure on the exchange rate in order to sustain the fixed exchange rate regime.

Finally, among the tasks of the central bank and state-owned commercial banks[2] was the provision of subsidized loans to the governmental enterprises (quasi-fiscal operations).

Figure 3.1: Belarus monetary targets and actual developments in 2004-2010



Source: nbrb.by.

Figure 3.1 shows the targeted and actual refinancing rate, exchange rate and CPI in the period 2006-2010 (yearly data). Following the crisis started in 2008, the targets were increased. However, the exchange rate and refinance rate targets still have been missed in 2009. The CPI was above the target ceiling in 2007 and 2008.

Based on the targets described we assume that monetary policy influenced the Belarusian economy through the credit channel, exchange rate channel, and interest rate channel[3]. Identification of these channels is important for making decision on the variables to be included in our empirical model.

[2] Around 80% of the Belarusian banking system was owned by the state, and this share has remained the same by now.
[3] The same channels are identified in researches of Kallaur et al. (2006), Horváth and Maino (2006), Komkov and Abakumova (2011).

3.2 The Exchange Rate Crisis of 2011 and the Post-Crisis Period

The crisis started in March 2011 and was caused by expansionary wage and credit policies[4] that led to surge of demand on foreign currency due to growing imports[5]. Because of insufficient foreign reserves the authorities stopped intervening in the foreign exchange market and attempted to solve the problem of foreign currency deficit with the administrative measures[6]. This did not bring results due to high devaluation expectations and loss of credibility by the NBRB. There appeared big queues to the exchange offices and for the first time since the late 90's an unofficial exchange rate came along in Belarus. When the NBRB devalued the official exchange rate from about 3000 to 4500 Belarusian rubles per US dollar in May 2011, the exchange rate of the black market depreciated further to about 9000 Belarusian rubles per US dollar. In September there were two official exchange rates: the one set by the NBRB at which currency for gas and medical goods importers was available, and the market exchange rate (40-50% higher than the official one), formed at an additional session of the Currency Exchange, at which banks could trade foreign currency and sell it to/buy it from the population. It was only in November 2011 when the authorities managed to stabilize inflation and unify the exchange rate after the crisis.

The prices of goods produced from imported materials during the crisis were formed based on the exchange rate on a black market. Also, due to increased inflation and devaluation expectations[7], consumption of population in that period surged compared to the previous periods.

Unlike in the previous years, the only target of the monetary policy since 2012 has been to curb inflation[8]. The NBRB has paid special attention to the interest rate policy and to accumulation of foreign exchange reserves. The authorities claimed that credit emission would be based on the market principles. The hard peg exchange rate regime was changed to the managed floating regime with minimal interventions.

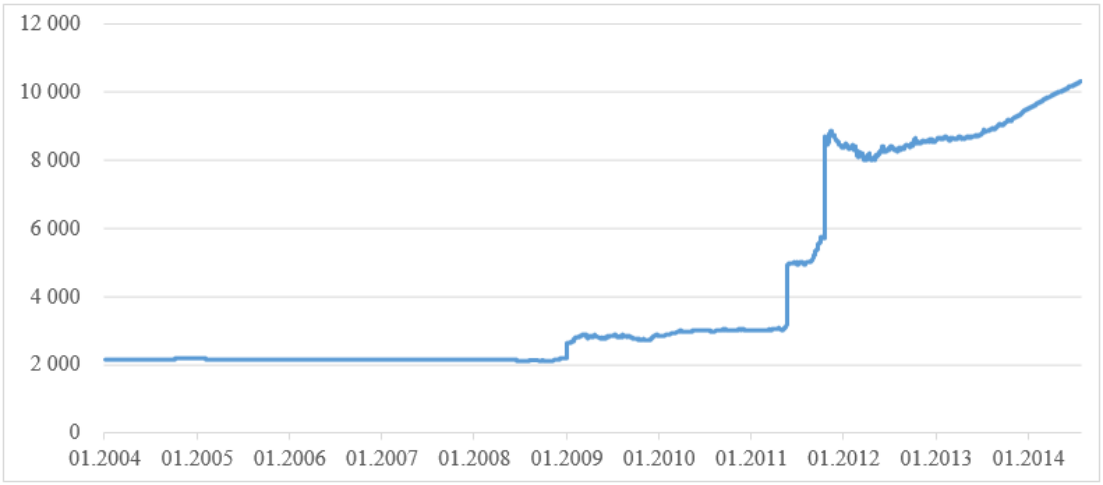
[4] The nominal wage was increased by 46% in 2010 to fulfil the promises before the presidential elections that took place on 19th December 2010.
[5] An additional import articles were foreign vehicles, demand on which surged after the decision to increase customs duties on the imported cars to Belarus from July 1, 2011 to make them equal in all member-states of the Customs Union.
[6] Among these measures were widening the range of exchange rate fluctuation from the official rate at the interbank market from ±2% to ±10%; launching an alternative session in the Currency Exchange where the exchange rate was allowed to be maximum 50% higher that the official one – this session was cancel a week later.
[7] Inflation in 2011 amounted to 108.7% (more than two-fold prices increase).
[8] Restrictive monetary policy was implemented: in the end of 2011 the NBRB increased the refinancing rate (till 45%), limited the supply on lombard auctions, and started to provide more expensive overnight credits.

Consistent with empirical research and conventional wisdom, the main benefit of having a flexible exchange rate is that it allows absorbing foreign and real shocks and, consequently, generates lower output and employment volatility.

However, according to the IMF staff conclusions (IMF country reports 2013, 2014), there are still large volumes of subsidized credit that increased by 35% for 9 months of 2013 compared to the same period of 2012. In addition, the Belarusian ruble depreciation rate is reported to be much slower than the growth of the inflation differential with key trading partners. Based on this development and keeping in mind the deteriorating current account deficit, the staff makes conclusion that the ruble may have become overvalued as in the pre-crisis period. The Belarusian authorities claim that a reduction in interventions could result in excessive volatility in the forex markets, that could lead to another crisis as the expectations of the general public are still shaped by the experience of the 2011 crisis. So, they prefer not to limit interventions.

With respect to this analysis, it seems that regardless the changes in the monetary policy targets stated in the official documents, the actual conduct of monetary policy has not changed much since the crisis of 2011.

Figure 3.2: USD/BYR nominal exchange rate, 2004:01-2014:07



Source: nbrb.by. Daily frequency.

The exchange rate control system after 2012 may be characterized as “dirty float” system, where the exchange rate is not solely determined by the market, but is actually determined by the monetary authorities. As the figure 3.2 evidences, the Belarusian ruble exchange rate was maintained within narrow bounds until mid-2013, after which it has been depreciated gradually (with almost a constant rate of 10 BYR per day).

3.3 On the Role of Foreign Shocks

In addition to domestic policies, Belarusian economy is affected by foreign shocks that policymakers do not directly control. Open economies are believed to be rather vulnerable to foreign shocks. We compare the trade openness of Belarus with the most and the least open economies, as well as with some of its peer CIS-countries.

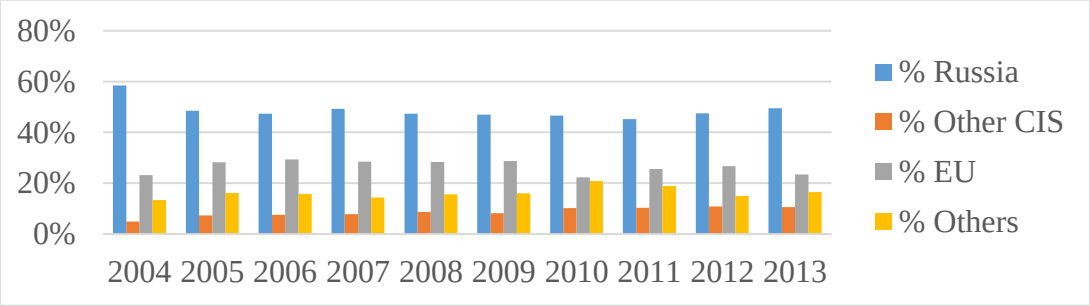
Table 3.1: Openness at constant prices (as of 01.01.2010)

	Country	Total trade as % of GDP
The most open economies		
1	Singapore	409.22
2	Hong Kong	398.18
3	Luxembourg	309.28
CIS countries		
42	Moldova	117.92
72	**Belarus**	**97.80**
113	Ukraine	76.19
125	Kazakhstan	69.58
163	Russia	49.27
The least open economies		
186	Cuba	29.69
187	Japan	29.31
188	United States	29.20

Source: Penn World Table 7.1 (http://research.stlouisfed.org/fred2/categories/33105/downloaddata).

As the data in Table 3.1 evidence, Belarus is in the middle of the list with its total trade being almost of the country's GDP size. So, we believe that the openness of the Belarusian economy contributes to a spillover of foreign GDP shocks onto domestic economic activity. Next we will look at the main trading partners of Belarus as the main source of foreign shocks transmission to Belarus is through the foreign trade. Trade with Russia amounts to about 50% of total trade each year (Figure 3.3). For this reason we analyze Russian shocks as foreign shocks.

Figure 3.3: Total foreign trade volumes of Belarus



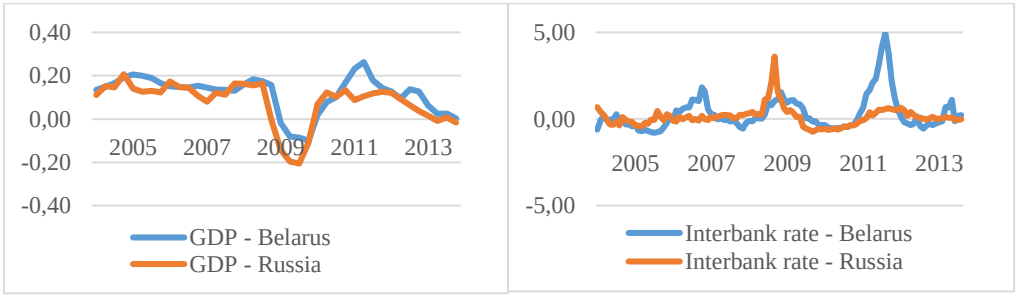
Source: belstat.gov.by.

The external demand shock can be identified by Russian output movements. Belarus enjoys strong integration of production chains with those of the Russian economy, as well as easy access to the Russian market. The boom in Russia is expected to cause a positive spillover effect on real output in Belarus and to create a powerful boost for Belarus's non-oil exports which were traditionally designed and produced for the Russian markets.

We also believe that Belarus is influenced by Russian interest rate shocks. Until 2005 monetary authorities aimed to reach convergence between the interest rates in Belarus and Russia as they targeted the exchange rate of currencies of these two countries. Later the Russian ruble was included in the currency basket against which the exchange rate was fixed. Moreover, due to significant share of debt to Russia[9], domestic variables are influenced by the price of foreign borrowing, which in turn depends on the Russian monetary policy and economic activity.

Figure 3.4 suggests that economic activity and interest rate movements in Belarus greatly depend on the dynamics of Russian economy; the correlation between quarterly GDP growth rates in Belarus and Russia is as high as 0.84, and the correlation between the monthly values of the interbank interest rates in the two countries is 0.4.

Figure 3.4: Real GDP of Belarus and Russia, Interbank Interest Rate of Belarus and Russia



Sources: nbrb.by, cbr.ru.

Finally, Belarus is subject to the oil price shocks with crude oil (supplied mainly by Russia) being equal to around 20% of the total Belarusian import. Until 2007, Belarus received oil from Russia at the price of internal Russian market, which was significantly below the world market price. Starting from December 2006, export duties on the oil sold to Belarus were imposed. In addition, export duties on the oil products exported outside the Customs Union are partially paid to Russian budget.

[9] In 2013 26% of public debt were Russian loans (http://www.rosbalt.ru/exussr/2013/02/20/1096546.html).

4 The Empirical Model and Estimation

This section will briefly explain the econometric methodology applied, the variables included into the model, the data used in the analysis, identifying assumptions and the estimation issues.

4.1 SVAR Model

Since the early eighties, the VAR models have become a standard tool for empirical analysis by macroeconomists. They are easy to use and do not require "incredible identification restrictions" (the often used phrase of Sims, 1980) to recover economic shocks from observables. Over the years, the development of structural VAR (SVAR) methodology further facilitated in handling problems concerning the identification of the contemporaneous and dynamic relationships between macroeconomic variables and the policy instruments. SVAR model is a multivariate, linear representation of a vector of observables on its own lags and (possibly) other variables as a trend or a constant. This methodology relates the observed movements in each of the variables to a set of innovations that have economic interpretation. SVARs have been used to document the effects of money on output (Sims and Zha, 2005), the effects of fiscal policy (Blanchard and Perotti, 2002; Ravnik and Žilić, 2010), among many other applications. Cushman and Zha (1996) find that the SVAR methodology produces better results that Choleski decomposition in identification of monetary policy shocks. We apply a SVAR model in order to investigate the influence of foreign and domestic shocks on Belarus imposing block exogeneity restrictions.

The relationships between the macroeconomic variables can be modelled by the following structural form of VAR model:

$$AY_t = A_0 + C(L)Y_{t-1} + \varepsilon_t, \tag{4.1}$$

where Y_t is an (N×1) vector of endogenous variables at time t, Y_{t-1} is an (N×1) vector of lagged endogenous variables, A is an (N×N) matrix of structural coefficients, A_0 is an (N×1) vector of constants, $C(L)$ is the polynomial shift operator L, and ε_t is an (N×1) multivariate white noise error process with the following properties:

$$E(\varepsilon_t) = 0, \qquad E(\varepsilon_t \varepsilon_\tau) = \begin{cases} \Sigma_\varepsilon & t = \tau, \\ 0 & otherwise. \end{cases} \tag{4.2}$$

Structural disturbances ε_t are uncorrelated, and the diagonal elements of the variance-covariance matrix Σ_ε are variances of ε_t.

Reduced form model (that can be easily estimated) is obtained by pre-multiplying the equation (4.1) by A^{-1}:

$$Y_t = v + D(L)Y_{t-1} + u_t, \tag{4.3}$$

where $v = A^{-1}A_0$, $D(L) = A^{-1}C(L)$, and $u_t = A^{-1}\varepsilon_t$. Innovation u_t do not have direct economic interpretation, $u_t \sim N(0, \Omega)$. The equations of the reduced VAR are estimated by empirical Generalized Least Squares (GLS) methods and residuals u_t are obtained.

However, it is impossible to obtain the structural from the reduced form and therefore the impulse response function has no meaningful economic interpretation, since reduced-form innovations u_t have no direct economic context as they are linear combinations of structural innovations.

To obtain the structural from a reduced form, it is necessary to impose exogenous constraints. Elements of matrix A are known if the instantaneous relation between structural and reduced innovations is known, while, knowing that $\varepsilon_t = Au_t$, it is possible to obtain information about the structural innovations. This model is known as the A model. Restrictions on the relationship among the parameters are valid only for the initial period, and later the effect is transmitted through the VAR depending on specification.

Assuming that u_t is the linear combination of ε_t, it is possible to orthogonalize the variance-covariance matrix of reduced shocks Σ_u, so $u_t = B\varepsilon_t$, $\Sigma_u = B\Sigma_\varepsilon B'$. Since structural disturbances ε_t are uncorrelated, it is possible to find a matrix B for which $\Sigma_u = BB'$. This model is known as the B model.

The SVAR methodology in this thesis is the AB model, as in Ravnik and Zilic (2010) and Borys and Horvath (2007), in which $Au_t = B\varepsilon_t$. The matrices A and B are constructed as follows in the general case:

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1N} \\ a_{21} & 1 & \cdots & a_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ a_{N1} & a_{N2} & \cdots & 1 \end{bmatrix}, \quad B = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & 0 & b_{NN} \end{bmatrix}. \tag{4.4}$$

The model requires (at least) $2N^2 - N(N+1)/2$ restrictions in total in both matrices to establish (over)identification conditions. The restrictions imposed on our model are described below (Subsection 4.3) following the description of variables included into the SVAR system (Subsection 4.2).

It is well-known that the shocks to small open economies have little impact on major foreign countries and therefore it is proper to treat the foreign variables as exogenous to domestic variables. To capture this phenomenon, we divide the SVAR system into foreign and domestic blocks. To describe the reduced VAR system for a small open economy, the set of variables Y_t is divided into two blocks as follows:

$$Y_t = (Y_{1,t}, Y_{2,t})' \tag{4.5}$$

where $Y_{1,t}$ represents the foreign block, while $Y_{2,t}$ represents the domestic block. The reduced-form VAR can then be represented as:

$$Y_t = \begin{bmatrix} Y_{1,t} \\ Y_{2,t} \end{bmatrix} \qquad B(L) = \begin{bmatrix} B_{11}(L)\ B_{12}(L) \\ B_{21}(L)\ B_{22}(L) \end{bmatrix} \qquad v_t = \begin{bmatrix} v_{1,t} \\ v_{2,t} \end{bmatrix} \tag{4.6}$$

The blocks $B_{11}(L)$ and $B_{12}(L)$ contain the coefficients that correspond to the foreign economy, while $B_{21}(L)$ and $B_{22}(L)$ contain the coefficients that correspond to domestic economy. The A_0 matrix from the structural VAR can be decomposed as:

$$A_0 = \begin{bmatrix} A_{0,11}\ A_{0,12} \\ A_{0,21}\ A_{0,22} \end{bmatrix} \tag{4.7}$$

It is assumed that the foreign variables in the Belarusian SVAR are predetermined and the domestic variables do not Granger cause the foreign variables. The block exogeneity can be imposed by excluding all domestic variable from the foreign block of equations both contemporaneously and in the lag structure of the reduced form model by using the following restrictions: $A_{0,12} = 0$ and $B_{12}(L) = 0$ respectively. Using the block exogeneity restrictions for a small open economy has a clear benefits as it allows for a larger set of international variables to be included into the model, while reducing the number of parameters to be estimated.

4.2 The Choice of Variables and Preliminary Data Analysis

This subsection describes the international and domestic variables to be included into the Belarusian SVAR model. The variables are summarized in Table 4.1.

Of the ten variables used in the model, three variables represent the foreign block. They are the foreign output (Y_{Ru}), the oil prices (P_{Ru}) and the foreign interest rate (R_{Ru}). The inclusion of foreign variables is essential for correct specification, improved identification of contemporaneous relationships and for capturing underlying impulse responses of variables to various shocks (Raghavan and Silvapulle, 2012). The mentioned variables are included to capture the close link between Russian and Belarusian economies. The price of oil is included to represent inflationary pressure.

The remaining five variables describe the Belarusian domestic economy. The Belarusian output gap (Y_{Be}) and the consumer price index (P_{Be}) are taken as the target variables of monetary policy and are known as non-policy variables as they do not react instantaneously to changes in the policy variables. The policy block is represented by interest rate (R_{Be}), money demand (MD_{Be}) and credit/GDP ratio (Cr/GDP_{Be}). The nominal exchange rate (EX_{Be}) is introduced to consider the effects of the identified monetary shocks on the value of the domestic currency. In addition to standard measures of economic activity, CPI inflation, policy variables and exchange rate, frequently used in the literature, we employ the net export ($NExp_{Be}$).

Table 4.1: Variables included in the Belarus SVAR system

Variable	Definition	Abbreviation
Foreign block		
Output	Output gap, obtained from Real GDP (base year 2003), s.a. by TRAMO, logs	Y_{Ru}
Oil Prices	Price of import oil for Belarus, $ per ton, logs	P_{Ru}
Interest Rate	Russia 3M Interbank Interest Rate, %	R_{Ru}
Domestic block		
Output	Output gap, obtained from Real GDP (base year 2003), s.a. by TRAMO, logs	Y_{Be}
Prices	Consumer Price Index, y-o-y %	P_{Be}
Interest Rate	1-day Interbank Interest Rate, %	R_{Be}
Money Demand	M1 Aggregate, y-o-y %	MD_{Be}
Credit/GDP	Share of loans in GDP, y-o-y %	Cr/GDP_{Be}
Exchange Rate	NEER, BYR per unit of foreign currency	EX_{Be}
Net Export	Net Export, $ mln	$NExp_{Be}$

As mentioned in subsection 3.1, the model contains observations from 2004 on. Our sample thus contains 120 observations and spans from 2004:1 to 2013:12. All the

data series used in the estimation are of monthly frequency to increase the number of variables included into the analysis. Borys and Horváth (2007) point to the usefulness of monthly data as opposed to quarterly data as the results obtained better correlate with economic theory.

The observations of Russian GDP are available on quarterly frequency only. The values are expressed in prices of 2008, in billions of Russian rubles. First, we used the time series to obtain the *Russian output gap* by applying the Hodrick-Prescott filter (the series was preliminary seasonally adjusted by TRAMO procedure), with the λ=1600. Next, we interpolated the series using quadratic match average procedure in Eviews.

Oil prices are logarithms of average monthly prices (in $ per ton) at which Belarus buys oil from all its importers.

Interest rates are Russian Three Month Interbank Rates, monthly data expressed in percentage points.

The output gap of Belarus is calculated using the same procedure as in Russian case. The difference is that the data were available on monthly frequency, so we applied the Hodrick-Prescott filter with λ=10,000 on seasonally adjusted logarithms of GDP preliminary calculated in prices of January 2003. *The prices* are calculated as year-on-year percentage change of Consumer Price Index.

Interest rate is 1-day Interbank interest rate in percentage points. We decided to use this proxy for the monetary policy instruments after investigating a pass-through from the NBRB refinancing rate to market interest rate (Table 4.2).

Table 4.2: Granger Causality – NBRB Refinancing Rate vs Interbank Rate

Null Hypothesis	Number of Observations	F-Statistic	Probability
Interbank rate does not Granger cause Refinancing rate	85	9.29	0.00
Refinancing rate does not Granger cause Interbank interest rate		0.20	0.82

We found that the Granger causality runs from the interbank rate to the refinancing rate, but not, as expected, the other way around (that corresponds to the finding of Horváth and Maino 2006 for the period 1995-2006). This result suggests that the NBRB adjusts the policy rate only with a lag, and can also be explained by interest rate control and underdeveloped financial market in Belarus.

Money supply is represented by M1 aggregate that includes notes in circulation and demand deposits nominated in Belarusian rubles. *Credit/GDP ratio* is calculated as a share of loans provided to all sectors of the economy in the nominal GDP. Only the loans nominated in Belarusian rubles are considered. The *exchange rate* is represented by the Index of the Nominal Effective Exchange Rate (NEER) (base year – 2005). This series is based on weighted averages of bilateral nominal exchange rate against major trading partners. Finally, *net export* is the difference of total export and total import expressed in $ mln.

The data for the Russian variables were taken from the Federal State Statistics Service. The data for Belarusian variables is obtained from the National Bank of the Republic of Belarus and the National Statistical Committee of the Republic of Belarus.

So, the two blocks of variables to be included into the SVAR system described in subsection 4.1 are:

$$Y_{1,t} = (Y_{Ru}, P_{Ru}, R_{Ru})' \tag{4.8}$$

$$Y_{2,t} = (Y_{Be}, P_{Be}, R_{Be}, MD_{Be}, Cr/GDP_{Be}, EX_{Be}, NExp_{Be})' \tag{4.9}$$

4.3 Domestic and Foreign Shocks Identification

The common approach in the literature to establish the identification of a SVAR model is to apply restrictions that are consistent with economic theory and prior empirical research findings. To establish the identification restrictions we use the results of Belarusian VAR studies and those of the SVAR studies of small open economies in transition.

In addition to foreign block exogeneity restrictions, the contemporaneous restrictions on the structural parameters are imposed (Table 4.3).

The motivation for imposing zeroes as constraints comes from the idea that there is a natural timing in the effect of economic shocks. There are no restrictions on the lagged structural parameters.

Table 4.3: Restrictions on the contemporaneous structure

Dependent variables	Explanatory variables									
	Y_{Ru}	P_{oil}	R_{Ru}	Y_{Be}	P_{Be}	R_{Be}	MD_{Be}	Cr/GDP_{Be}	EX_{Be}	$NExp_{Be}$
Y_{Ru}	1	0	0	0	0	0	0	0	0	0
P_{oil}	0	1	0	0	0	0	0	0	0	0
R_{Ru}	NA	0	1	0	0	0	0	0	0	0
Y_{Be}	0	NA	0	1	0	0	0	0	0	NA
P_{Be}	0	NA	0	NA	1	0	0	0	0	NA
R_{Be}	0	NA	NA	NA	NA	1	NA	0	0	0
MD_{Be}	0	0	0	NA	NA	NA	1	0	0	0
Cr/GDP_{Be}	0	0	0	NA	0	NA	0	1	0	0
EX_{Be}	0	NA	NA	NA	NA	NA	NA	0	1	0
$NExp_{Be}$	0	0	0	0	0	0	0	0	0	1

1. The foreign output is assumed to be completely exogenous to all the other variables in the model and affected only by its own lags.

2. Almost 100% of import oil comes from Russia, the oil prices are set by the agreements between the Russian and Belarussian Governments in the end of every year. So the oil price also does not depend on any domestic or foreign variable.

3. The foreign interest rate is assumed to be contemporaneously affected only by demand driven fluctuations in foreign output.

4. The domestic output is assumed to depend contemporaneously on the oil prices – a crucial input for most sectors of Belarusian economy. Also, following Cushman and Zha (1995) we assume contemporaneous effect of net export, as the arrival and departure of imports and exports may be related to overall output in the same period. Changes in monetary policy are assumed not to cause the firms to change their output immediately because of adjustment costs.

5. The domestic price level is affected contemporaneously by the oil price and the level of domestic economic activity. Some instantaneous price setting is also assumed to be influenced by net export.

6. The identification of domestic interest rate includes the oil prices, foreign interest rates, domestic output, prices and money. As the information about foreign interest rate and oil prices is available contemporaneously, innovations in these variables are included to the NBRB information set. The foreign interest rate is included to capture the foreign monetary policy influence, while the oil prices represent external inflationary pressure in the economy. The contemporaneous inclusion of

output and prices gives the reaction function a similar form of that of the Tailor rule identification. The monetary authority is assumed to see output and price when choosing the interest rate level which is an arguable assumption because GDP and CPI data are typically known only with a delay. Still, Christiano et al. (1998) claim that this assumption seems at least as plausible as assuming that GDP and CPI are not immediately at the central bank's disposal. The authors claim that the monetary authority does possess monthly data on aggregate employment, industrial output and other indicators of aggregate real economic activity, as well as it possesses substantial amounts of information regarding the price level. Finally, the monetary aggregate is included as a part of the transmission process. The information about M1 aggregate is available to the central bank from the reports of chartered banks.

7. Following E. Parrado (2001) we assume the usual money demand function. The demand for nominal money balances depends on income, price level, and the interest rate.

8. The share of loans in GDP is assumed to be influenced in the same period by economic activity and interest rate.

9. Exchange rate is usually assumed to describe the financial market equilibrium and to be contemporaneously affected by all the variables in the system. In case of Belarus the exchange rate is subject to regulation, and we assume it to be influenced contemporaneously by some variables that are included into the money supply equation.

10. We consider the net export to be immediately influenced neither by economic activity and prices, nor by the exchange rate, reflecting trade contracts and advance production planning.

4.4 Estimations Issues

Before analyzing the model, we take a closer look at the variables. We start with the analysis of stationarity. Table 4.4 shows the results of the Augmented Dickey-Fuller test checking the presence of a unit root in variables included in the estimated SVAR. The length of the time lag in the test has been selected according to the Akaike criterion. The results obtained confirm the presence of a unit root at levels in most variables. From the plots in Appendix A.1 we can observe that the time series reflect

increased instability in 2008 and 2011 corresponding to the World Economic and Belarusian crises respectively.

Table 4.4: Unit root tests for variables at levels

	Based on Akaike Criterion		Based on Schwarz Criterion	
Variable	**ADF statistic**	**ADF p-value**	**ADF statistic**	**ADF p-value**
Y_{Ru}	-3.03	0.03	-3.03	0.03
P_{oil}	-2.62	0.09	-2.97	0.04
R_{Ru}	-2.54	0.10	-2.96	0.04
Y_{Be}	-2.28	0.18	-2.28	0.18
P_{Be}	-1.95	0.30	-3.81	0.00
R_{Be}	-1.71	0.42	-2.34	0.16
MD_{Be}	-1.56	0.49	-1.61	0.48
Cr/GDP_{Be}	-1.14	0.69	-1.27	0.64
EX_{Be}	0.05	0.96	0.05	0.96
$NExp_{Be}$	-2.75	0.07	-4.54	0.00

Source: results from EViews. The test critical values are: -3.49 for 1% level, -2.89 for 5% level, -2.58 for 10% level. Null hypothesis: the time series has a unit root.

Estimation of a VAR model in levels of series that exhibit unit-root properties increases the risk of drawing invalid statistical inference due to the non-standard distributions of the estimated coefficients. On the other hands, estimation of a model in the first differences of such variables increases the risk of losing important information contained in the levels (such as the possibility of cointegrating relationships).[10] Given that our sample is short and that the focus of this thesis is on the short-term spillover effects of external shocks on domestic variables, we prefer to estimate a VAR model. The model is estimated in levels not to run the risk of losing important information concerning the co-movements in data.

A VAR model containing 10 variables and a constant (to capture the mean of the process) was first estimated on the full sample (January 2004 – December 2013). To determine the number of lags to be included, a number of criteria could be used. We set the maximum lag order equal to 8 and receive different optimal number of lags (from 1 to 8) calculated by applied criteria. We should take into account that choosing the VAR order unnecessarily large could reduce the forecast precision of the model and the estimation precision of the impulse response. So, the principle followed by us

[10] The appropriate way to estimate a VAR model containing non-stationary variables is the Vector Error Correction Model (VECM) that requires a large number of observations in order to analyze the long-term connections between variables.

is to include just enough lags so that the residuals of the model are not autocorrelated. We estimated the model using different number of lags and using the Portmanteau test we found that a model with lag number equal to 3 has no autocorrelation in residuals up to 12 lags meaning that the estimators from the model will be consistent.

Additionally we carry out stability tests as we expect the breaks in some of the series caused by the crises. In case a break exists, the VAR will estimate a relationship that holds on average that may be quite different from the true relationship, that leads to poor forecasts. We used CUSUM and CUSUM-SQ tests that are derived from the recursive residuals. From the plots of Appendix A.2 we conclude that foreign variables and domestic output gap become unstable in 2008-2009, and for all the domestic variables CUSUM statistics noticeably departs from zero after 2011. The CUSUM squared statistics strays out the 95% confidence band for almost all of the cases that allows us to reject the null of model parameter stability.

The structural break points are captured by dummy variables, that indicate the change in dependent variables that could not be explained by the variables included in the model.

First, we need to account for output gap and interest rate instability in Russia that was caused by sharply declining export earnings from energy and metals and accelerating capital flight during the world economic crisis. Additionally, the situation in Russian economy and the world oil prices influenced the prices of oil for Belarus. So we introduce the first dummy – *D_Russia* – for the period from *July 2008 until June 2009* into all equations. We refer to this period as to the period of crisis in Russin based on the OECD statistical database, according to which the quarterly GDP growth in Russia in period was negative.

Second, Belarusian variables seem to be greatly affected by exchange crisis of 2011. As described in subsection 3.2, in this period economic development was characterised by high inflation and devaluation expectations, foreign currency deficit and existence of multiplicity of exchange rates with the official one, included in the model, having almost no influence on the economy. So, we include the second dummy – *D_Belarus* – for the period *from March 2011 until January 2012* in all the equation. The start of the period corresponds to the inflation acceleration and multiplicity of exchange rates. The ending month of the period suggests the end of the most dramatic phase of the crisis, when the rate of inflation and policy instrument started to decline.

Finally, we use a dummy for the exchange rate to reflect the permanent shift caused by sharp depreciation. The period for *D_NEER* is from *March 2011 until December 2013*.

Table 4.5 shows the dummy variables included into the SVAR model. We excluded *D_Belarus* dummies from the equations of the foreign block, as the estimated coefficients were found insignificant. However, we believe that the world economic crisis did influence Belarusian economy as well, so we include *D_Russia* dummies in both blocks (some of the estimated coefficients appear to be significant). *D_NEER* appears only in the equation of the exchange rate to reflect the shift caused by domestic currency devaluaion.[11] Since a number of zero restrictions are applied on the coefficients, the reduced-form VAR model is estimated by EGLS. The estimation was carried out using JMulTi.

Table 4.5: Choice of dummies

Equations	D_Russia	D_Belarus	D_NEER
Y_{Ru}	X		
P_{oil}	X		
R_{Ru}	X		
Y_{Be}	X	X	
P_{Be}	X	X	
R_{Be}	X	X	
M_{Be}	X	X	
Cr/GDP_{Be}	X	X	
EX_{Be}	X		X
$NExp_{Be}$	X	X	

Note: cells marked with "X" indicate inclusion of the corresponding dummy variable.

Based on CUSUM tests (Appendix A.2) we conclude that stability improved for most of the equations. Signs of all the coefficients are as expected (Table 4.6).

[11] Other combinations of dummy variables have been tried to assess robustness of the results. In particular, both D_Belarus and D_NEER have been included into the block of the domestic economy. However, the results were practically the same, so we opted for a specification with more restrictions to decrease the degrees of freedom of estimated model. The results of the alternative models are available upon request.

Table 4.6: Coefficients of dummies

Equations	D_Russia	D_Belarus	D_NEER
Y_{Ru}	-0.005**		
P_{oil}	-0.085*		
R_{Ru}	2.246***		
Y_{Be}	-0.004	-0.005	
P_{Be}	0.020*	0.098***	
R_{Be}	0.012	0.115	
M_{Be}	-0.018	0.019**	
Cr/GDP_{Be}	0.044	-0.049*	
EX_{Be}	0.015		0.225***
$NExp_{Be}$	-415.891***	296.752**	

Source: JMulti output. *, **, *** indicate that coefficients are significant at the 10, 5, and 1 percent levels, respectively.

The coefficients show, that output gaps both in Russia and Belarus were lower during the crises periods, while interbank interest rates were higher. Price of oil decreased in 2008 following the world oil prices decline. Prices in Belarus were higher during both crisis periods compared to non-crisis periods with a bigger increase during 2011. Money demand increased in 2011 due to domestic currency depreciation, while the credit share in GDP declined. The dully coefficient in the exchange rate equation is highly significant and confirms the considerable depreciation of Belarusian ruble. Finally, the world financial crises apper to decrease net export in Belarus compared to non-crisis period, while the trade balance improved during the crisis of 2011 due to the positive effect of depreciation.

5 The Effects of Foreign and Domestic Shocks on Belarusian Economy

5.1 Theory

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

Foreign demand shocks. Unexpected growth of foreign demand would boost domestic output as increase of foreign demand determines a higher level of exports that leads to an increased need of inputs to production.[12] According to the mainstream theory, such as the model in Engel (2011), by increasing the demand for home goods which drives up the home real wage, the foreign demand shock will raise domestic inflation. Due to the growth of transactions demand, M1 is expected to increase as well. Consequently, the interest rates is expected to rise. The trade balance may improve, which would cause nominal effective exchange rate appreciation.

Oil price shocks. The effect of oil prices shock on domestic output is expected to be negative: Belarusian industrial output relies heavily on oil inputs[13], higher prices of which can lead to a loss of competitiveness of Belarusian goods on foreign and domestic markets. So, the domestic output is expected to decrease. The prices are expected to grow in the aftermath of oil price increase. When inflation rises, domestic monetary policy in expected to react by increasing interest rates to hold down the prices and to avoid the built-in of these price shocks in inflation expectations. Consequently, the money demand is expected to fall. Interest rate hikes may make exchange rate appreciate in the short-term and depreciate in medium/long tern to counteract the loss of external competitiveness. Finally, the net export may decline in the short term. In the longer run, in case of high inflation, the external trade balance is not likely to improve following the domestic currency depreciation.

[12] According to the State Statistics Service of Russia, the share of Belarus in Russian import is around 5%, while more than 35% of Belarusian exports goes to Russia that enhances the sensitivity of Belarusian exports to changes in Russian output. The key items imported from Belarus to Russia are transport vehicles (25%), food products (20%), machines and electronic devices (15%).

[13] Export of mineral products (mainly oil products made of Russian oil) and chemical products amount respectively to 37% and 22% of the total export of Belarus according to the National Statistical committee of Belarus.

Foreign monetary shocks. The higher interest rates curb Russian demand and thus imports, so Belarusian output may decline due to the contraction of exports to Russia. As a result of falling demand, domestic prices may also decrease. The domestic interest rates will probably rise not to allow a significant exchange rate depreciation. This is an expected reaction of monetary authorities in a country with exchange rate targeting regime, where in order to keep the exchange rate parity constant, the interest rate should be adjusted. Consequently, the money demand is expected to fall. The current account is negatively influenced by decrease in exports to Russia and positively – by the currency depreciation and possible growth of export to other countries – then, which effect overweighs the other becomes an empirical matter.

Domestic interest rate shocks. The interest rate channel is the most effective channel of monetary transmission in the countries with market economy, where the real sector is financed mainly through the securities market. This is proved by findings of Peersman and Smets (2001), Coricelli et al. (2006), Anzuini and Levy (2007), and other authors. Belarus belongs to the countries where the financial resources are distributed mainly through the bank lending. Moreover, most of the loans are distributed by the government at preferential rates. So the interest rate channel is believed to play a small role in monetary transmission in Belarus (see Kollar et al., 2006; Komkov and Abakumova, 2011).

The rise in interest rates can be interpreted as a sign that the monetary authority believes the economy is growing more than expected. In other words, current output is greater than potential output, which generates inflationary pressure. Thus, after a domestic monetary contraction the cost of borrowing in the market increases, which is expected to reduce consumer spending and investment, and consequently – to decrease the output (to the potential output level) and price (to its level of full employment) in the short to medium terms. Money demand is expected to decline because higher interest rates will lead investors to put more of their portfolio in interest rate bearing assets than in money. Further, increase in the domestic policy rate causes ruble assets to become more attractive, which would lead to effective exchange rate appreciation. The trade balance is expected to worsen in this case.

Credit shocks. A central bank's policy changes affect the amount of credit that banks issue to firms and consumers, which in turn affects the real economy. Within the credit channel two directions of monetary transmission are usually identified (see, for example, Holtemoller, 2002). The broad credit channel is connected with the change

in credit risk that influences the risk premium for external financing. If interest rates increase due to restrictive monetary policy, interest payments increase and present values of collateral decrease. As a consequence, the external finance premium rises and the credit availability reduces. A broad credit channel is operative if monetary policy has a systematic impact on the external finance premium that in turn affects aggregate output. In Belarus firms have almost no long-term financial funds that could serve as a collateral. Moreover, because of undeveloped financial market, most companies do not resort to raising capital externally via equity and debt markets. So the monetary policy is believed to cause no effect on real economy through the described channel. That is why we will pay attention to the narrow credit channel, connected with the effect of change in supply of credit by commercial banks caused by the monetary policy shocks.

The growth of the share of output produced using the borrowed resources can be a consequence of significant capital inflows, increased economic stimulus for productions, or growth of subsidized loans provided to inefficient enterprises to maintain their output at least at the same level. This shock is expected to result in growing output and prices. The amount of money in the economy would also rise. The interest rates are expected to increase to curb inflation pressure. The unexpected credit expansion is believed to cause the exchange rate appreciation and widening current account deficits (similarly to some economic models, for example IS-LM-BP, the current account is viewed by us as consisting solely of imports and exports).

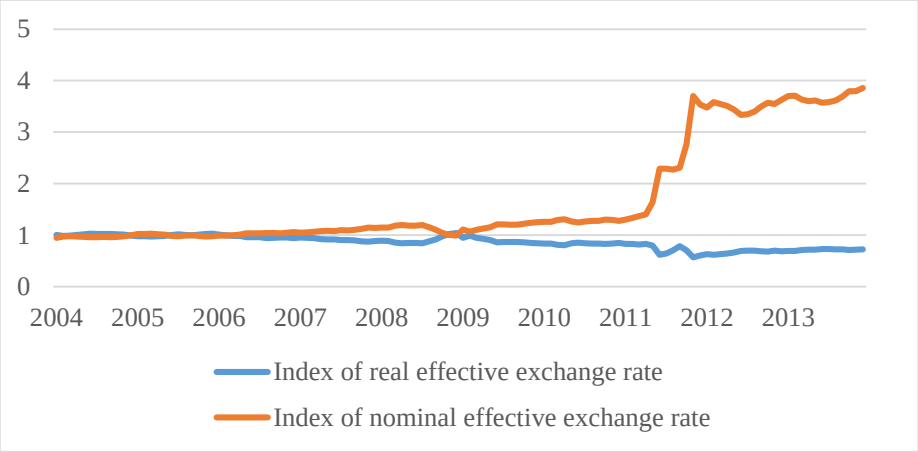
Exchange rate shocks. The response of output gap to exchange rate shock in ambiguous. On the one hand, national currency depreciation causes negative effect on the financial position of individuals and enterprises who have borrowings in foreign currency, as well as national producers using imported inputs. This may decrease spending and investment leading to decline in output gap. On the other hand, a depreciation of domestic currency may stimulate economic activity through increase of international competitiveness of domestic industries (export increases). Also, due to increased prices of foreign goods spending is diverted to domestic goods (import decreases). As a result, current account may improve that would stimulate the economic activity.

When discussing the changes in current account caused by currency depreciation, the attention should be paid to *real* depreciation. The current account improves in case of *real* exchange rate depreciation. The *nominal* depreciation of national currency results in the *real* depreciation on condition that the rate of nominal

depreciation is faster that the rate of growth of domestic prices relative to prices abroad (this is true for the countries where domestic inflation is higher than inflation of their trade partners, which is the case of Belarus).

We will look at the index of real and nominal effective exchange rates of Belarus (Figure 5.1).[14] We observe that starting from 2006 nominal exchange rate depreciation. However, the index of real exchange rate is below 1 (with except for 2 months in 2008) meaning that due to high inflation growth the real exchange rate appreciates. Even the devaluation of Belarusian ruble that took place in 2011 did not result in the real exchange rate depreciation.

Figure 5.1: Indexes of nominal and real effective exchange rates



Source: nbrb.by. Expressed in Belarusian rubles for a unit of foreign currency, 2005 = 1, monthly frequency.

With respect to this overview, we would expect the current account to worsen after the nominal depreciation of Belarusian ruble. This might cause negative effect on the output gap. The effect of currency depreciation on the price level is ambiguous: prices are expected to fall in case of reduction in export and economic activity, however, higher cost of imported inputs for production will cause the prices to grow. In the money market, an unexpected domestic currency depreciation prompts agents to hold more domestic currency (money demand grows). The interest rate is expected to increase to attract funds needed to finance the growing budget deficit from investors who are more reluctant to lend money to the country whose currency became weaker.

[14] According to explanations to the methodology used by the NBRB, NEER is calculated using the reverse quotation (BYR per unit of foreign currency). REER is calculated based on NEER and the ratio of inflation rates. So, the directions up mean depreciation of domestic currency, and the directions down mean its appreciation.

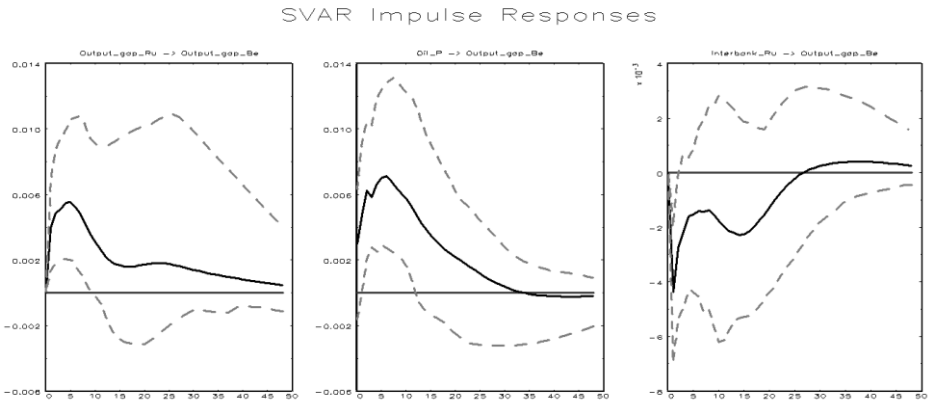
5.2 Empirical Evidence

In order to get an idea about the transmission of foreign shocks to the Belarusian economy, we will analyze responses of domestic variables to foreign demand shock, oil price shock, and foreign monetary shock. Next, we will switch to analysis of Belarusian monetary transmission channels. Finally, we will pay attention to the role of foreign and domestic shocks in explaining domestic variables volatility.

5.2.1 The Effects of Foreign Shocks

In this subsection we analyze the effects of the foreign shocks on Belarusian macroeconomic variables. The impulse response functions presented below are accompanied by 95% confidence bands, which were bootstrapped using 100 replications. In our interpretations we refer to horizons of 6 months as the short run, 12 months as the medium run, and 24 months and afterwards as the long run.

Figure 5.2: Output gap responses to foreign shocks



Russian demand shock *Oil price shock* *Russian monetary shock*

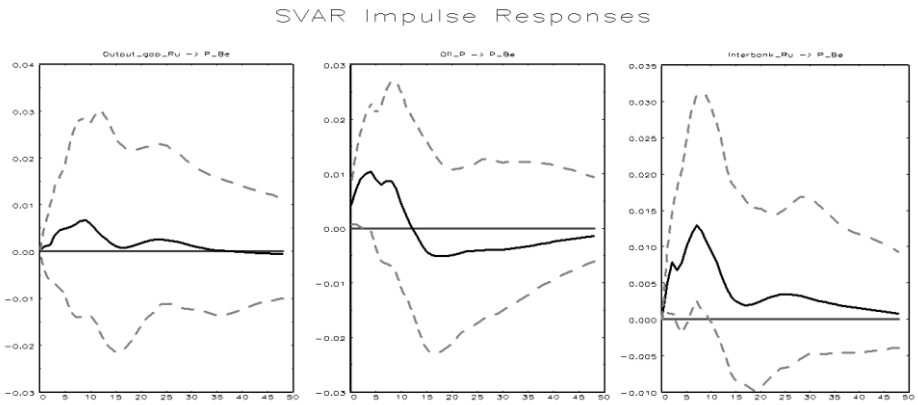
A one standard deviation increase of foreign demand, representing 0.0043 percentage points (p.p.), leads to domestic output gap expansion of 0.0054 p.p. after five months, after which the response starts declining. The response is statistically significant for ten months. The direction of the response corresponds to our expectations.

It is interesting to note that an increase in oil price (by 0.15 p.p.) leads to output gap increase by 0.0071 p.p. after six months. Later, the output gradually declines and returns to its pre shock level in three years. The positive effect of the shock is significant for eleven months. This evidence may indicate that a positive spillover

effect from Russia after oil prices increase[15] compensates the negative effect on the economy of Belarus. This result corresponds to findings of other authors, e.g., Kandil et al. (2007) for the case of oil-importing Turkey.

Foreign interest rate increase by 1.31 p.p. causes Belarusian output gap decrease of -0.0044 p.p. after one month, after which the magnitude of the shock gradually becomes smaller. The effect is insignificant starting from the second month until the end of the forecast period. The response is in line with our predictions.

Figure 5.3: Price responses to foreign shocks



Russian demand shock *Oil price shock* *Russian monetary shock*

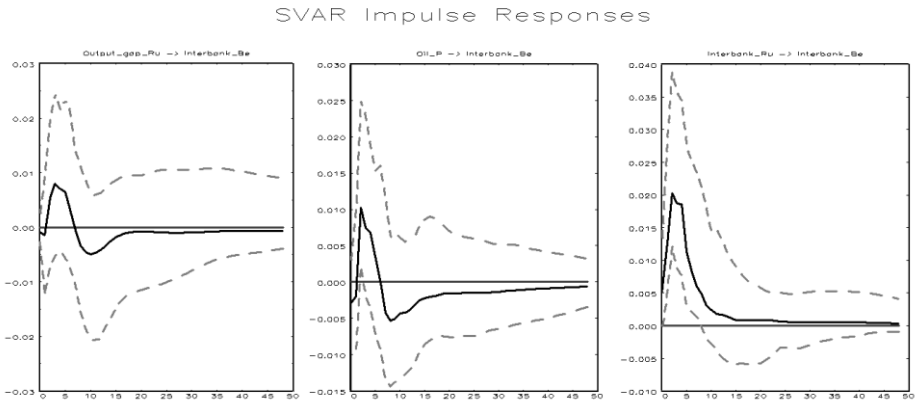
An unexpected demand shock in Russia leads to growth of prices in Belarus. However, the response is not statistically significant during the whole forecast period.

Following the oil price shock, we observe an expected increase in inflation: prices reach maximum of 0.92 p.p. after two months. Starting from the month three, the price level declines and the response becomes statistically insignificant.

After the foreign monetary contraction domestic price level grows. The response reaches the maximum of 1.30 p.p. after seven months. The response is statistically significant during eight months. The unexpected positive impact of Russian monetary tightening on Belarusian prices might be explained by the high deflationary and inflationary expectations. Another explanation (made by Mackowiak 2006 who got the same response for emerging markets) is that increase in the foreign real interest rate induces inflation in the non-tradable goods sector even in the case of fixed exchange rate regime.

[15] The correlation of oil prices for Belarus and world oil prices in 2004-2013 is found to be 0.46.

Figure 5.4: Interest rate responses to foreign shocks



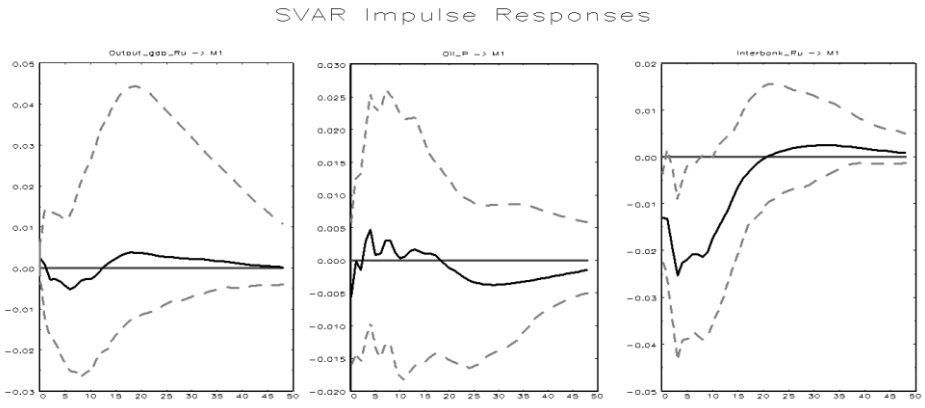
Russian demand shock *Oil price shock* *Russian monetary shock*

Similarly to the price level, the domestic interest rate does not show a statistically significant reaction on the foreign demand shock. The interest rate increases in the short run and decreases in the medium run, but the confidence bands are quite wide.

The domestic interest rate grows following the oil price shock, as expected. The peak of 0.75 p.p. is observed after three months. Afterwards, the interest rate declines swiftly and becomes negative after seven months. The impact is statistically significant only in the second month.

Russian monetary shock seems to have a significant spillover on Belarusian monetary policy instrument. The maximum response of 2.02 p.p. is observed after two months. In the following months the amplitude of the shock declines quickly. The shock is significant during seven months.

Figure 5.5: Money demand responses to foreign shocks

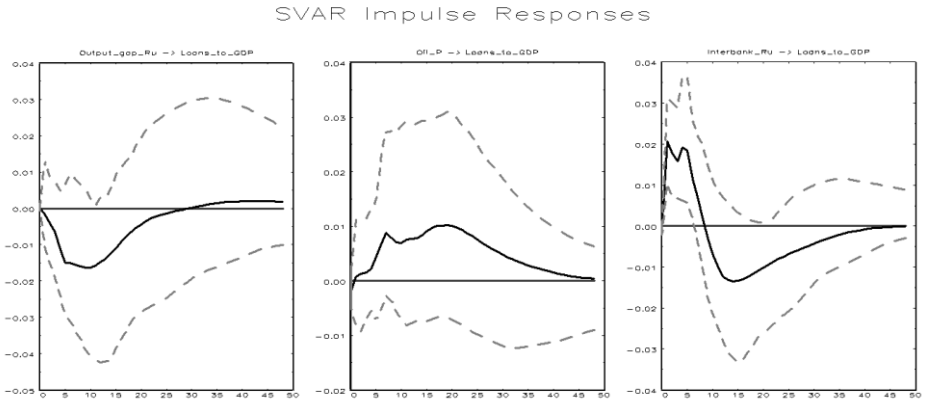


Russian demand shock *Oil price shock* *Russian monetary shock*

Money demand is found to change insignificantly after the foreign demand and oil price shocks – the confidence intervals easily contain the zero line.

Meanwhile, foreign monetary shock appear to cause decline of domestic money demand by -2.54 p.p. after three months. The response is significant during seven months. This result correlates with our theoretical predictions.

Figure 5.6: Credit/GDP changes to foreign shocks



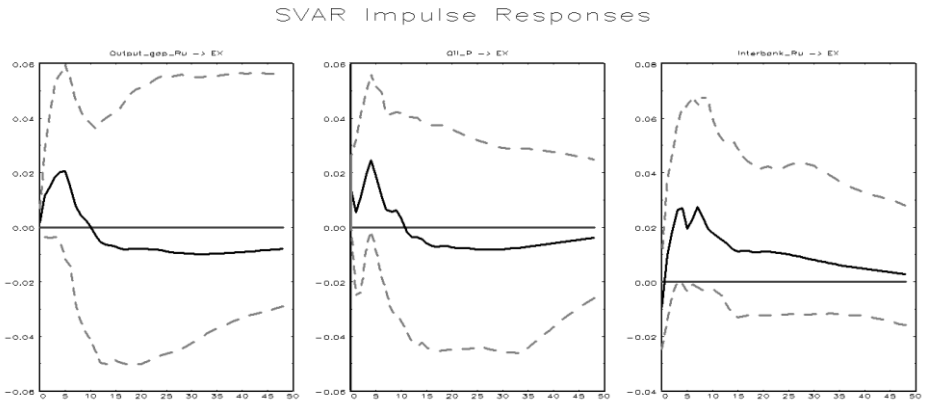
Russian demand shock *Oil price shock* *Russian monetary shock*

Analyzing the responses of credit-to-GDP ratio, we can observe a negative reaction to the foreign demand shock and a positive response to the oil price change. But we again cannot make reliable predictions regarding the responses, as they are statistically insignificant.

The credit/GDP appears to rise significantly following a foreign monetary shock. The peak of 2.06 p.p. is observed after one month. The response declines afterwards and becomes statistically insignificant after seven months.

The positive impact of oil prices and foreign monetary shocks on credit expansion might be explained by the growth of loans distributed through administrative mechanism in order to support Belarusian producers.

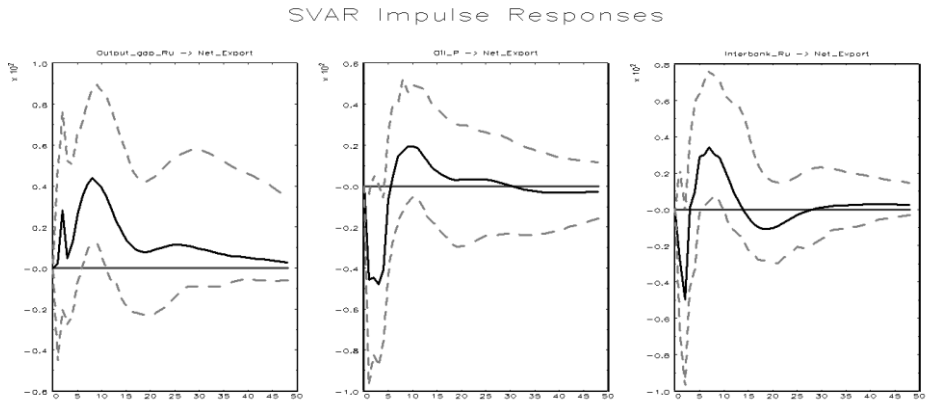
Figure 5.7: Exchange rate responses to foreign shocks



Russian demand shock *Oil price shock* *Russian monetary shock*

The unexpected growth of Russian demand and oil prices cause Belarusian ruble depreciation during twelve months and appreciate in the medium to long run. The depreciation following the foreign money shock is more persistent. However, all the effects are statistically insignificant.

Figure 5.8: Net export responses to foreign shocks



Russian demand shock *Oil price shock* *Russian monetary shock*

In Figure 5.8 we can observe the responses of net export to the foreign shocks. Russian demand shock causes the current account to improve, the effect is positive during the months the forecast period. The peak of $43.80 mln is observed after eight months. The response is significant between months seven and ten. The net export reaction is in line with our expectations.

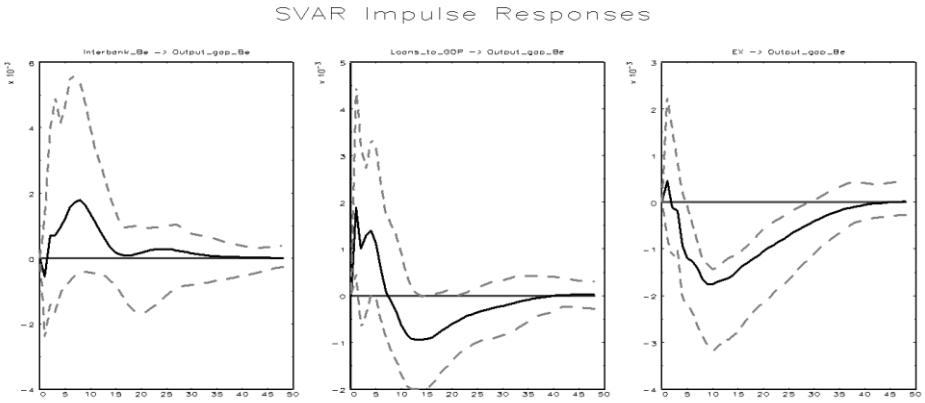
The unexpected oil price increase appear to worsen the net export only during the short five-months period. The bottom is -$48.15 mln is reached after three months. Afterwards, the balance stabilizes, its change stops being significant.

The net export is found to decline for two months following the foreign interest rate shock. So, the negative effect from decrease of Belarusian export to Russia appear to be more prominent that the effect from currency depreciation that is supposed to stimulate export to other trading partners and reduce import. Belarusian exporters seem to be unable to diversify markets and greatly depend on the Russian market. Another explanation could be the real currency appreciation caused by the growth of prices that stimulates imports and curbs exports. However, the response is not statistically significant. Starting from the month three the response becomes positive. The maximum of $34.02 mln is reached after seven months. In the medium run the response is significant during months six to nine.

5.2.2 The Effects of Belarusian Monetary Policy Shocks

In this subsection we show the responses of domestic variables to domestic interest rate shocks, credit shocks, and exchange rate shocks.

Figure 5.9: Domestic output gap responses to domestic shocks



Interest rate shock *Credit shock* *Exchange rate shock*

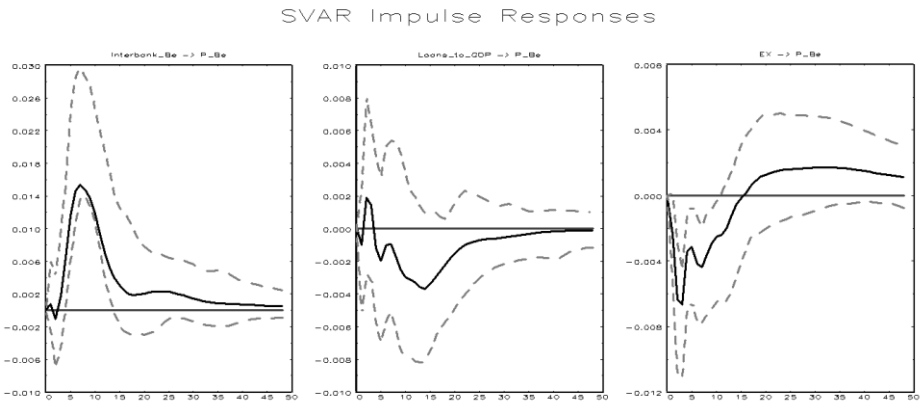
We start with the analysis of domestic output gap responses to monetary policy shocks. One standard deviation increase of interest rate, representing 2.92 p.p., leads to a decrease of output gap in the first month, but it is neither economically, nor statistically significant. The output gap grows in the following periods, but is again significantly insignificant.

The credit expansion seems not to play an important role in stimulating economic growth in Belarus. The credit shock of 4.18 p.p. positively influences the output gap during nine months, but the response is significant (0.0019 p.p.) only in the first month.

During the months fourteen to twenty one the response of output is significantly negative, with an average magnitude of -0.008 p.p.

Considering the exchange rate shock of 0.065 index points, we can say that it causes the output gap to decrease significantly in months five to twenty nine with a bottom of 0.0018 p.p. after eight months. This finding may be explained by declining net export following the exchange rate shock (we will see it when analyzing the Figure 5.15) that confirms conclusion of our discussion on inability to improve the net export and stimulate economic activity by depreciation domestic currency in the presence of high inflation rates in Belarus.

Figure 5.10: Domestic price level responses to domestic shocks



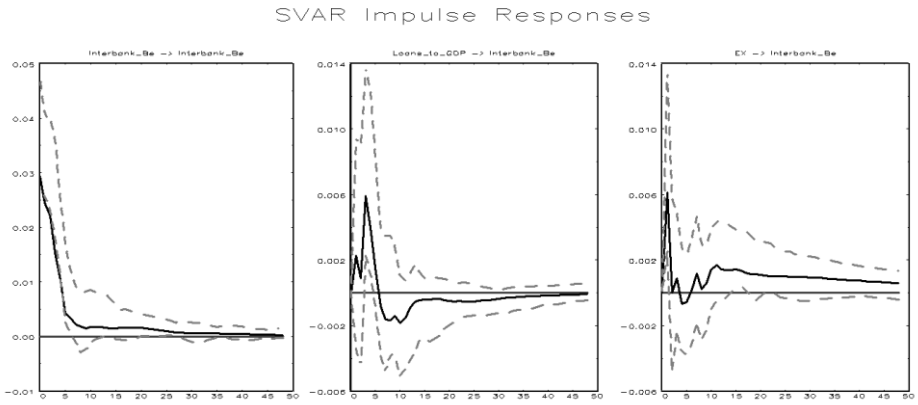
Interest rate shock *Credit shock* *Exchange rate shock*

Next, we turn our attention to the responses of the price level. Following the interest rate shock prices unexpectedly grow by the maximum of 1.54 p.p. The growth is statistically significant in months four to thirteen. The explanation to this unexpected result may lie in the response of an interest rate shock that becomes loses its persistence after six months and does not prevent prices from growing any longer. Thus, rising interest rates does not seem to be effective in curbing inflation in Belarus.

The impulse response of price level to the credit expansion is not significant, the direction of the response in negative.

We can observe a significantly negative decline of prices (by as much as -0.67 p.p. after three months) following domestic currency depreciation, that is explained by decline of economic activity and export (Figures 5.9, 5.15). The response is statistically significant during ten months.

Figure 5.11: Domestic interest rate responses to domestic shocks



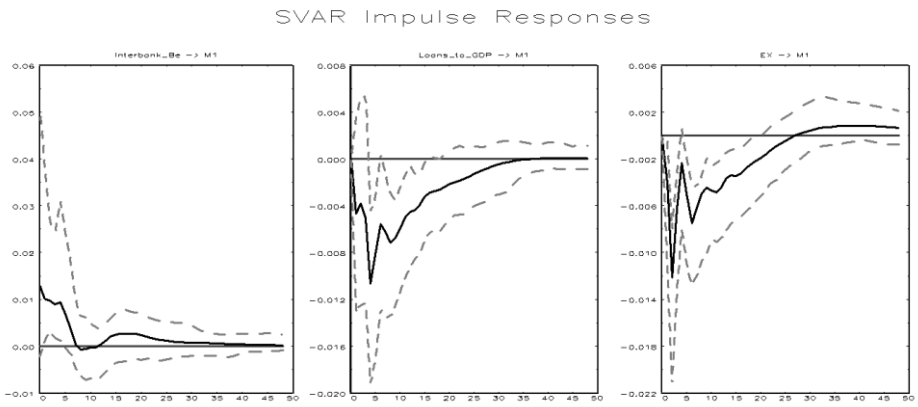
Interest rate shock *Credit shock* *Exchange rate shock*

In figure 5.11 we can observe that the interest rate shock is persistent for six months.

The credit expansion causes an expected increase of interest rate. The response is significantly positive during the months three and four, when its magnitude equals 0.59 p.p.

Exchange rate depreciation causes an increase of interest rate by as much as 0.61 p.p. after one month following the shock. In the following months the interest rate response swiftly declines and becomes statistically insignificant.

Figure 5.12: Domestic money demand responses to domestic shocks



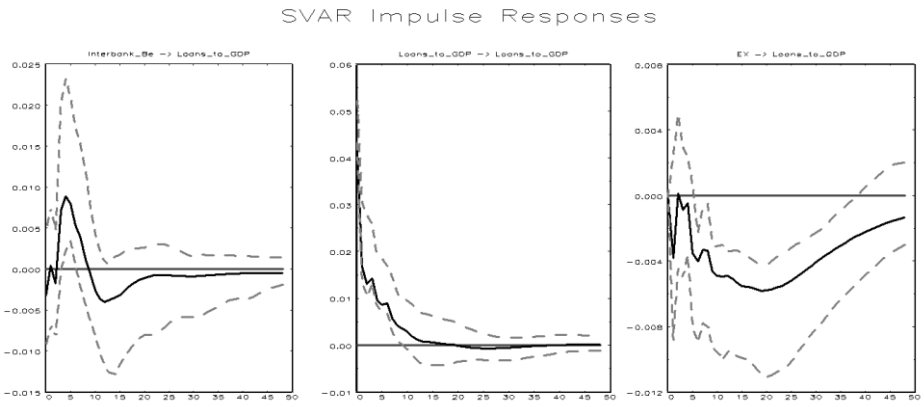
Interest rate shock *Credit shock* *Exchange rate shock*

Figure 5.12 reflects the effects of monetary policy shocks on the money demand. The money demand increases by 1.29 p.p. on impact and decrease gradually. The response is significantly positive between months one and four.

Credit expansion leads to decline in the money demand, the effect is significant in the medium run with an average magnitude of -0.8 p.p.

As for the effect of exchange rate shock, it causes the money demand to decline as well. The response is significant for roughly two years with the maximum magnitude of around -1.0 p.p. The unexpected negative effect of the currency depreciation on money demand might be explained by the output contraction and prices decline (Figures 5.9, 5.10) following the shock.

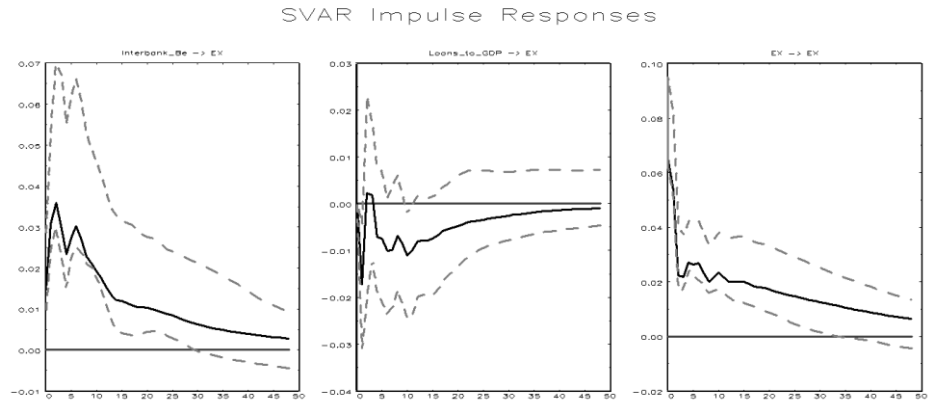
Figure 5.13: Credit/GDP responses to domestic shocks



Interest rate shock *Credit shock* *Exchange rate shock*

The interest rate shock increases the share of borrowings in the domestic currency in GDP in the first year and decreases it afterwards. The response is significant for months three to six. The credit shock is persistent for about one year. The exchange rate depreciation causes a statistically significant decrease in the credit/GDP ratio. The response reaches the bottom of -0.58 p.p. after nineteen months.

Figure 5.14: Exchange rate responses to domestic shocks



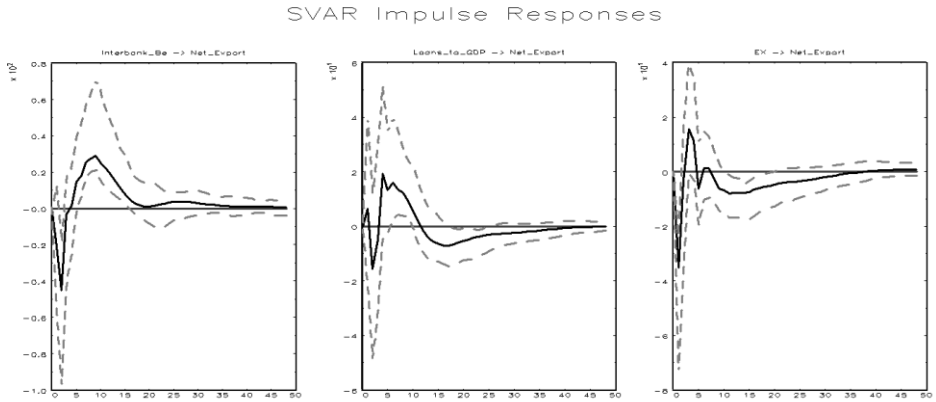
Interest rate shock *Credit shock* *Exchange rate shock*

Next, we shall analyze the responses of the exchange rate to monetary policy shocks. The exchange rate appears to depreciate by as much as 0.036 index points following the interest rate increase. The response is positive and statistically significant during thirty months. The result does not correspond to our expectations. The possible explanation could be a desire to maintain the uncovered interest rate parity that induces the NBRB to depreciate the Belarusian ruble in response to the interest rate growth.

The credit shock appears to cause statistically significant appreciation of Belarusian ruble by 0.002 index points during one month after the shock. Afterwards the response becomes insignificant.

The effect of the shock seems to be significant for thirty one months.

Figure 5.15: Net export responses to domestic shocks



Interest rate shock *Credit shock* *Exchange rate shock*

Finally, we analyze the impulse responses of net export to domestic monetary policy shocks. We observe an economically and statistically significant decrease of net export by -$45.17 mln in the second month following the monetary policy shock. The domestic economic growth appears to recover from the shock quite quickly: after four months run the response becomes significantly positive. The the peak of $28.86 mln reached after nine months.

The net export grows following the credit expansion during four months in the medium run. Similarly to the reaction to interest rate shock, the net effect is significant for only one month. The effect becomes insignificant after month eleven.

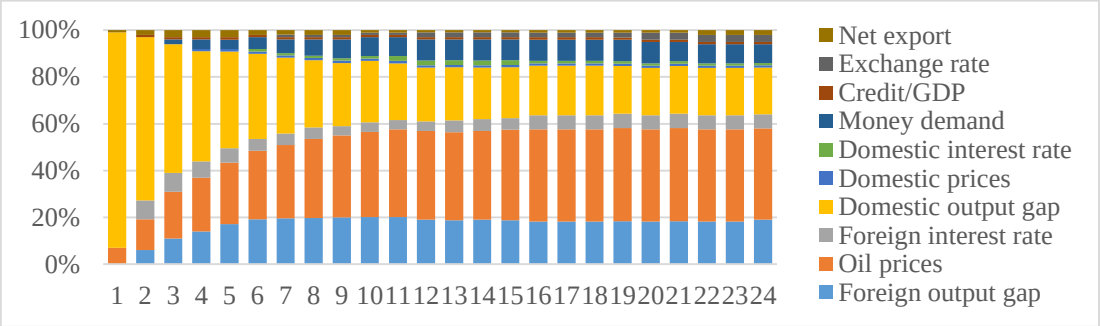
The currency depreciation leads to statistically significant net export decline of as much as -$35.09 mln during the first two months. Very swiftly the response becomes positive but insignificant.

We can note that the time path of all the impulse response functions converges to zero over time, meaning that the estimated system of equations is stable.

5.2.3 Variance Decompositions

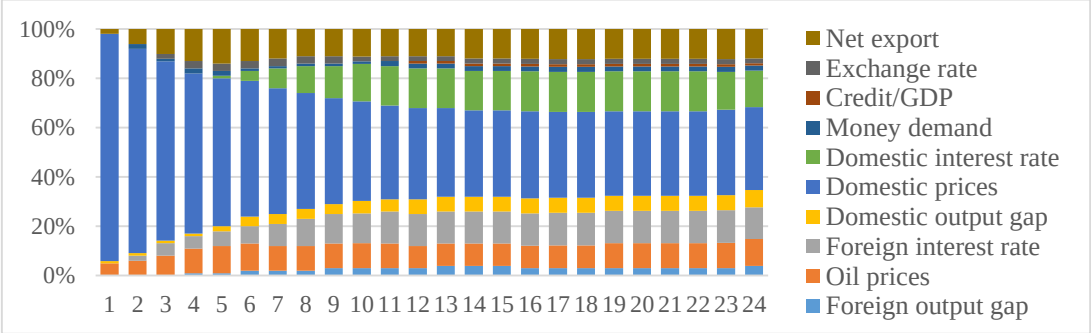
While an impulse response analysis provides information on the size of external shock spillover effects on domestic variables, a variance decomposition shows the proportion of variations in the Belarusian variables that was attributed to external and domestic shocks in the period under study.

Figure 5.16: Variance Decomposition - Domestic output gap



Analyzing the variance decomposition of domestic output gap, we find that external shocks become dominant source of output fluctuations after six months. In a two year horizon the foreign shocks jointly explain 64 percent of variability in domestic output gap, of which 38 percent is attributed to unexpected oil price changes.

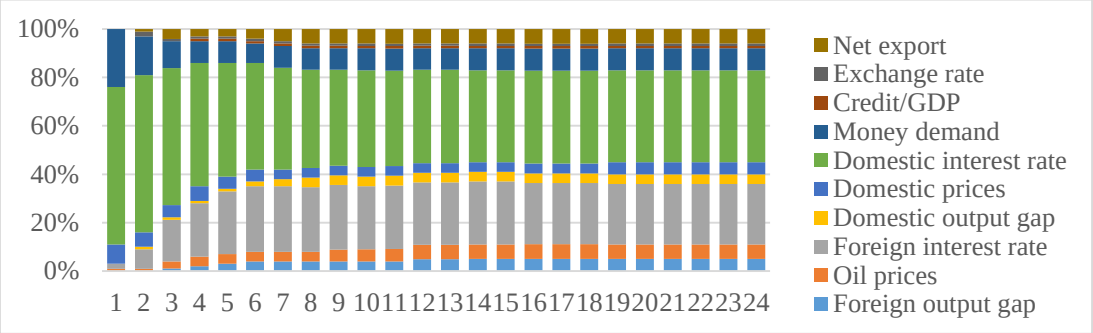
Figure 5.17: Variance Decomposition - Domestic price level



In the short run almost all of the variance in price level is explained by its own fluctuations. In the medium to long run an important role is also played by domestic

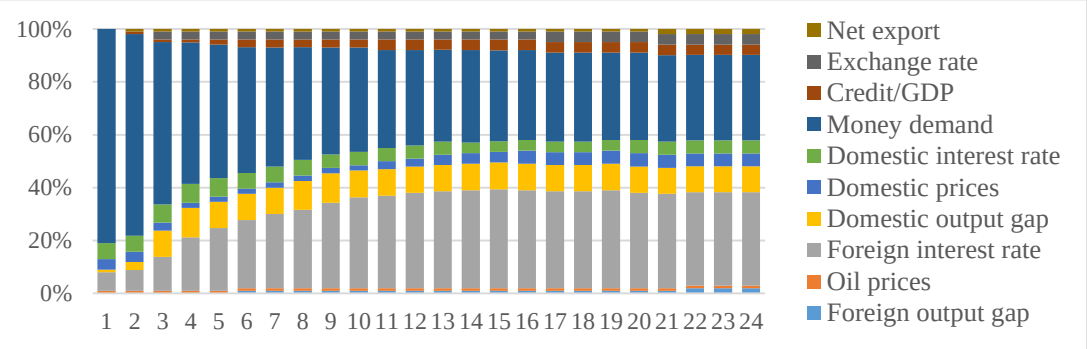
and foreign interest rates that explain correspondingly 15 and 13 percent of fluctuations. Net export and oil price account for around 10 percent of variations each.

Figure 5.18: Variance Decomposition - Domestic interest rate



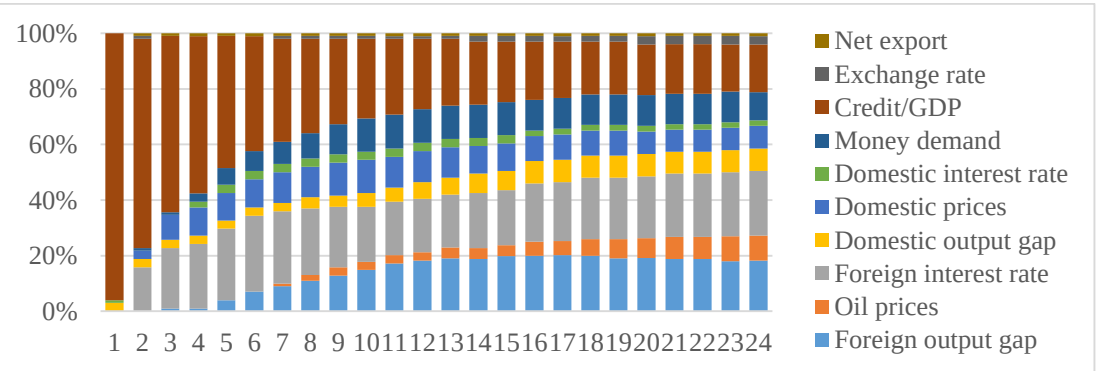
Next, we look at the share of domestic interest rate explained by foreign and domestic shocks. We find that foreign shocks account for around 40 percent of the interest rate changes. The prime mover appears to be the foreign interest rate, that starting from month five explains 25 percent of domestic interbank rate.

Figure 5.19: Variance Decomposition - Money demand



The money demand in Belarus appears to be explained mainly by Russian interest rate shocks. They account for about 45 percent of variation in money demand, while the share explained by the domestic interest rate is only as high as 5 percent.

Figure 5.20: Variance Decomposition - Credit/GDP



As regards the fluctuations in credit/GDP ratio, it is also found to be greatly influenced by foreign shocks in the long run. Among the domestic shocks, apart from the shock in itself, the credit/GDP ratio is noticeably influenced by changes in money demand (10 percent).

Figure 5.21: Variance Decomposition - Exchange rate

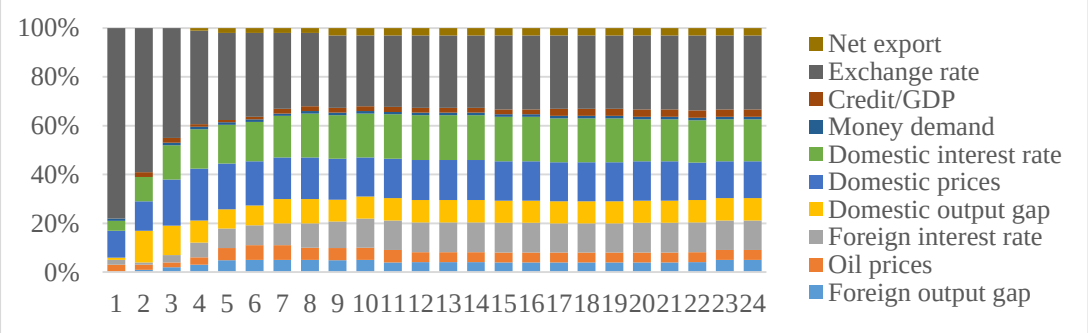
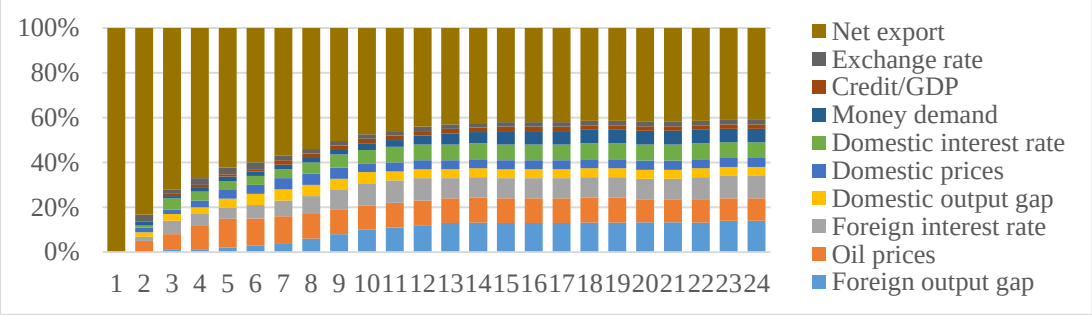


Figure 5.21 displays the fraction of the variance in exchange rate due to the foreign and domestic shocks. Among the shocks originated abroad the most important is the interest rate explaining 12 percent of domestic currency variation in the long run. Domestic inflation and interest rate account for about 15 percent each.

Figure 5.22: Variance Decomposition - Net export



Finally, we analyze the variance decomposition of the net export. Among the domestic shocks explaining fluctuations in net export, the highest role belongs to its own historical development. The foreign output gap changes cause the most significance effect among the exogenous shocks (they explain around 15 percent of fluctuations). The joint effect of foreign shocks after two years is 34 percent.

5.3 Results Interpretation

Interpreting our results, we should first summarize the responses of Belarusian variables to foreign and domestic shocks. Overall, the responses of domestic variables

to foreign shocks are mostly in line with our predictions (see Table 5.1 for the summary).

Table 5.1: Theoretical and actual effects of shocks

	Foreign demand shocks		Oil price shocks		Foreign monetary shocks	
	Theory	Actual	Theory	Actual	Theory	Actual
Y_{Be}	↑	↑	↓	↑	↓	↓
P_{Be}	↑	↑	↑	↑	↓	↑
R_{Be}	↑	↑	↑	↑	↑	↑
MD_{Be}	↑	↓	↓	↑	↓	↓
Cr/GDP_{Be}	↑	↓	↑	↑	↓	↑
EX_{Be}	↓	↑	↓	↑	↑	↑
$NExp_{Be}$	↑	↑	↓	↓	?	↓,↑
	Domestic monetary shock		Credit shock		Exchange rate shock	
Y_{Be}	↓	↑	↑	↑	↓	↓
P_{Be}	↓	↑	↑	↓	?	↓
R_{Be}	↑	↑	↑	↑	↑	↑
MD_{Be}	↓	↑	↑	↑	↑	↓
Cr/GDP_{Be}	↓	↑	↑	↓	↓	↓
EX_{Be}	↓	↑	↓	↓	↑	↑
$NExp_{Be}$	↓	↓,↑	↓	↑,↓	↓	↓,↑

Note: shaded cells indicate the statistically significant responses.

The most statistically significant effect seems to be caused by Russian interest rate increase, while the responses to Russian demand and oil price shocks are mainly found to be uncertain. The responses to foreign shocks appear to be significantly different from zero only in the short and medium terms.

Next, we should discuss the importance of different channels of monetary transmission in Belarus. Compared to the other shocks, the exchange rate changes cause the most statistically significant responses of domestic variables that are mostly correspond to our expectations. The same conclusion of the prime role of the exchange rate channel in Belarus is made by Kallaur et al. (2006) and Komkov et al. (2011).

Table 5.2 summarizes the share of the variance in Belarusian variables that can be explained by the foreign and domestic shocks.

Table 5.2: Fraction of variances attributed to foreign and domestic shocks

	Foreign shocks after 6 months	Foreign shocks after 24 months
Output gap	53%	64%
Price level	20%	28%
Interest rate	35%	36%
Money demand	28%	39%
Credit/GDP	34%	50%
Exchange rate	19%	21%
Net export	21%	34%

Foreign shocks appear to be the most important for the domestic output gap fluctuations. Comparison of our results with findings of other authors suggests that the foreign factors manage to describe a higher fraction of output changes in Belarus than in other developing countries. Horváth and Rusnák (2008) find that in case of Slovakia due to the structural reforms the output gap after two years is mainly influenced by domestic factors, while foreign variables explain only 14 percent of output gap fluctuations. A higher portion of output variation (54 percent) in two years is attributed to foreign shocks for the case of Croatia, as Krznar and Kunovac (2010) conclude. The analysis of the economies of the Czech Republic, Hungary and Poland by Maćkowiak (2005) suggests that 25-50 percent of real aggregate output variation in these countries could be attributed to external shocks in the long-run.

The highest share of the variation in output gap (39 percent) is found to be explained by oil price shocks. As we mentioned above, the price of oil imported from Russia is correlated with the world oil price. The oil price on the world markets influences the price of oil products. In this situation, the oil price shock increases revenue for Belarus from export of its own oil and oil products (mainly to the European Union) that bring 1/3 of the total export income. Additionally, the country benefits from expansion of demand in Russia – the net oil-exporter, where Belarus delivers mainly consumer and investment goods. On the other hand, Belarus is influenced negatively by the oil shock as it has to spend more currency on the oil import. As the impulse response function suggests, the positive effects overweigh the negative ones. It also worth mentioning, that the share of fluctuations in output attributed to foreign demand shocks is also rather high – 20 percent.

Exchange rate and the price level are found to be the least vulnerable to foreign shocks that explain correspondingly 21 and 28 percent of fluctuations. This finding indicates a high degree of price level and exchange rate regulation by the Government.

For comparison, Maćkowiak (2005) and Horváth and Rusnák (2008) found that around 80 percent of prices variation originated abroad in the mentioned CEE countries.

Among the foreign factors, the highest predicting power of all the domestic variables (except for output and net export) belongs to the foreign interest rate shocks. It accounts for almost 30 percent of variation in domestic interest rate, money demand and loans over GDP fluctuations. For some of the variables, the foreign interest rate is a more important mover than the domestic interest rate.

The important role of Russian monetary policy for interest rate movements in Belarus is in line with Saxena (2008) who finds that domestic short-term interest rates are significantly affected by foreign interest rates, especially for countries with fixed exchange rate. According to the author, in this group of countries domestic interest rates move in line with the foreign interest rates to make the interest rate parity condition hold. It is considered, that floating the exchange rate helps reduce the impact of foreign interest rates on domestic rates. However, Frankel et al. (2004) conclude, that floaters are also limited in being independent in their interest rate changes. So, even though Belarus have switched from fixed exchange rate regime to the floating one, due to high foreign currency liabilities and close economic ties with Russia the dependence on foreign interest rate remains significant.

6 Sensitivity Analysis

This section explores the robustness of the results of our baseline specification. Specifically, we check the sensitiveness of the results with respect the timing assumption and the identification scheme of the structural matrix.

6.1 Sensitivity to Change of Shocks Identification Scheme

We are interested to know if our conclusions change after making a different assumption regarding variables included into the A matrix. So we use an alternative identification of monetary policy equation proposed by Cushman and Zha (1995). According to this scheme, the monetary authority has an immediate access to information about the exchange rate (the same assumption is also made by Kim and Roubini 2000), foreign interest rate, the money demand and foreign prices. However, it is unable to observe the data on output and general prices.

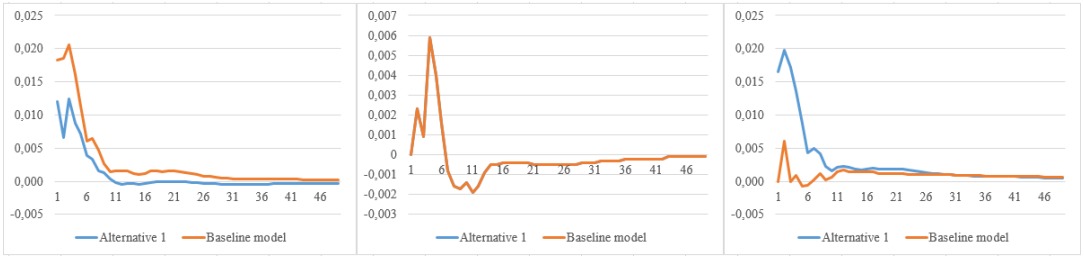
Table 6.1: Contemporaneous structure restrictions - alternative identification 1

Dependent variables	Explanatory variables									
	Y_{Ru}	P_{oil}	R_{Ru}	Y_{Be}	P_{Be}	R_{Be}	MD_B	Cr/GDP_{Be}	EX_{Be}	$NExp_{Be}$
Y_{Ru}	1	0	0	0	0	0	0	0	0	0
P_{oil}	0	1	0	0	0	0	0	0	0	0
R_{Ru}	NA	0	1	0	0	0	0	0	0	0
Y_{Be}	0	NA	0	1	0	0	0	0	0	NA
P_{Be}	0	NA	0	NA	1	0	0	0	0	NA
R_{Be}	0	NA	NA	0	0	1	NA	0	NA	0
MD_{Be}	0	0	0	NA	NA	NA	1	0	0	0
Cr/GDP_{Be}	0	0	0	NA	0	NA	0	1	0	0
EX_{Be}	0	NA	NA	NA	NA	NA	NA	0	1	0
$NExp_{Be}$	0	0	0	0	0	0	0	0	0	1

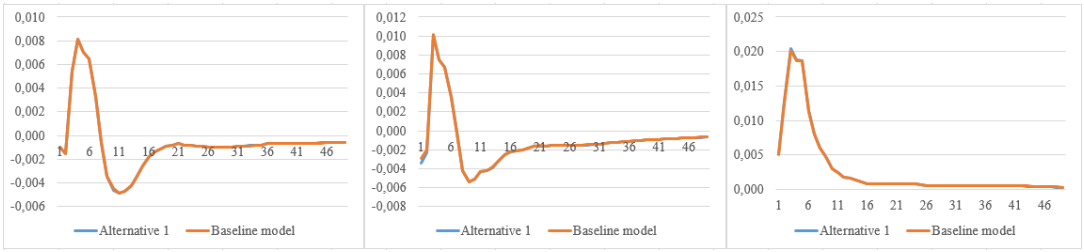
Note: shaded cells show change of restrictions compared to the baseline model.

With respect to the first alternative identification, the responses of the interest rate (Figure 6.1) and the predicting power of the foreign variables (Table 6.2) did not change much compared with the baseline specification.

Figure 6.1: Interest rate responses - alternative identification 1



Interest rate shock *Credit chock* *Exchange rate shock*



Foreign demand shock *Oil prices shock* *Foreign monetary shock*

Table 6.2: Fraction of variances attributed to foreign and domestic shocks - alternative identification 1

	Foreign shocks after 6 months	Foreign shocks after 24 months
Output gap	47%	60%
Price level	21%	28%
Interest rate	36%	37%
Money demand	28%	39%
Credit/GDP	35%	49%
Exchange rate	21%	23%
Net export	22%	34%

Another alternative identification scheme (Table 6.3) is to allow for a contemporaneous impact of the domestic factors, including the monetary policy instrument, on the real economy, as in Landolfo (2007).

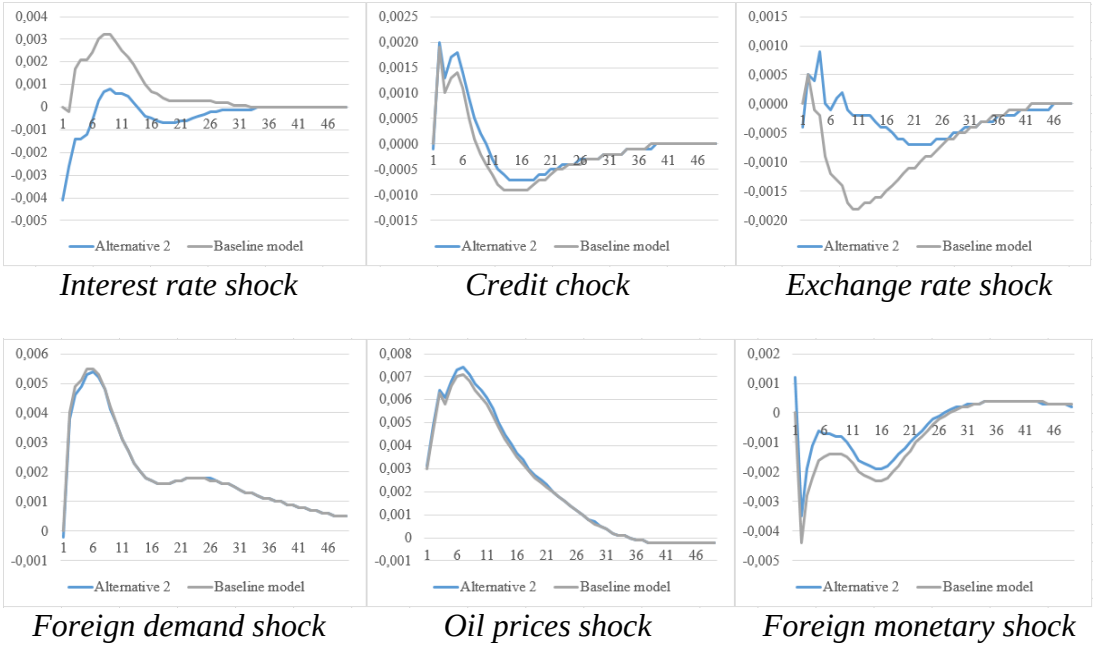
Table 6.3: Contemporaneous structure restrictions - alternative identification 2

Dependent variables	Explanatory variables									
	Y_{Ru}	P_{oil}	R_{Ru}	Y_{Be}	P_{Be}	R_{Be}	MD_B	Cr/GDP_{Be}	EX_{Be}	$NExp_{Be}$
Y_{Ru}	1	0	0	0	0	0	0	0	0	0
P_{oil}	0	1	0	0	0	0	0	0	0	0
R_{Ru}	NA	0	1	0	0	0	0	0	0	0
Y_{Be}	0	0	0	1	NA	NA	NA	NA	NA	NA
P_{Be}	0	NA	0	NA	1	0	0	0	0	NA
R_{Be}	0	NA	NA	NA	NA	1	NA	0	0	0
MD_{Be}	0	0	0	NA	NA	NA	1	0	0	0
Cr/GDP_{Be}	0	0	0	NA	0	NA	0	1	0	0
EX_{Be}	0	NA	NA	NA	NA	NA	NA	0	1	0
$NExp_{Be}$	0	0	0	0	0	0	0	0	0	1

Note: shaded cells show change of restrictions compared to the baseline model.

As regards the second alternative identification (see Figure 6.2), the amplitude of the output gap response to the exchange rate shock is slightly higher in baseline model. Also, Belarusian output gap seem to decrease following the foreign interest rate shock if to allow for its instant impact that corresponds to theoretical predictions. The direction of all the changes remains the same. The share of variations that can be attributed to foreign shocks is also robust across identifications (Table 6.4).

Figure 6.2: Domestic output gap responses - alternative identification 2



Interest rate shock *Credit chock* *Exchange rate shock*

Foreign demand shock *Oil prices shock* *Foreign monetary shock*

Table 6.4: Fraction of variances attributed to foreign and domestic shocks - alternative identification 2

	Foreign shocks after 6 months	Foreign shocks after 24 months
Output gap	53%	64%
Price level	25%	30%
Interest rate	35%	37%
Money demand	23%	32%
Credit/GDP	32%	48%
Exchange rate	19%	21%
Net export	23%	34%

6.2 Sensitivity to Change of the Period

In this sensitivity analysis we check whether the impulse responses and significance of foreign shocks is different for the model covering only the period before the crisis of 2011. We estimate another model for the period January 2004 – February 2011. The new model contains the *D_Russia* dummy variable in all the equations. In order to eliminate the autocorrelation of residuals we estimate the model on 3 lags.

We first take a look at the changes of non-policy variables (output gap, price level and net export) and policy variables (interest rate and exchange rate) under the influence of the foreign shocks.

Figure 6.3: Responses of non-policy variables to foreign shocks - period change

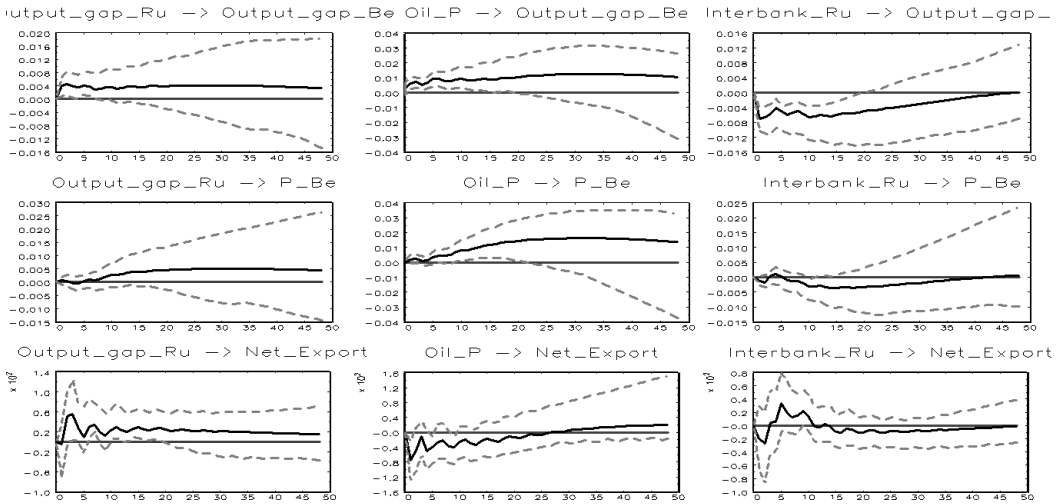
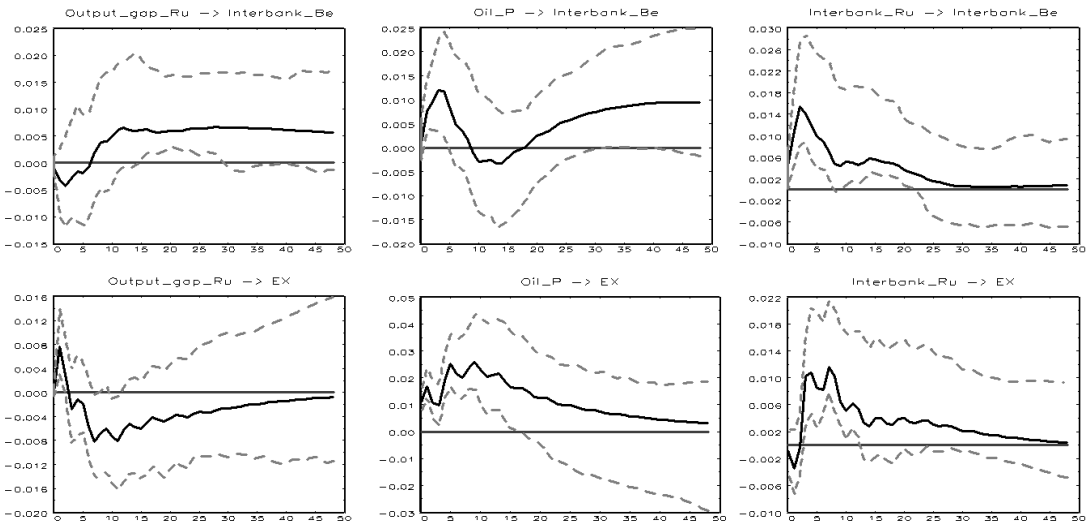


Figure 6.3 shows the impulse responses of Belarusian non-policy variables to the foreign shocks. The responses are more or less similar to those in the baseline

model. The difference is only in the higher significance of price level response to the oil price shock in the shorter-period model.

Figure 6.4: Responses of policy variables to foreign shocks - period change



Analyzing the responses of monetary policy variables to foreign shocks, we find that the domestic currency depreciation in all cases is statistically significant in the short and medium terms, while in the baseline model the responses are not significant. The directions of responses of both domestic variables are in line with that of the full-period model.

Next, we compare how the predicting power of foreign shocks changed in the model based on a shorter period.

Table 6.5: Fraction of variances attributed to foreign and domestic shocks – period change

	Foreign shocks after 6 months	Foreign shocks after 24 months
Output gap	77%	70%
Price level	21%	32%
Interest rate	24%	52%
Money demand	58%	48%
Credit/GDP	43%	67%
Exchange rate	20%	46%
Net export	25%	40%

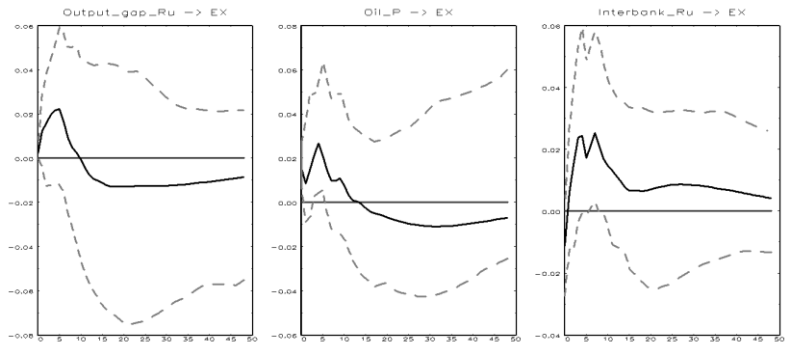
In comparison with the baseline model, in the long run foreign shocks seem to have a slightly higher predictive power of interest rate (52 percent versus 36 percent) and exchange rate (46 percent versus 21 percent). In both models the foreign shocks predict the highest share of variation in the domestic output changes and the lowest

part of variation – in price level and exchange rate. Overall, the shorter-period model confirms our findings and evidenced that the effect of the crisis of 2011 is correctly captured by the dummies in the baseline model.

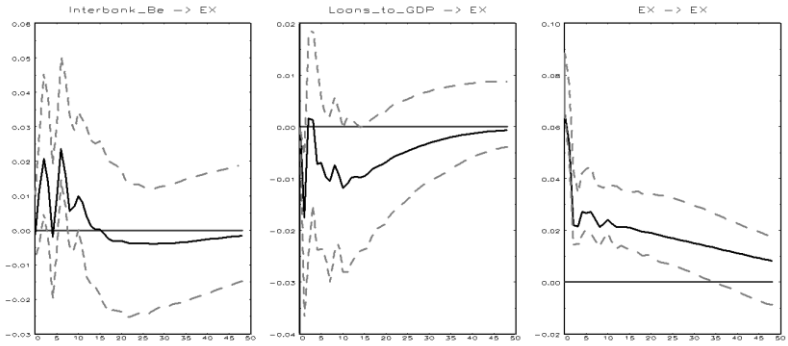
6.3 Sensitivity to Introducing Another Dummy Variable

Finally, we check the sensitivity of the baseline model to inclusion of another variable – *D_CUnion* – that equals 1 in the period *from July 2010 until December 2013*. The dummy is included only into the equation of the net export. This allows us to account for the abolition of trade tariffs after creation of Customs Union of Belarus, Russia and Kazakhstan that is believed to have caused influence on import and export flows. The dummy is found to be significant at 1 percent confidence level.

Figure 6.5: Exchange rate impulse responses - model with another dummy



Foreign demand shock *Oil prices shock* *Foreign monetary shock*



Interest rate shock *Credit chock* *Exchange rate shock*

Figure 6.5 presents the impulse responses of exchange rate to foreign and domestic monetary shocks. No significant differences with the baseline model are found except for the response to the domestic interest rate shock that appears to be highly fluctuative in the short run. According to the variance decomposition results, adding a dummy for Customs Union leads to smaller role of foreign innovations in

explaining the net export compared to the baseline specification. The dummy variable coefficient is negative (-381.895) suggesting the overall negative effect of the change of terms of trade on Belarusian foreign trade balance.

Table 6.6: Fraction of variances attributed to foreign and domestic shocks - model with another dummy

	Foreign shocks after 6 months	Foreign shocks after 24 months
Output gap	53%	65%
Price level	21%	26%
Interest rate	33%	36%
Money demand	28%	42%
Credit/GDP	34%	52%
Exchange rate	19%	20%
Net export	14%	22%

7 Conclusions

In this thesis we have developed a structural Vector Autoregressive model of the Belarusian economy with block exogeneity restrictions. Key insights which differentiate this work from previous studies come from imposing some reasonable restrictions on contemporaneous relations among Belarusian macroeconomic variables and from including variables representing exogenous block.

During the period under study (2004-2013) two crises took place that hit Belarusian economy. Applying dummy variables for these periods leads to estimated behavior of variables in the normal times (covering most of the period). So, the results obtained provide an important insight into the functioning of the economy of Belarus and the foreign factors that may undermine its stability.

First, we analyzed the effect of foreign shocks on Belarusian macroeconomic variables. Russian demand shock is found to result in economically and statistically significant increase in domestic output and net export. Russian monetary contraction also has a notable spillover effect on Belarusian interest rate. Interestingly, the effect of oil price shock on Belarusian output is found to be positive.

Next, we identified domestic monetary policy shocks and found that the exchange rate channel plays the most important role in Belarusian monetary policy transmission mechanism. Unexpected domestic currency depreciation causes decline in output and deterioration of foreign trade balance. In the long run it leads to significant contraction of credit to the economy and growth of prices.

As for the importance of foreign shocks, we found that they account for 20 to 60 percent of fluctuations in the Belarusian variables in the long run. Specifically, foreign interest rate shocks explain around 30 percent of fluctuation in Belarusian interest rate, money demand and loans over GDP ratio. Russian demand and oil price shocks account for a large share of variation in domestic output gap (19 and 39 percent respectively) and net export (14 and 10 percent respectively). Domestic prices and exchange rate are found to be the least influenced by foreign shocks. Overall, the direction of responses and importance of foreign shocks are robust across identifications and give evidence about importance of foreign shocks for Belarusian variables, especially for the output gap.

Regarding the macroeconomic policy, the thesis finds support for the view that one of the important questions for Belarussian authorities should be the way of the economy stabilization in response to external shocks. Deepening the integration with Russia within the framework of Customs Union could be beneficial for Belarusian foreign trade and output in terms of improved access to Russian market and probably better negotiation position on the price of oil, that would mitigate the negative impact of Russian shocks on Belarus. At the same time, a possible integration of the monetary system could make domestic monetary policy even less powerful in affecting domestic economic activity. To reduce the risks connected with dependence on one strategic partner, the structural economic reforms could be helpful in foreign trade diversification. The credit market liberalization could increase the role of interest rate channel in monetary transmission and improve the efficiency of domestic monetary policy.

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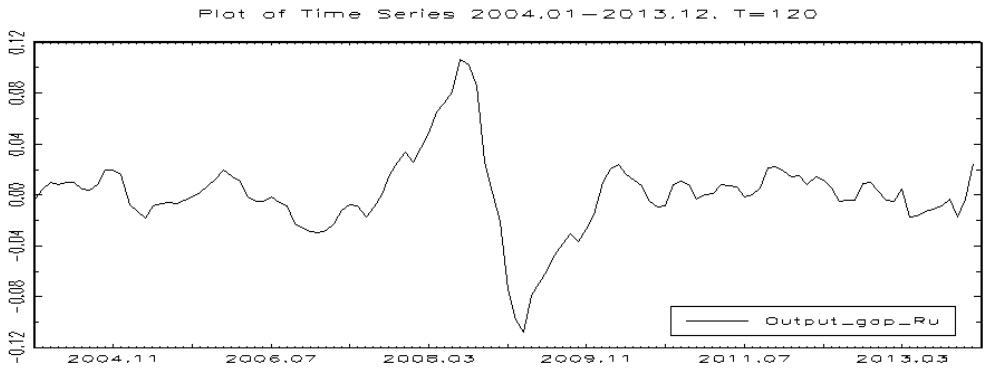
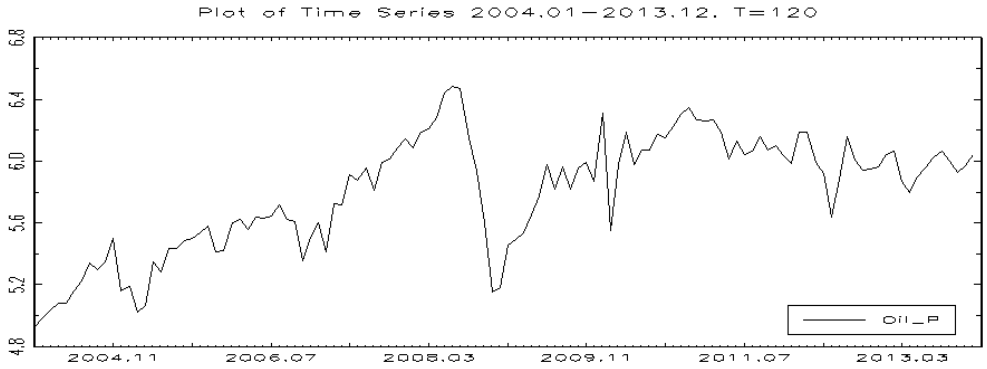
Appendix A

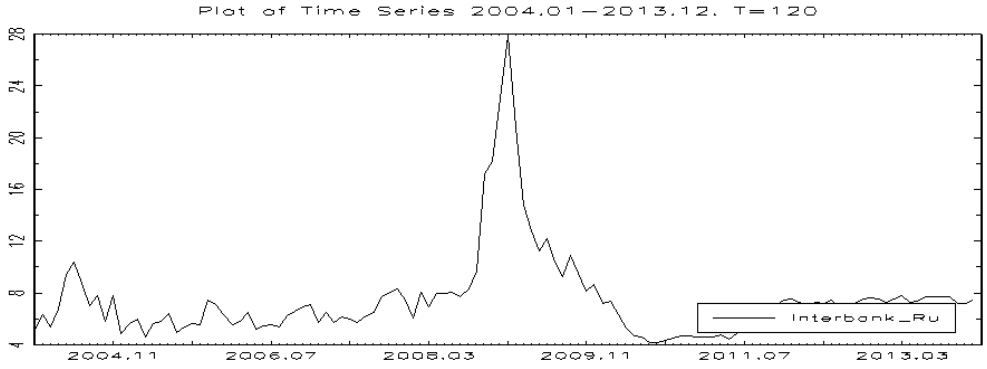
A.1 Plots of the Series



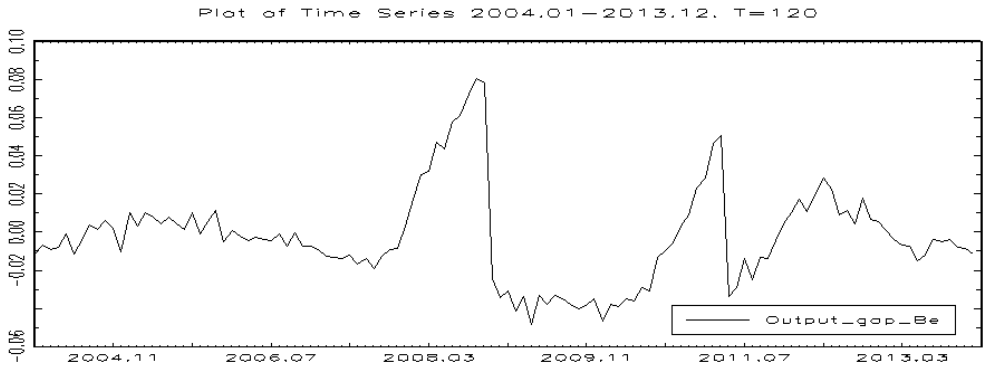
Output gap obtained from log real GDP of Russia



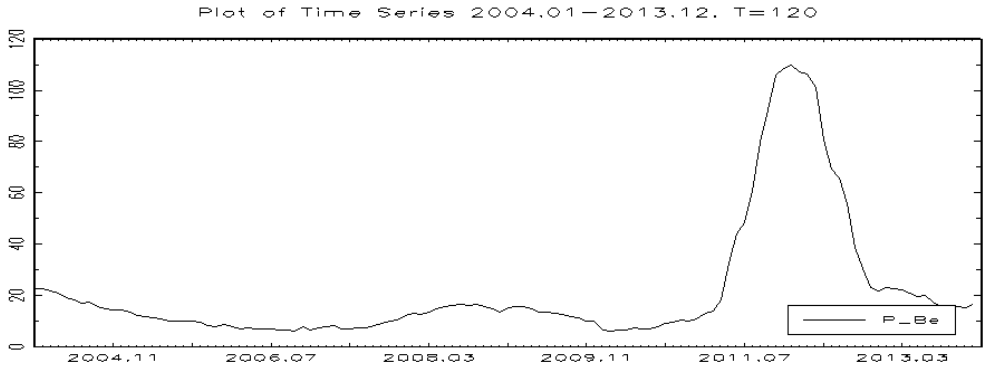
Prices of crude oil imported to Belarus, logs



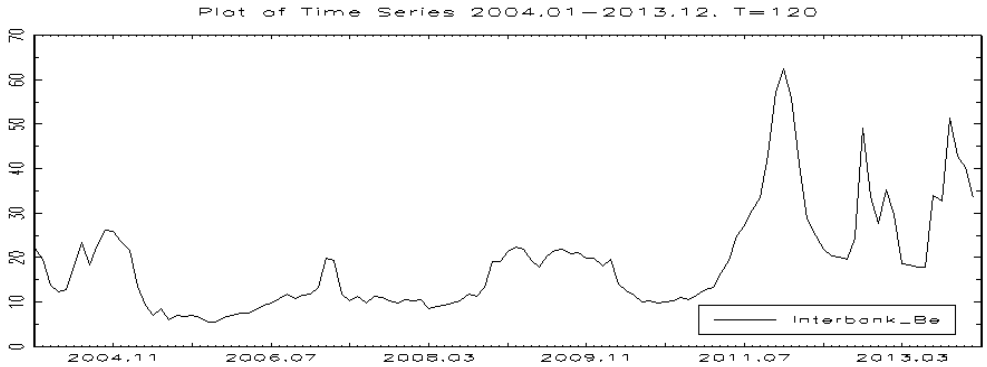
Russian 3-month interbank rate, percent



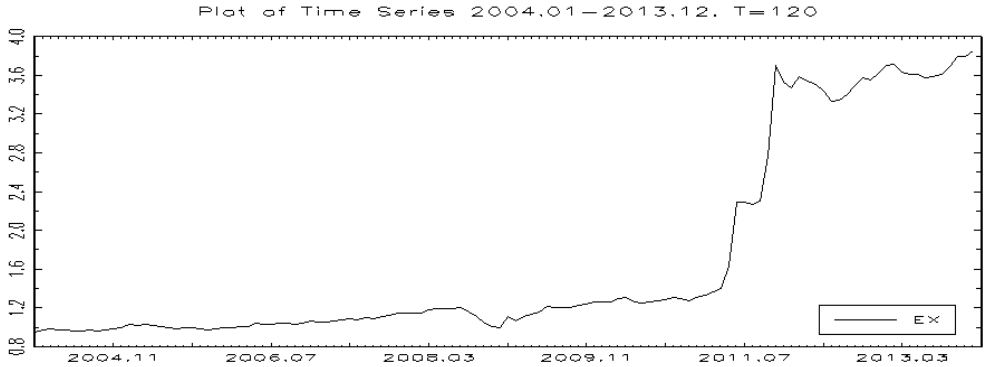
Output gap obtained from log real GDP of Belarus



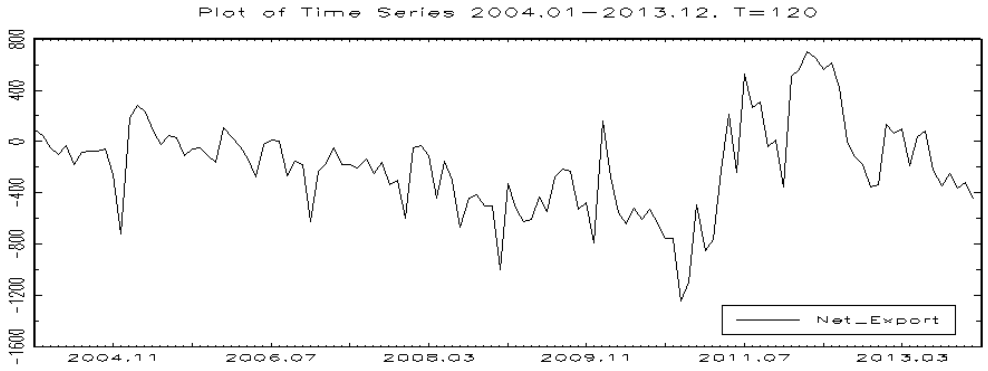
CPI of Belarus, y-o-y change in %



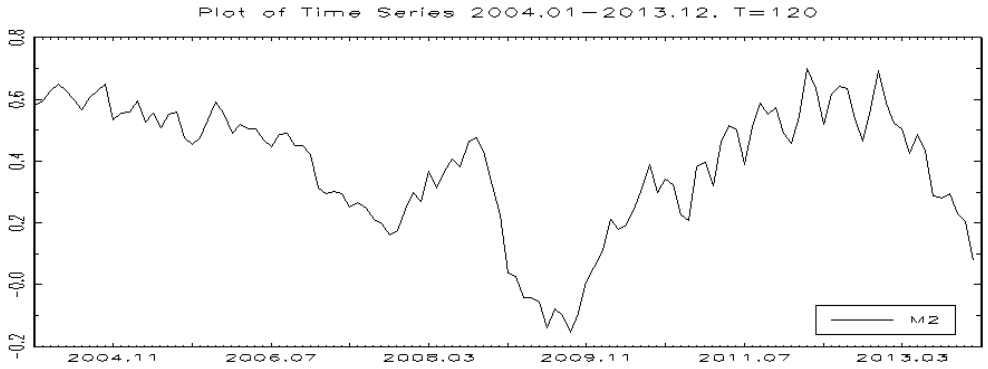
Interbank rate in Belarus, %



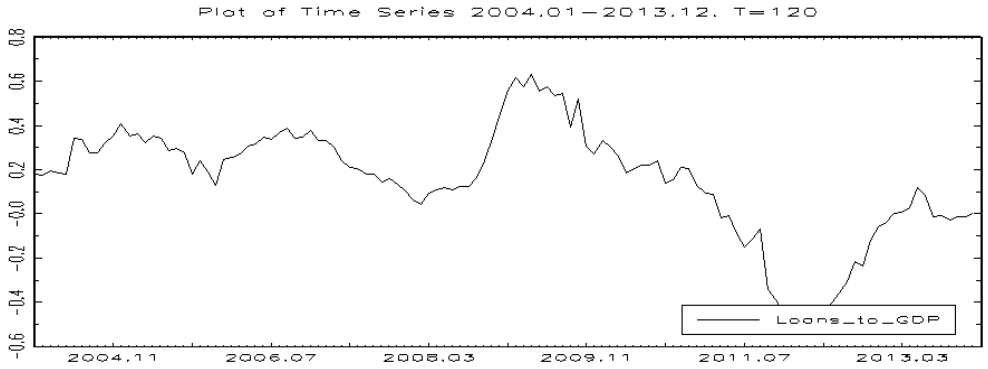
Index of nominal effective exchange rate, BYR per unit of foreign currency



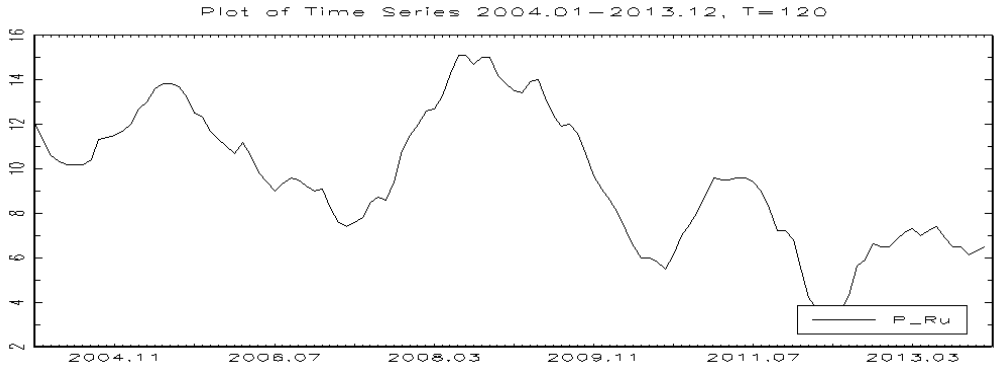
Net export, $ mln



Money supply (M1), y-o-y change in percent



Loans in national currency-to-GDP ratio, y-o-y change in percent



Russian CPI, y-o-y change in percent

A.2 Stability Tests

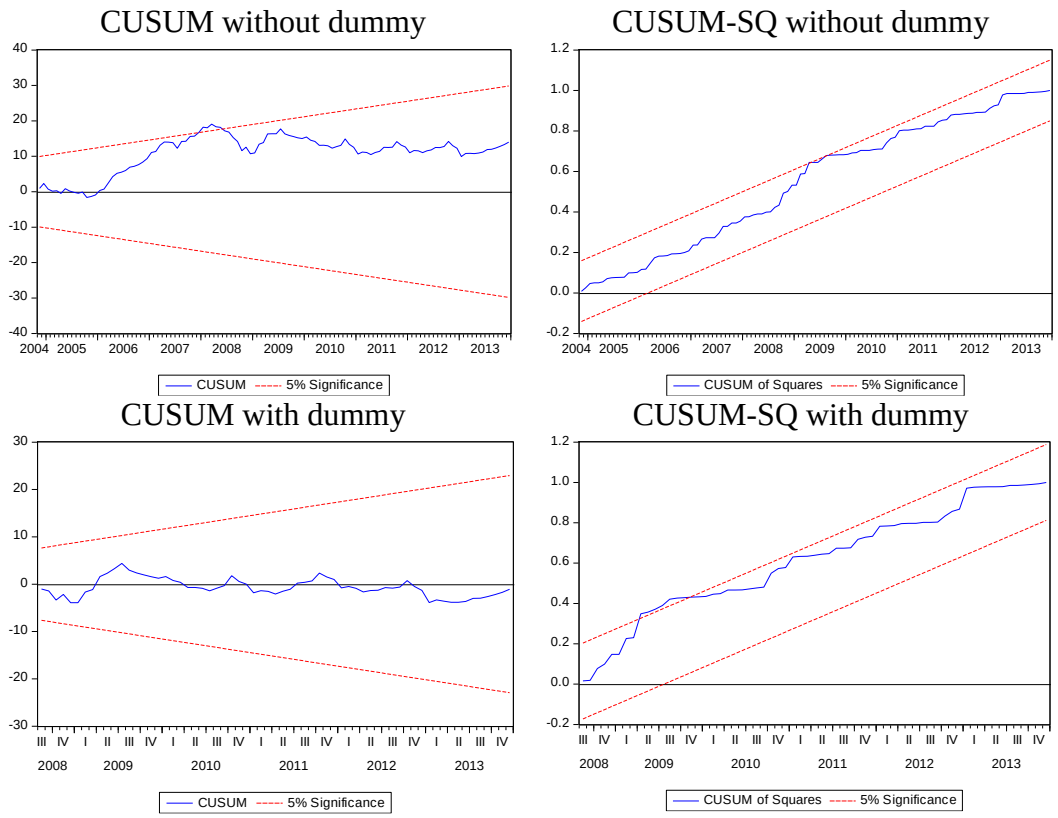


Figure: Foreign output gap

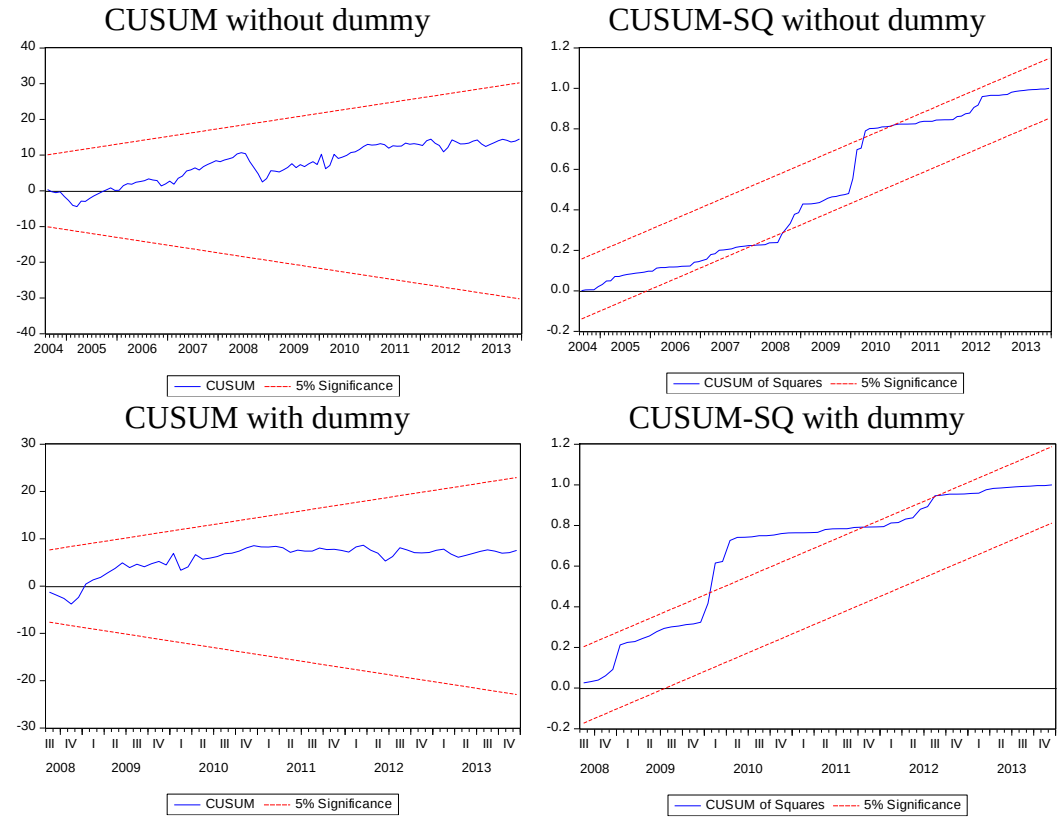


Figure: Oil prices

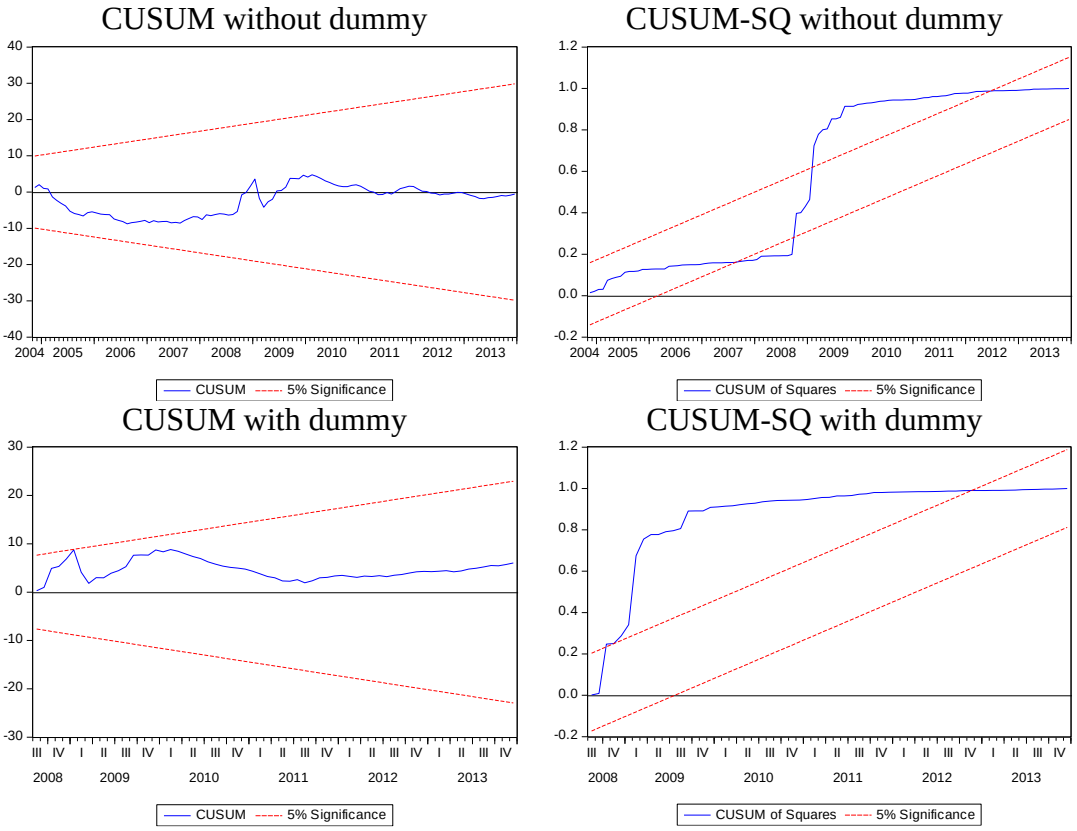


Figure: Foreign interest rate

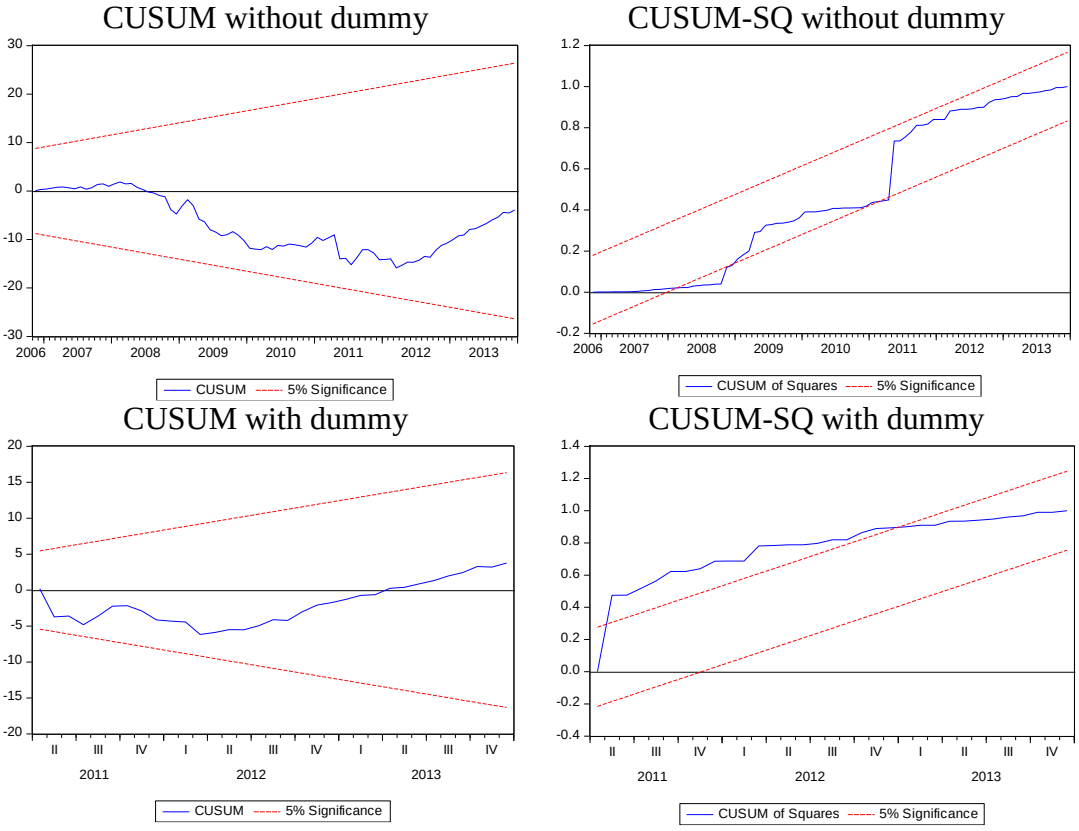


Figure: Domestic output gap

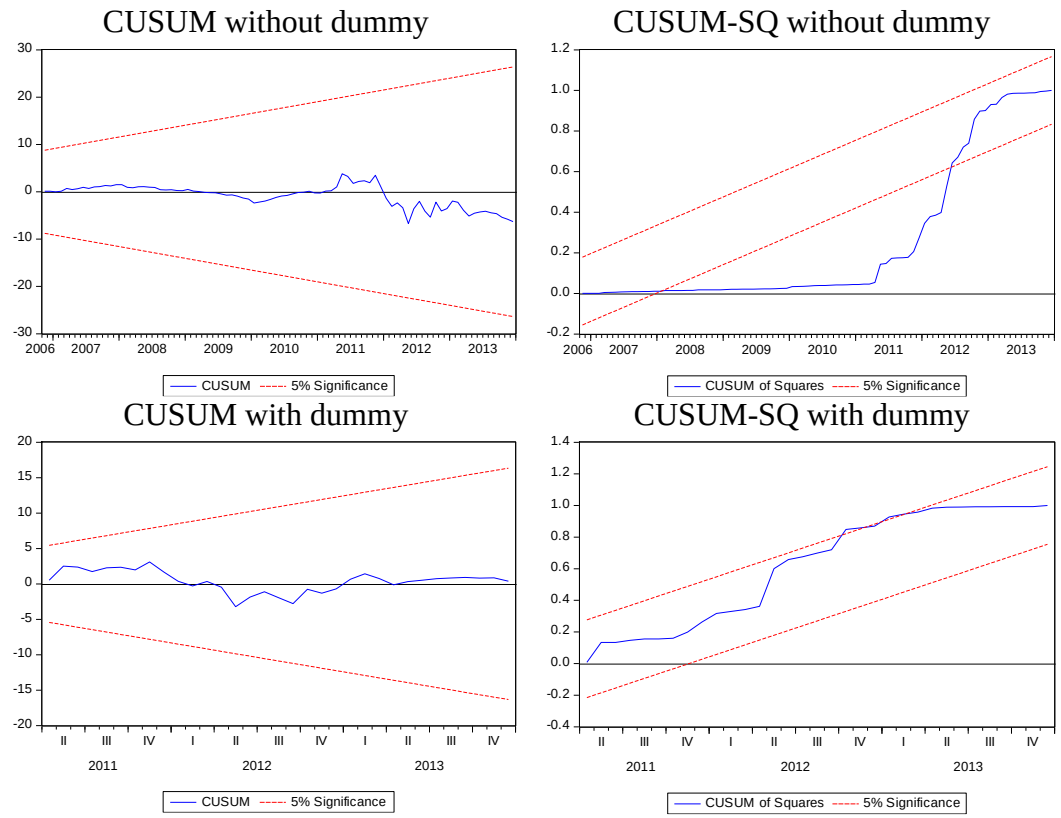


Figure: Domestic prices

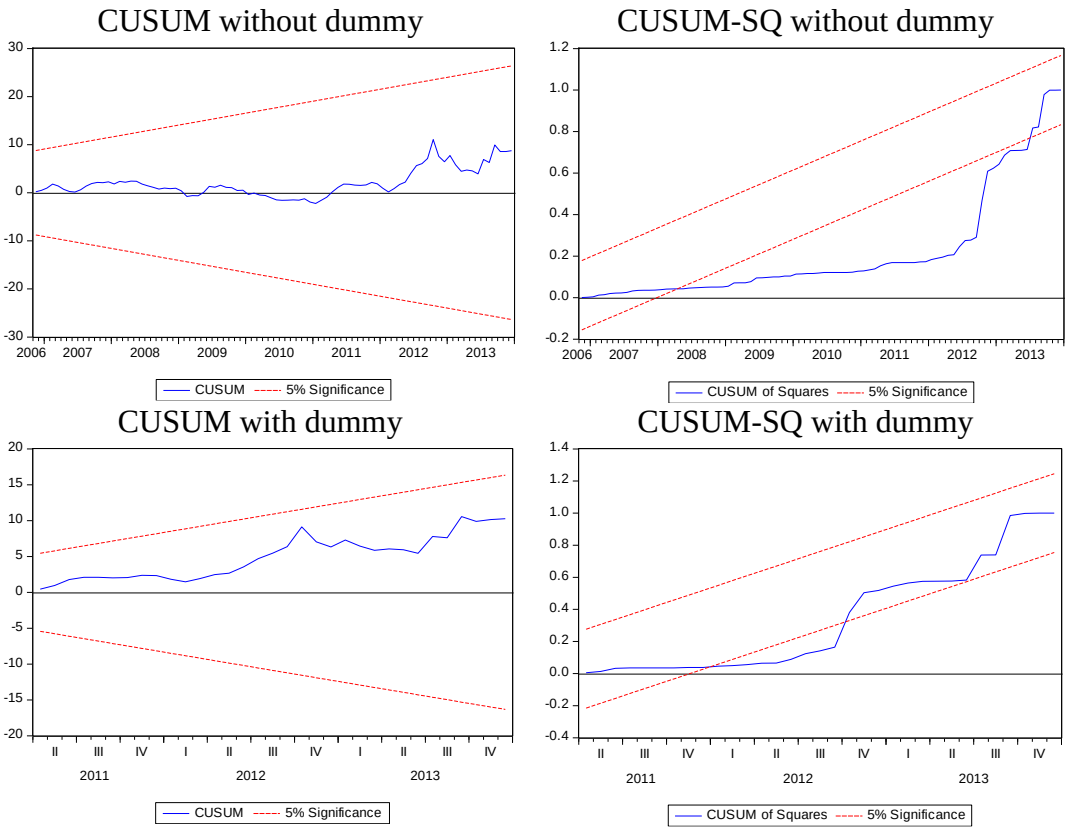


Figure: Domestic interest rate

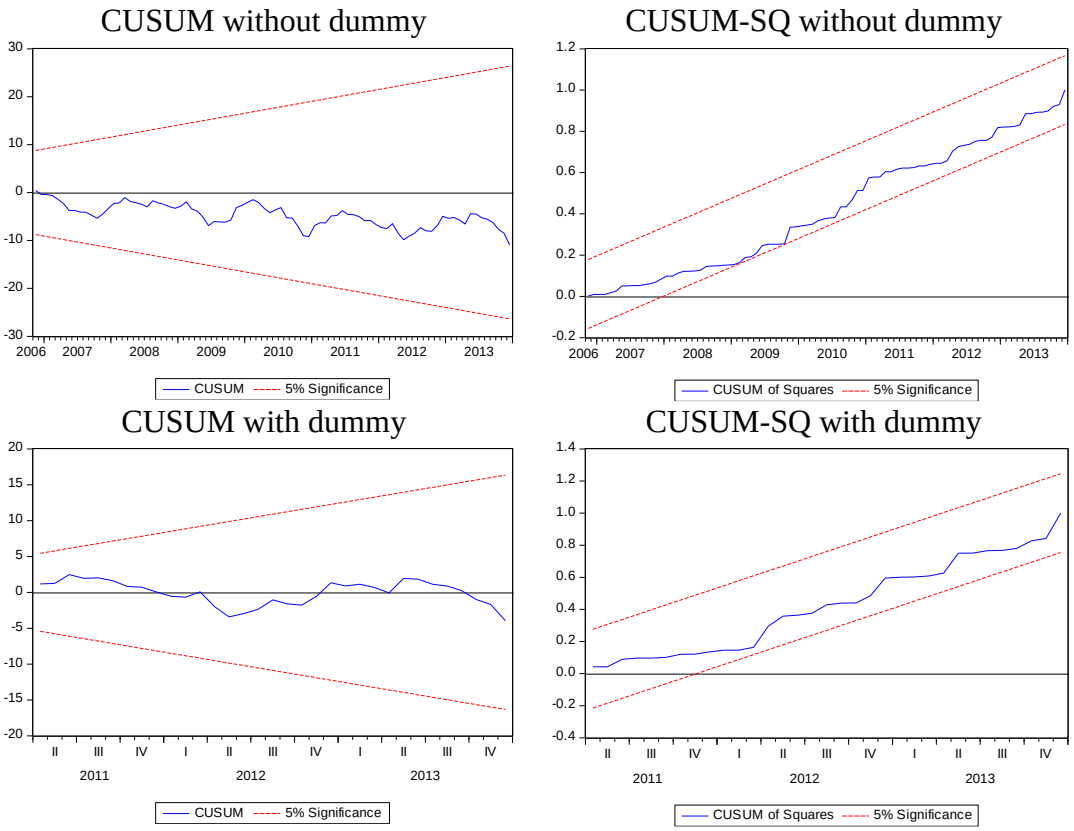


Figure: Domestic money demand

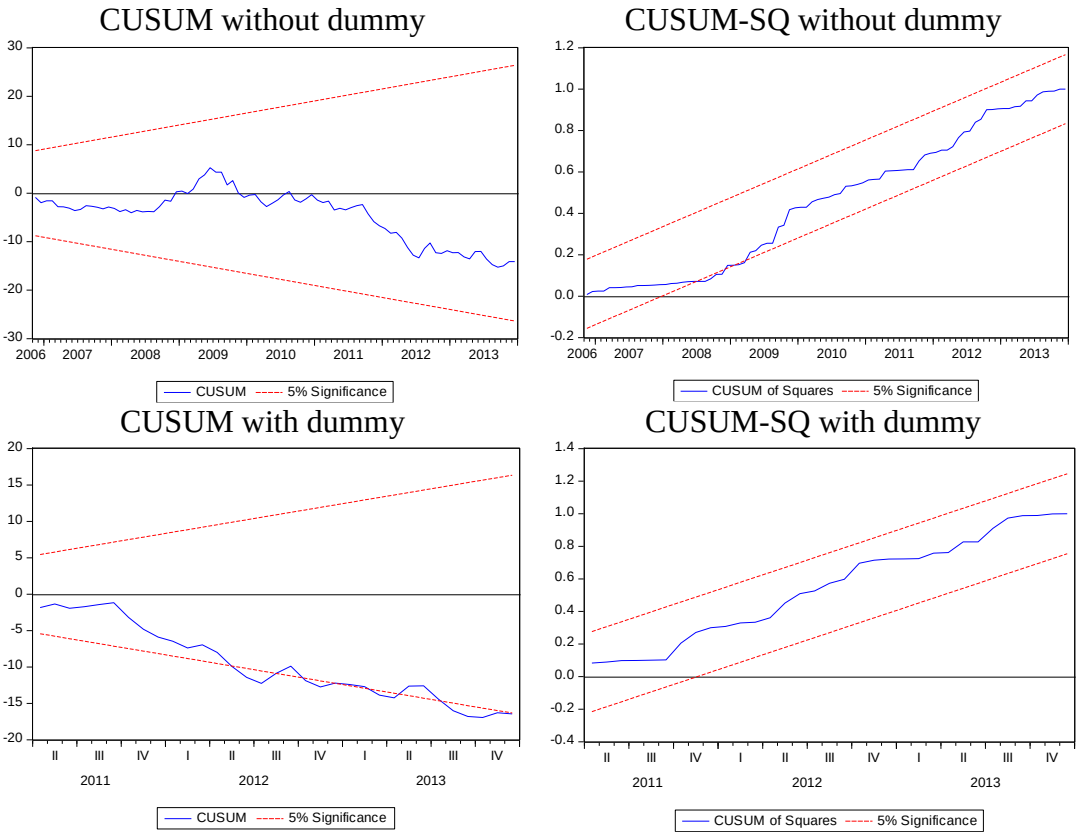


Figure: Domestic credit/GDP ratio

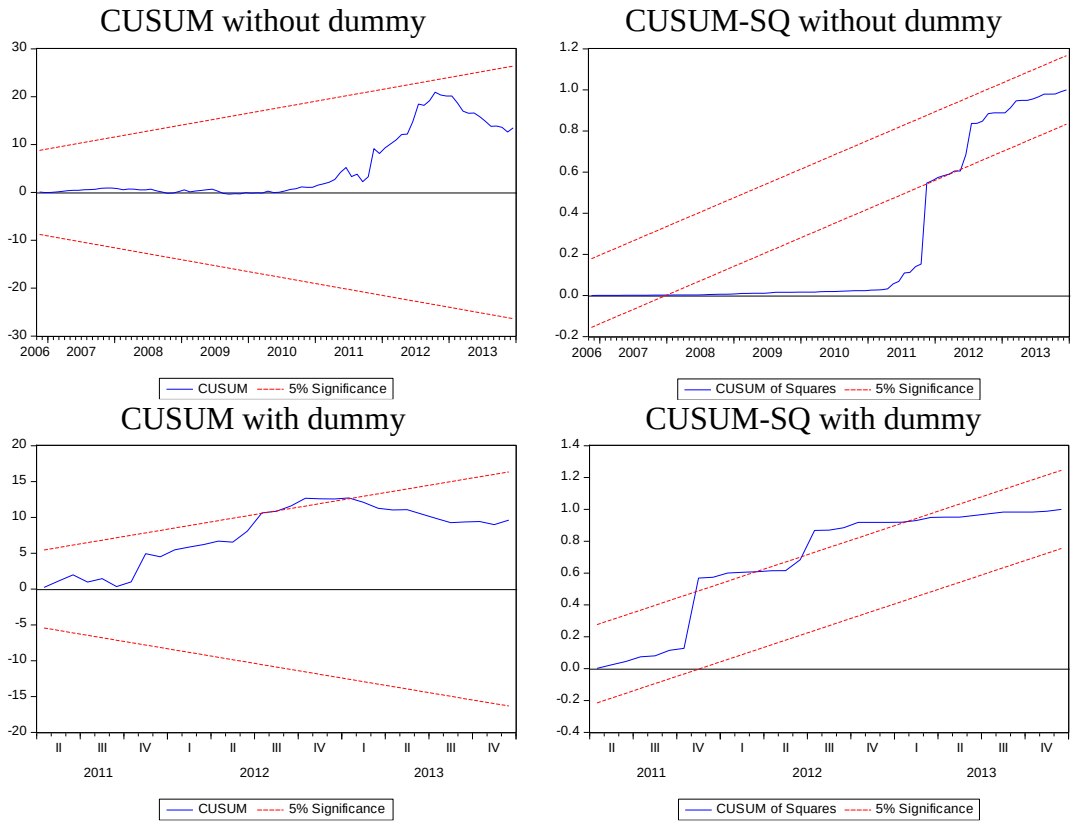


Figure: Exchange rate

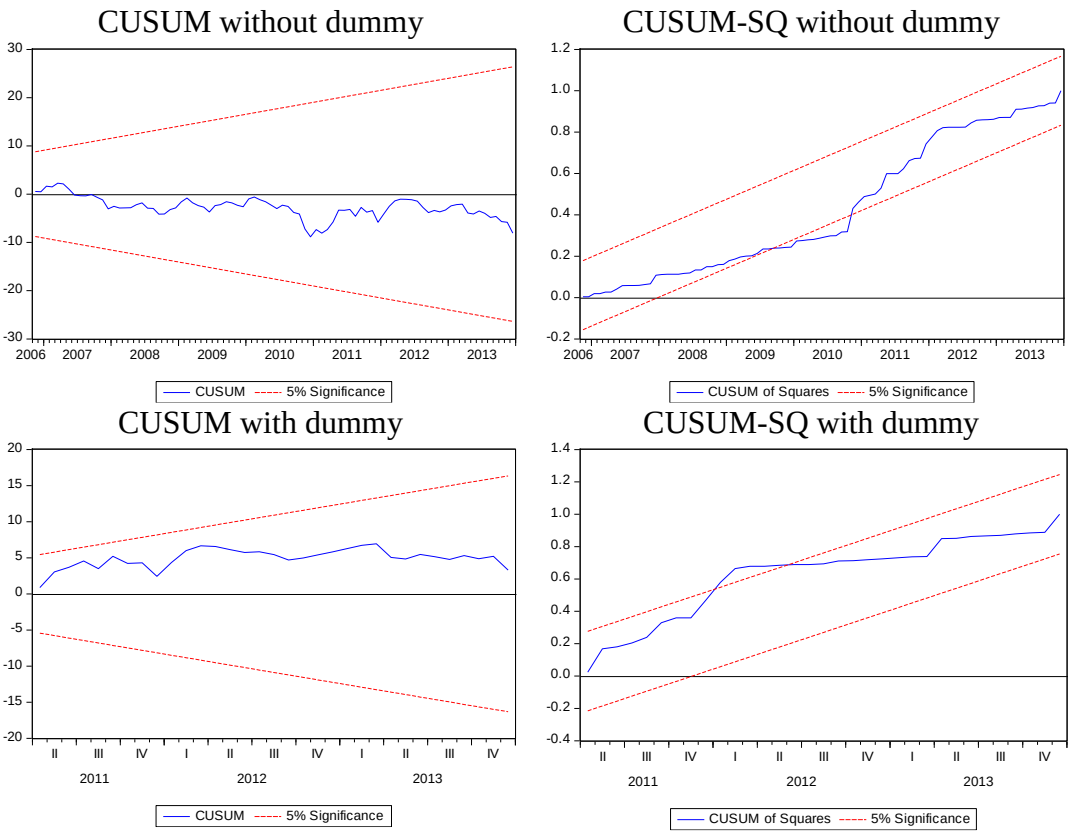


Figure: Net export