MACROECONOMIC EFFECTS OF THE RECENT OIL PRICE SHOCKS IN CEE NET OIL IMPORTING COUNTRIES

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ABSTRACT

The paper studies the effects of oil price shocks on real economy of ten net oil importing CEE countries. In particular, I focus on the relationship between oil prices and GDP growth which is analysied by multivariate Vector Autoregressive Model. I find evidence of non-linear effects of oil price shocks on real economic activity for most of the countries with oil price increases having greater negative impact in terms of magnitude than that of oil price decreases. However, the shocks themselves are found to be statistically significant only in few cases. From the Granger Causality analysis I conclude that oil prices have direct or indirect impact on real activity in all the countries but Croatia, Poland and Romania. An increase in oil prices is found to have a negative effect on the GDP growth in the short-term for all the countries under study. The results from different specifications for individual countries show that the largest accumulated loss of GDP growth after a positive oil price shock is reached in the Czech Republic while the accumulated gain in GDP growth is found for Estonia, Hungary, Latvia and Lithuania. The surprising result of a positive impact of the shock for some countries can be explained by relatively low dependence of these countries on imported oil and the mitigating effect of the other macroeconomic variables. Moreover, the structure of the economy and the success of transition reforms also matter for the significance of the impact of oil price shocks.

CONTENTS

1. Introduction

Recent oil price increases have created concerns about their impact on the economy of different countries. As economic activity is heavily dependent on energy use (see Table 1), oil use in particular, runaway oil prices could become inflationary and cause an economic recession. This is especially true nowadays given the world's growing appetite for energy (see Figure 1). According to the International Energy Agency (IEA), global energy needs are likely to continue to grow steadily for at least the next two-and-a-half decades. If governments stick to current policies, the world's energy needs will be more than 50% higher in 2030 than today (or 37% higher with alternative policy scenario). Over 60% of that increase would be in the form of oil and natural gas (IEA (2005)).

Since the oil crises of the 1970s there has been a strong interest in the presumed macroeconomic consequences of oil price fluctuations. However, despite substantial research, we are still far from a consensus about the channels through which oil prices influence the economy and the magnitudes of their effects. The oil price swings of the past few years have been substantial, making, thus, an understanding of those effects especially important from a policy perspective.

The consequences of oil price fluctuations are expected to be different for oil importing and oil exporting countries. Whereas an oil price increase should be considered bad news for the former countries the opposite should be true for the latter. The transmission mechanisms through which oil prices have an impact on real economic activity include both supply and demand channels. The supply-side effects occur from the fact that oil is a basic input to production;

therefore, an increase in oil price leads to a rise in production costs and consequently induces firms to lower output. The demand-side effects stem from the impact of oil prices on consumption and investment. It is worth noting that oil price changes also influence foreign exchange markets and inflation, giving thus rise to indirect effects on real activity.

By the mid-1980s the estimated linear relationship between oil prices and real economy began to loose significance. In fact, the declines in oil prices observed over the second half of the 1980s had smaller effects on the economy than predicted by linear models (e.g., Jones *et. al.* (1996)). Initially, the weak response of economic activity to oil price decreases was seen as a breakdown in the relationship between oil price movements and the economy, making researchers to start examining different oil price specifications in order to reestablish its significance. Thus, Mork (1989),[1] Lee *et al.* (1995) and Hamilton (1996) introduced non-linear transformations of oil prices. To be more specific Mork (1989) allowed for increases and decreases of oil prices to be used as separate variables. Two other non-linear measures, namely scaled specification and net specification, were proposed by Lee *et al.* (1995) and Hamilton (1996), respectively. The former takes the volatility of oil prices into account, while the latter considers the amount by which oil prices have gone up over the last year.

While the empirical studies developed into the area of non-linear relationship between oil prices and real activity, the theoretical literature is normally not explicit about this issue. Thus, classic supply-side effects cannot explain asymmetry. Operating through supply-side effects, reductions in oil prices should help output and productivity as much as increases in oil prices

[1] Mork found that increases of oil prices have different effects from those of oil price decreases. The latter turned out to be statistically insignificant in the US. This implied a departure from the linear specifications, in which oil price rises and falls have symmetrically equal impact on real economy. Similar asymmetry was also found at a more detailed industry level, and further research established that economic activity in seven industrialized countries responded asymmetrically to oil price movements.

tend to hurt them. Accordingly, economists have begun to explore the channels through which oil prices affect economic activity asymmetrically (Lilien (1982), Hamilton (1988), Davis *et al.* (1997)). Monetary policy, adjustment costs, coordination problems, uncertainty and financial stress, and asymmetry in the petroleum product markets have been offered as explanations. Of these explanations, adjustment costs, coordination problems and financial stress seem the most consistent with the historical record (Brown *et. al.* (1999)).

Empirical studies analysing an impact of oil price shocks on the US economy have been recently extended to other developed countries including a few works for low-income countries (e.g., Dudine *et. al.* (2006)) although there is a surprising lack of research devoted to transition economies. Therefore, the present paper contributes to the existing literature in three ways. First, unlike most of the studies, I focus on the consequences of recent oil price shocks on ten net oil importing Central and Eastern European countries (CEEC). Second, I assess the relationship between oil prices and real activity by adding extra possible transmission channel, namely imports from EU-15 Member States which is suggested by the dependence of the economic growth of CEE countries on the economic activity in the rest of the EU. Third, and last, for this assessment I use linear and three leading non-linear approaches, that is asymmetric, scaled and net specifications. To my knowledge, it is the first paper aiming to examine oil price-real activity relationship for this region using such a variety of oil price shock measures. The puzzling feature of the effects of oil price rises in the region is their positive impact on economic activity for some of the countries under study as well as general insignificance of oil price shocks with rare exceptions. Therefore, the paper also contributes by identifying possible factors that mitigate a negative impact of oil price shocks. My interest in CEE countries can be explained by vulnerability of their economies to external shocks, including oil price fluctuations, and the need to identify main transmission channels of oil price shocks to real economy for adequate policy responses. Thus, the purpose of the paper is to measure an impact of oil price shocks on real activity of net oil importing CEE countries and to identify the role and significance of major transmission channels. The main hypothesis regarding this impact stems from the empirical findings which report the weakening relationship between oil price shocks and real economy since 1990s. In order to verify whether this tendency holds for the considered countries I use six-variable Vector Autoregressive Model applied to the quarterly data from 1995:Q1 to 2005:Q1.

The main findings may be summarized as follows. As the first step, the Granger Causality type analysis show that oil prices do not directly Granger cause GDP growth in all countries in the linear specification and in Croatia, Poland, Romania and Slovenia in all specifications. However, the Wald test which verifies the significance of oil price coefficients in the VAR framework that is the hypothesis that oil price shocks impact real economy through the third variables in the model shows that oil price variable is significant in at least one specification for all countries but Croatia, Latvia, Poland and Romania. Combining the results of these two tests I conclude that oil prices have direct or indirect impact on real activity in all countries but Croatia, Poland and Romania. The same Wald test is applied to the other variables in order to identify their relative importance in model as a whole. Its results indicate that the variables play an important role in the VAR framework and shape the relationship between oil prices and real activity in all countries but Lithuania, Poland and Slovenia.

An increase in oil prices is found to have a negative effect on the GDP growth in the short-term for all the countries under study. Nevertheless, the oil price shock itself is found to be statistically insignificant for most of the countries in all specifications of the model. There are four exceptional cases, however, which are the following: asymmetric measure of the negative oil price shock for Hungary, scaled measure of the negative oil price shock for Slovakia, and net measure of the positive oil price shock for Estonia and Lithuania, which produce an immediate significant impact on real activity of these countries. The largest impact of an oil price shock occurs during the year of the shock depending on a country, being reached in either the second or the fourth quarter. After this the impact of the shock becomes very small, dying out almost completely after two years. Three countries, namely Estonia, Hungary and Slovenia, experience also the second largest fall in the GDP growth around the tenth quarter after the shock. The Czech Republic reacts differently from the rest of the countries showing the sustained fall in the GDP growth during the second and the third year after the shock in scaled and net specifications. The results, obtained from different specifications, are qualitatively similar, though in magnitude being the largest in net specification and the smallest in scaled specification. Among the medium-sized results these are bigger in asymmetric specification showing the importance of separation positive and negative movements of oil prices. The numerical difference of the results is explained by the specific features of the corresponding measures of the shock.

Focusing on the countries where the corresponding oil price shock measures are statistically significant the numerical results are the following: by the end of the second year after the 100% oil price shock accumulated loss of the GDP growth in the Czech Republic equals 0.3% from asymmetric specification, and 8.2% from net specification. Estonia experiences the accumulated loss of the GDP growth after the 100% oil price shock during the year of the shock which ranges from 10.8% to 0.2% depending on the specification. However, by the end of the second year after the shock the accumulated gain of the GDP growth which varies from 1.2% in scaled specification to 19.5% in net specification is observed. For Hungary the accumulated gain of the GDP growth after the 100% shock is around 2% for asymmetric specification and 7.6%

for net specification. Surprisingly, oil price decreases from asymmetric specification constitute a significant advert shock to the real activity accounting for 2% loss of the GDP growth during the first two quarters of the shock. For Latvia only oil price increases from asymmetric specification significantly impact real activity with accumulated gain of the GDP growth reaching 9% by the end of the second year after the 100% oil price shock. Linear and net specifications show that Lithuania undergoes immediate significant loss of the GDP growth of 3% and 4.8%, accordingly. After this, by the end of the second year after the shock, the accumulated gain of the GDP growth of 7.5% and 17%, accordingly, occurs. For Slovakia, the negative oil price shock from scaled specification produces the significant immediate impact of +1.2% of the GDP growth which oscillates around 1% during the following two years. The effects of oil price increases from the same specification are not, economically, different from zero. Overall, oil price decreases are found to be statistically significant for Hungary and Lithuania in asymmetric and scaled specifications and for the Czech Republic and Slovakia in scaled specification, producing economically negligible effect on real activity in Lithuania and equivalent impact to that of oil price increase in the Czech Republic and Hungary in scaled specification. However, for the latter country, the negative 100% oil price shock from asymmetric specification causes the significant immediate loss of the GDP growth of 2% while for Slovakia in scaled specification the same shock leads to immediate gain of 1.2%. From the inspection of the variance decomposition I conclude that oil price shocks together with inflation and short-term interest rate are considerable sources of volatility for most of the variables in the model. For real GDP, however, REER and EU-15 imports play no less significant role.

The paper is organized as follows. In Chapter 2 I discuss macroeconomic situation during the last fifteen years, individually, for each country under study. Chapter 3 presents the data used in econometric analysis and variables' description together with the economic justification of their use. Model specification and the measures of oil price shock are described in Chapter 4 while in the next Chapter I discuss empirical results obtained from the model estimation. Chapter 6 concludes by the evaluation of the results from economic perspective for individual countries under study.

2. Macroeconomic dynamics in the CEE net oil-importing countries during the last fifteen years

The countries of Central and Eastern Europe (CEE) have recently experienced the whole burden of the transition period to a market economy and Western-style democracies (see Table 2), as well as of structural reforms required for their accession to the European Union. During the last fifteen years the Central European economies had several speculative attacks some of which developed into a currency crisis, abandonment of the fixed exchange rate regime and devaluation of the currency. Although the trade relations with former Soviet Union countries weakened after the break down of the COMECON, the recession in Russia during the crisis in 1998 also had considerable impact on the countries in the region. For example, the Baltic countries, affected by the Russian crisis in 1998, experienced a decrease in economic growth. The Czech Republic's crisis in 1998-99 was partly the result of a decline in growth in Germany and the effects of the Russian crisis. By now all considered countries but one, namely Croatia, have been accepted in the European Union. The accession process re-oriented the economies of CEE countries in the direction of the EU making them dependent on the economic activity of the latter.

The structure of the economy of each of the ten countries under study plays an important role for the macroeconomic effects of oil price shocks. These countries are characterized by high energy-intensity of production, higher labor intensity and a smaller share of oil products consumption in the CPI baskets.[2] The oil dependence of these countries had been decreasing at the beginning of the transition period due to the common output losses as a result of economic

[2] Energy intensity is a measure of the energy efficiency of a nation's economy and is calculated as units of energy per unit of GDP.

crises as well as the reduction of the industrial production as a share of GDP.[3] However, the recovery of their economies and still low energy effectiveness of production have somewhat reversed this process. The total energy dependence of the ten CEE countries is much smaller than that of the fifteen-state EU before the 2004 enlargement. In 2002, the average share of imports in domestic energy consumption in CEE countries was 61.9%, while the EU average was 77% (see Table 3). However, the CEE average has major variations in the background. Import dependence is lowest in Romania and Poland (about 30%-35%). At the other end of the scale, Lithuania, Slovakia and Croatia are very dependent on energy imports.

In this chapter I examine the trends in the oil consumption during the last decade for considered countries as well as their overall macroeconomic performance along this period.

2.1 Croatia

The imports of energy in Croatia cover 40% of the country's consumption of energy while oil accounts for 40% of total energy imports. After 1992 there was a slight rise in the demand of oil. Decrease in domestic production compared to imported oil is a trend that was expected and it will continue in the years to follow given the diminishing oil reserves in Croatia. Total energy consumption in Croatia in 2004 increased by 4.1% in comparison with the previous year. In relation to the lowest consumption achieved in 1992, the total energy consumption was increased by 37.8% but still did not reach the level from 1988. The anticipated consumption of oil products is expected to grow by 10% till the year 2025. In 2004 the energy intensity (energy consumption for GDP unit achievement) showed a negative tendency, decreasing by 0.3%. However, in comparison with the European Union the average amount of the energy intensity in

[3] Oil dependence of a country is identified as a percentage of imported oil in total oil consumption.

Croatia is approximately 24% higher, which represents the obstacle to the development of entire Croatian economy and achievement of sufficient competitiveness level.[4]

Before the dissolution of Yugoslavia, Croatia, after Slovenia, was the most prosperous and industrialized area with a per capita output perhaps one-third above the Yugoslav average. After the break-up of former Yugoslavia, Croatia experienced rapid growth in the number of banks, strong deposit growth and substantial increases in deposit interest rates in the period 1995-1998. The failures of numerous medium-sized banks in 1998 and 1999 led to the first currency crisis in September 1998. Another factor that contributed to the deep recession in 1999 was the Kosovo conflict, which affected tourism – a key source of foreign exchange. The economy emerged from a mild recession in 2000 with tourism, banking, and public investments leading the way. However, another currency crisis happened in August 2001, caused by self-fulfilling private expectations. Nowadays, unemployment remains high, at about 18%, with structural factors slowing its decline. While macroeconomic stabilisation has largely been achieved, structural reforms lag because of deep resistance on the part of the public and lack of strong support from politicians. Growth, while impressive at about 3% to 4% for the last several years, has been stimulated in part through high fiscal deficits and rapid credit growth. The EU accession process should accelerate fiscal and structural reform. Market liberalization has already affected the telecommunications, transport and energy sectors. As energy and infrastructure are key building blocks of development in Croatia, the liberalization of the energy market suggests lower effect of oil price shocks on CPI, because producers do not have the monopoly power to transfer the increase of oil prices into output price increase. Moreover, stable

[4] All the numbers are taken from the Croatian Chamber of Economy Industry and Technology Department, July, 2006 and Austrian Energy Agency.

growth and the lowest dependent ration on imported oil in my sample suggests that oil price shocks do not have considerable impact on real activity.

2.2 Czech Republic

The Czech Republic is the third largest oil consumer, in terms of magnitude, after Poland and Romania, among the considered countries (see Figure 3). The majority of domestic consumption of oil is ensured by means of import. In-hand oil production of the Czech Republic provides only about 4% of the consumption. The present level of domestic consumption of oil oscillates around 8 million tonnes. Total consumption of oil was influenced by the development of the Czech economy (see Figure 2). During the economic recovery (1994-1996) oil consumption was steadily increasing, while during the recession (1996-2000) it stayed approximately stable at a level of 175 thousands barrels per day. Since 2000, when the Czech economy started to gain pace, oil consumption has been showing a constant increase and by 2003 has overcome its 1995 pick of the whole transition period. In the period from 1990-2003, the measure of the total dependence on energy imports showed a marked decrease from 0.833 to 0.569 (EU-15 in 2001: 0.501).[5] GDP energy requirements have in the above-mentioned period of time decreased by 23.6% (Czech Energy Committee (2004)). Nevertheless, the hitherto relatively low performance of the Czech economy has determined the current high value of energy requirements per unit of GNP in comparison with EU-15, while the domestic consumption of primary energy sources per capita has already reached the EU-15 level. These facts show that Czech economy is energy-intensive and is dependent on imported oil, which makes it vulnerable to oil price shocks.

[5] Total dependence on energy imports is defined as a ratio of the total domestic production of primary energy sources and of the total domestic consumption of primary energy sources.

In regard to economic performance, in 1990s the Czech Republic was perceived as the most successful transition economy in Central and Eastern Europe as it achieved economic transformation with minimum unemployment and no hyperinflation. The economic development of the Czech Republic passed through four different phases in years 1990 to 2003 (1990-1993, 1994-1996, 1996-1999 and 2000 till present accordingly). The first phase is characterised be the transformation-related depression lasted till 1993 when GDP declined by 15%, industrial production by 34% and agricultural production by 24% in comparison with 1989 (Czech Energy Committee (2004)). The unemployment rates, however, remained low. The Czech economy experienced two strong inflationary shocks – the first one after price liberalization in 1991 and a second one as a consequence of the tax reform. The GDP approached the initial level of the year 1989 in the second transformation phase (1994-1996). The inflow of foreign capital intensified, the inflation rate decreased and the unemployment rate remained at the level of 3%. Strict restrictive policy, which was launched as a response to adverse economic development, contributed to the onset of the third, critical, phase. Most macroeconomic key figures stagnated or were getting worse. However, in 1999 the decline of the GDP stopped, inflation was reduced, growth of real wage was renewed and trade and balance payment improved significantly. In regard to the present phase of the economic development, the GDP has been growing constantly at an average growth rate of 3.1% since 2000. In 2000 the value of the GDP generated exceeded for the first time the level of 1990. The average year-to-year inflation dropped from 4.7% (2001) to 0.1% in 2003; registered unemployment rate reached the value of 10% at the end of 2003. Industrial production has been growing at an annual rate of 5-6% in the last three years (Czech Energy Committee (2004)).

These facts suggest that due to the high dependence of the country on imported oil and increasing trend in oil consumption as well as inflationary shocks in the 1990s the oil price shock may have a significant impact on real economic.

2.3 Estonia

Estonia is the smallest country and the smallest oil consumer in the considered region with oil consumption being relatively stable during 1994-2005 (see Figure 2). Nevertheless, Estonia has positive net imports of oil the main part of which constitute petroleum products. However, due to its size and considerable natural resources, of which oil shale is of the greatest importance, Estonia has the lowest daily consumption of crude oil among ten CEE countries (see Figure 3). Mineral products account for 7.4% of imports (95% of them consisted of fuels, of which two-thirds were light and heavy oil and one-third gas). As to the energy efficiency, despite of the fact that energy intensity of the economy dropped by nearly 60% during 1995-2003 (see Table 4), Estonia is not yet fully compliant with all EU energy regulations. Since Estonia is one of the less dependent EU-25 countries on energy sources one would not expect that oil price increases have a considerable impact on its real activity.

As to the economy, in early 1992 both liquidity problems and structural weakness stemming from the communist era precipitated a banking crisis. As a result, effective bankruptcy legislation was enacted and privately owned, well-managed banks emerged. Also the Currency Board (CBA) was introduced in 1992. The most direct consequence of the changed economic environment has been the sharp decline in production in all branches of the economy. The cumulative decline of the GDP during the period 1990-1994 was 36%. However, over the last fifteen years Estonia has made remarkable progress in transition and it is one of the most advanced countries among the new EU member states. The economy has been growing by an average of close to 6% a year since 1995 though being interrupted by two banking crises in 1996 and 1998. Some 80% of economic activity is in the private sector, and price and trade liberalisation, enterprise privatisation and effective financial sector reforms have taken place. GDP growth of 9.8% in 2005, places Estonia among the fastest growing economies in the region. Main drivers of such a growth included technology sector exports and strong domestic demand fuelled by investment activity.

During the past decade, a broad industrial restructuring occurred in Estonia and at present the share of industry in the GDP is 22.7%, which is comparable to the economic structure of developed countries. The structure of Estonian imports has been largely determined by the necessity to purchase fuel and other raw materials. EFTA countries dominated Estonian foreign trade until 1994. As Estonia's main trading partners, Finland and Sweden, and also Austria, joined the EU from 1 January 1995, the EU share was the highest in 1995 and also afterwards. While acknowledging the significant progress made in Estonia, a few transition challenges remain and Estonia still has GDP per capita around 40% less than that of the Western European countries (Commission of the European Communities (2005)). Nevertheless, all listed facts point out that the Estonian economy is one of the least effected by oil price shocks in my sample of countries.

2.4 Hungary

Hungary is an energy-poor country, relying on imports for over half of its primary energy requirements. For example, over 80% of Hungary’s oil consumption is met by imported oil. During the period of 1994-2004 oil consumption showed slow but constantly declining trend with slight signs of recovery since the end of 2004 (see the Figure 2). Primary energy consumption per capita in 2004 was one of the lowest among EU-25 countries. Despite the fact that the Hungarian economy is relatively energy-intensive (see Table 4) all listed factors allow one to suggest that oil price shocks will not have considerable effect on real activity in this country.

As to the economic situation, Hungary enjoyed one of the most liberal and economically advanced economies of the former Eastern bloc. By 1988, Hungary had already developed a two-tier banking system and had enacted significant corporate legislation which paved the way for the ambitious market-oriented reforms. These factors allowed for relatively less disruptive effect of reforms on the economy. After Hungary's GDP declined about 18% from 1990 to 1993 and grew only 1%–1.5% up to 1996, strong export performance has propelled GDP growth to 4.4% in 1997, with other macroeconomic indicators similarly improving. These successes allowed the government to concentrate in 1996 and 1997 on major structural reforms such as the implementation of a fully funded pension system, reform of higher education, and the creation of a national treasury. Inflation has declined from 14% in 1998 to 3.7% in 2006 though unemployment has persisted above 6% and Hungary's labor force participation rate of 57% is one of the lowest in the Organization for Economic Cooperation and Development (OECD). Prior to the change of regime in 1989, 65% of Hungary's trade was with Comecon countries. By the end of 1997, Hungary had shifted much of its trade to the West. Trade with EU countries and the OECD now comprises over 70% and 80% of the total, respectively.

Nowadays, Hungary continues to demonstrate strong economic growth and acceded to the EU in May 2004. However, policy challenges have remained and include cutting the public sector deficit to 3% of GDP by 2008, from about 6.5% in 2006, and tackling a persistent trade deficit. The current government has announced and begun to implement an austerity program designed to address these issues, leading to eventual adoption of the euro.

2.5 Latvia

The Latvian economy is characterized by low energy intensity and the second lowest daily consumption of oil among the rest countries which exhibited rapid decline in 1997 and remained relatively stable since then (see Figures 2-3). Moreover, the primary energy consumption per capita in Latvia is the lowest among EU-25 countries. Overheating high growth during recent years supported by strong domestic demand together with the factors listed above suggest that oil price shocks will not affect the real economic activity of the country significantly. However, the energy market is not fully competitive since the prices of energy resources are determined by a few monopoly enterprises. This gives them power to set energy prices according to the higher oil world prices. Significant adjustment to energy prices was done recently, which gave ground to higher inflation expectations. The possibility of nearly unrestricted pass through of world oil prices to domestic prices suggests that oil price increases may have considerable inflationary consequences for the Latvian economy.

Upon regaining independence in 1991, the Latvian economy experienced a sharp economic decline as it began its transition to a market economy and lost its economic links with the former Soviet Union (FSU). Real GDP during these years fell by half. The government quickly realized that a comprehensive reform program was needed and introduced fiscal discipline as well as limits to enterprise subsidies. The country has now reached the final stages of the transition to a market economy, having acceded to the European Union in May 2004. Most markets have been liberalized, privatization is close to completion, and vital strides in legal reform, institutional development, and the social safety net are being implemented. Price liberalization took place in most of the markets early in the transition and restrictions on foreign exchange transactions have been very limited.

In the past few years Latvia has recorded impressive economic performance, with real GDP growth of 7.2% in 2003, 8.5% in 2004, and 10.2% in 2005. It has been mainly driven by robust domestic demand, both consumption and investment. Unemployment has been also declining and was at 8.7% in 2005. However, according to national statistics, 16% of the population lives in poverty. Income levels remain the lowest among the 25 members of the EU at only 47% of the EU average (in purchasing power parity, 2005). Income disparities have been one of the reasons for significant labor out-migration observed in Latvia following EU accession. As a result, labor shortages are starting to emerge and will probably expand in the coming years due to the aging population. Addressing these issues will be one of the biggest challenges ahead. There are some concerns of overheating reflected in persistent both external and internal imbalances: the current account deficit reached 12.4% of GDP in 2005 and consumer price inflation has remained persistently high at 6% since mid-2004, driven by initially by one-time effects related to EU accession but sustained by rapid credit, wage, and domestic demand growth as well as the rise in oil prices.

2.6 Lithuania

In the last ten years Lithuania has been substituting gas for oil; therefore, its oil consumption has rapidly declined from 1997 to 1999 (see Figure 2). Total primary energy consumption per capita in 2004 was one of the lowest among EU-15 countries. However, the dependence of the economy on the imported energy sources as well as energy intensity of the economy in 2004 was one of the highest (see Table 4). Thus, it is reasonable to conclude that oil price increases may have some impact on Lithuanian economy.

The economy of independent Lithuania had a slow start, as the process of privatization and the development of new companies slowly moved the country from a command economy toward the free market. By 1998, the economy had survived the early years of uncertainty and several drawbacks, including a banking crisis, and seemed poised for solid growth. However, the collapse of the Russian ruble in August 1998 shocked the economy into negative growth and forced the reorientation of trade from Russia toward the West. Thus, in 1997, exports to former Soviet states made up 45% of total Lithuanian exports. In 2005, exports to the East were only 18% of the total, while exports to EU members amounted to 65%. The 1999 crisis was the result of the government's wrong-footed economic policies and its inadequate response to the August 1998 Russian financial crisis. The policies implemented after the crisis, underscore a commitment to fiscal restraint, economic stabilization, and accelerated reforms. Thus, the year 2001 was a good one for the Lithuanian economy. The 5.9% growth in GDP went beyond even the most optimistic expectations. In 2002 the economic growth averaged at 6%. A sticking fact is that in 2003 there was deflation (change in CPI was -1.2%) while GDP picked at its maximum value for the last five years – 10.5%. The deflation was caused by a decrease in prices in food and non-alcoholic beverages, while the increase in fuel prices and transport services was negligible. An important feature of transition economies is that food expenditure has the highest share in the consumer basket. For Lithuania this share is 31%, while electricity, gas and fuel altogether weight 15% in the basket. This implies a relatively weaker relationship between oil price shocks and inflation in Lithuania. After almost two years of deflation, consumer prices increased at a rate of 2.3% in 2005, while GDP growth was 7.5%. The reasons could be high oil prices, administrative decisions, and the one-time effect of 2004 EU accession.

2.7 Poland

Poland is the largest oil consumer among the ten oil importing CEE countries with a constantly increasing trend (see Figure 2-3). These high figures of oil do not correspond to the dependence ratio or energy consumption per capita which was the lowest for Poland in 2004 among EU-25 countries (see Table 4). This may suggest a weak relationship between oil price hikes and GDP growth. In Poland the policy of low prices of fuels and energy has been conducted after WWII until 1989 what led to numerous distortions in the economy. The reform of fuels and energy prices has been initiated in 1990 jointly with the general economic reform. Price growth was very high in the first stage of the reform. In the next year the process of price adjustment was continued in more moderate way. The whole process resulted in current situation in which the prices of liquid fuels are market based. As of 2000, prices of fuels and energy, expressed in US$ by exchange rate, were by 30-50% lower than in the European OECD countries. The same prices, expressed in US$ by Purchasing Power Parity, were higher than in EU countries, and the prices of liquid fuels were considerably higher than the EU average (Sollnski (2004)). Therefore, giving current competitive Polish market oil price shocks may have noticeable impact on GDP growth in Poland in case of restrictive monetary policy.

Since the turning point of 1989, Poland has undergone great political, social and economic changes. The start of the economic reform process was extremely tough. During the period of transformation, the Polish economy was still in economic disarray and radical reform was selected as the only solution to save it. A shock therapy programme of during the early

1990s enabled the country to transform its economy into a robust market economy. Despite temporary slumps in social and economic standards, Poland was the first post-communist country to reach its pre-1989 GDP level. Consistently implemented economic policies led Poland in a relatively short time on to the list of the most dynamically developing economies in Europe. Already by the mid-1990s Poland had become known as the ‘flying Eagle of Europe’ and the ‘Tiger of Europe.’

After the financial crisis and slowdown in 2001 the general economy had been growing at a rate of nearly 6% until 2005 when the growth rate fell to 3.2%. Real salaries increased by 4% in 2003. Industrial production also grew at a 21.9%, with the private sector now accounting for more than 75% of national income (Hunter. and Ryan (2004)). While inflation had remained under control in 2002-2003, it somewhat rose in 2004 fueled by increases in fuel prices and factors having to do with Poland’s accession to the European Union while falling back to a record-low level of 0.7% in 2005 (Sollnski (2004)). In 2004 aggregate unemployment stood at 19.3% falling to 17.6% in 2005. Despite this improvement, Poland still has the highest unemployment rate in the European Union. In terms of international trade, Poland continues to expand its exports especially to the EU nations-further distancing the Polish economy from its heavy industry orientation toward the former Soviet Union. Exports to the EU now account for nearly 70% of total Polish exports. As to the national currency it has been steadily gaining against dollar since 2001/2 financial crisis. This appreciation of the zloty may cushion the effects of oil price increases on the Polish economy, however, hurting exports.

2.8 Romania

Romania's energy sector must rank among the oldest in the world, being the first country to produce oil commercially. The country is relatively energy-rich, having significant oil and gas reserves, however, the major part of these has yet to come on stream, and the historical oil fields now require higher investment. For the time being therefore, Romania has become a net-importer of crude oil and gas due to obsolete equipment and a slow-down of investment in exploration and production. In my sample of countries it is the second largest oil importer after Poland (see Figure 3). In the second half of the 1990s due to the profound economic crises Romanian oil consumption declined considerably (see Figure 2) but since then the need of import of energy resources increased from 33. 6% in 2001 to around 40% in 2005 and is estimated to increase further to 49-50% in the year 2015. The drop of energy intensity of 3% during the 1990s was mainly due to the structural change of the economy, namely drop of industry ration in total GDP form 40.5% in 1990 to 33.2% in 1996 and 25.23% in 2000 and increase of the ratio of services (Sollnski (2004)). Despite this fact Romanian economy remains one of the most energy inefficient among considered countries. All this suggests relatively small impact of oil price shocks on real activity.

Romania underwent the most abrupt economic transition of all the Central and Eastern European countries. After a steep decline in GDP of 29% in the three years after the start of the transition, economic growth returned. However, this growth was driven by credit-based expansion of existing, inefficient heavy industries, and therefore could not be sustained. In 1993, Romania embarked upon an adjustment program that showed some results. GDP, which had fallen for three consecutive years, stabilized in 1993 and registered 3.4% growth in 1994, 6.9% in 1995, and 4% in 1996. After 1997, there was again a decline in GDP of -6.6% in 1997, -7.3%

in 1998, and -4.5% in 1999. Monthly retail price inflation, which averaged 12.1% in 1993 (the equivalent of 256% annually), declined to 28% in 1995. However, inflation picked up again in 1996 and 1997 due to excessive government spending in late 1996, and price and exchange rate liberalization in early 1997. Inflation in 1999 hovered around 50% (Sollnski (2004)). The annual inflation rate registered in 2005 was around 8% with slight steady decline since after. Since 2001 the economy has been growing steadily at around 4-5%. However, despite some success in early 2000s the economy grew considerably less in 2005 than in the previous year. One of the reasons was that Romanian industry was hit by the severe appreciation of the domestic currency, the rise in energy tariffs, subsidy cuts and fiercer competition. In order to overcome the remaining challenges the economy must somehow cope with a sharp exchange rate appreciation resulting from heavy money inflows from Romanians who work abroad and other capital inflows which are attracted by Romania's prospects of joining the EU (so-called "Dutch disease"), the unimpressive productivity gains and growing current account deficit.

Despite country's comparatively low dependence on imported oil and high drop of oil consumption in the second half of the 1990s, I would expect some adverse effect of oil price increases on the Romanian GDP growth as a result of poor performance of the economy, particularly negative growth in the second half of the 1990s, and one of the highest energy intensiveness of the economy among considered countries.

2.9 Slovak Republic

The Slovak Republic is a net importer of energy and is highly depended on imported oil though it is among the lowest oil consumers in my sample (see Graph 3.2). During the first half of the 1990s the oil consumption was relatively stable. The highest peak in consumption of oil for the past fifteen years was registered in 1998 what is related to economic recovery after 1994-1998 slowdowns. Since that time the trend has been quite volatile with a new peak in 2002, though lower than the first one, and with two sharp declines in 2000 and 2003/4 (see Figure 2). Very high energy intensity of the economy and high dependence on imported oil suggests that oil price shocks may have considerable negative effects on GDP growth in Slovakia (see Table 4).

Slovakia is undergoing the difficult transition from a centrally planned economy to a modern market economy with a reform slowed in 1994-1998 period due to the crony capitalism[6] and unsustainable fiscal policies. Real annual GDP growth peaked at 6.5% in 1995 but declined to 1.3% in 1999. Much of the growth during this time was attributable to high government spending and over-borrowing rather than productive economic activity. The economic growth, the strongest in Central Europe, has been more balanced since then. The main structural reforms taken place in 1998-2006 have lead to a considerable progress in macroeconomic stabilization and Slovakia's economy exceeded expectations in 2001-2005 during the general European slowdown (economy grew at 4.1% in 2002, 4.2% in 2003, 5.4% and 6% in 2004 and 2005 accordingly). Headline consumer price inflation dropped from 26% in 1993 to an average 7.5% in 2004, though this was boosted by hikes in subsidized utilities prices ahead of Slovakia's accession to the European Union. Since 2005 inflation has not broken the 3% limit. In 2006, Slovakia reached the highest economic growth amounted to 8.3% among the members of OECD and the third highest in the EU (just behind Estonia and Latvia). However, despite the high rates of economic growth, the country has failed to address regional imbalances in wealth and

[6] Crony capitalism is a term describing an allegedly capitalist economy in which success in business depends on an extremely close relationship between the businessman and the state institutions of politics and government, rather then on the free market competition, and economic liberalism.

employment. Unemployment peaked at 19.2% (Eurostat regional indicators) in 2001 and though it has fallen to around 9.8% in 2006, it remains a problem. The basis of growth also remains relatively narrow as the innovative capacity of the economy seems weak outside the Foreign Direct Investment (FDI) -dominated sectors.

2.10 Slovenia

Slovenia's consumption of oil is fully based on imported oil. However, Slovenia has the highest consumption of electricity which suggests that the country has found alternative sources of energy production and thus is not highly dependent on oil imports. Moreover, Slovenia has the lowest TPES to GDP ratio of the rest ten CEE countries due to the specialization of Slovenian firms in med- to high-tech manufacturing (see Table 4). The final energy consumption of Slovenia remained stable between 1980 and 1988, around 3.7-3.8 Mtoe; it broke down thereafter to 1.9 Mtoe because the serious economic recession, then increased again to reach 4.6 Mtoe in 2000. Despite relative effectiveness of the economy I would expect the oil price shocks to have significant effects on real activity of the country.

Since gaining independence from the former Yugoslavia in 1991, Slovenia has taken significant steps to advance its economy. With a rich industrial history, with a traditional openness to the world, with rational economic policies, and with proven economic development, Slovenia is among the most successful countries in transition from socialism to a market economy. Because of the relative smallness of its own market, the Slovene economy has always been oriented toward export, over 60% of which are to the countries of the EU. Surging exports and a jump in domestic consumption are behind the fastest growth of GDP in Slovenia since 1997 which average to 3.8% during the period of 1997-2005. The robust growth represents a rebound from a lackluster 2003, when GDP expanded by only 2.5%, the lowest rate since independence in 1991. Inflation rates in 2001-2003 were relatively high at over 5% per annum. In 2003, unemployment was forecast at over 11%, a drop from the 13.6% recorded in 1999. Of the 10 new states to join the EU in 2004, the Slovenian economy is considered to be particularly strong and the most stable and has the highest per capita GDP. Its per capita income is now 84% of the EU average. The high level of openness of the Slovenian economy makes it extremely sensitive to economic conditions in its main trading partners and changes in its international price competitiveness. However, despite the economic slowdown in Europe in 2001-2003, Slovenia maintained 3% GDP growth. Traditional anti-inflationary policy may impact the decline in GDP growth during the hikes in oil prices and hurt exports to which the economic activity of the country is very sensitive.

3. Data and variables' description

In this paper I use quarterly macroeconomic data for ten CEE countries: Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. All listed countries are net oil importers.

The sample consists of 41 quarterly observations from 1995:Q1 to 2005:Q1. The choice of the period under study can be explained by a number of considerations. First, most of the countries I study simply did not systematically collect quarterly frequency aggregate data before 1995. Second, major data revisions having taken place in the early 1990s have made the quality of these data unsatisfied. Third, pre-1995 transition shock manifesting itself as a structural break in time series would make the interpretation of the results questionable. Finally, in countries like Hungary or Poland, many relevant variables are available at the quarterly frequency even before 1990. At the same time, in these same countries GDP and its components were not collected until 1995. To ensure cross-country comparability in time periods and data quality, I thus restrict my attention to post-1995 period.

The primary data sources are the International Financial Statistics of the IMF, local central banks, statistical offices and research institutes, the OECD and Eurostat databases, the ILO and the WIIW databases. For estimation purposes the following set of variables is used: real GDP, real effective exchange rate (REER),[7] real oil price, inflation, short-term interest rate, total imports for fifteen EU countries (see variables' description in Table 5).

Prior to the empirical analysis, the raw data are transformed in several steps. First, all variables are de-seasonalized using the X11 procedure, with multiplicative adjustment; the

[7] REER is defined such that an increase means real appreciation of the currency considered. An appreciation of the exchange rate is expected to hurt the country's external competitiveness.

exceptions being inflation and the interest rate, where the adjustment is additive (Benczur, Ratfai (2005)). The quarterly measures are obtained by taking averages from a monthly data where necessary. Some variables (real GDP, REER, real oil price and EU-15 imports) are expressed in logs, while the remaining ones are simply defined in levels.

The choice of the variables is based on an attempt to capture main possible transmission channels of the oil price shocks to the real economy justified in theory. Real oil prices and real GDP growth are used since the main objective of the paper is to analyse the effects of the former variable on the latter. Therefore, only one measure of economic activity is used, namely, real GDP. The choice of the oil price variable is an important one. The measure I use, and as proposed in Jimenez-Rodriguez and Sanchez (2004), has three main advantages over competing definitions.[8] First, it avoids the undesirable property of the nominal oil price measure (e.g., Hamilton, 1996) that, due to the positive inflation, an identical oil price shock would induce a decreasing effect on real variables over time. Second, such a measure represents a common oil price shock to all countries under study. One caveat here, owing the fact that I do not use bilateral exchange rates, is that I cannot recover a real oil price shock faced by an individual country. Third, by taking the real price directly facing the US makes my results comparable with the majority of the literature (e.g., Mork *et al.* (1989), Carruth *et al.* (1998), and Hooker (1996, 1999)).

The remaining variables are included to capture some of the most important transmission channels through which oil price shocks may affect economic activity indirectly. The most immediate, direct effect of an oil shock will be a rise in the price level, measured here by CPI. Several lines of research (e.g., Bohi (1989), Bernanke *et. al.* (1997)) assert that restrictive

[8] A comparable definition has been used in a multi-country study by Darby (1982).

monetary policy accounts for much of the decline in aggregate economic activity following an oil price increase.[9] For example, a counter-inflationary (restrictive) monetary policy, which is accomplished by increasing interest rates, would temporarily intensify the losses in real GDP while it reduced inflationary pressure. In order to separate an effect of a policy-makers' reaction to an oil price shock on real economy from a shock in itself short-term interest variable is used. Since the depreciation of a national currency exacerbates an inflationary impact of an oil price shock while appreciation may hurt exports with further consequences to aggregate demand and supply, I try to capture it by the REER variable. Finely, EU-15 imports variable proxes an increasing dependence of CEE countries' economic growth on economic activity in the EU.

The next chapter specifies the macroeconomic model and econometric techniques used to assess empirically an impact of oil price shocks on the GDP growth for individual countries and identify the role of the other variables as "intermediaries" in oil price-GDP relationship.

[9] For the contrary view see Hamilton and Herrera (2003)

4. Methodology

The following vector autoregression model of order p (or simply VAR (p)) is considered:

$$y_t = c + \sum_{i=1}^{p} \Phi_i y_{t-i} + \varepsilon_t \qquad (1)$$

where y_t is a (n x 1) vector of endogenous variables, $c = (c_1, ..., c_\tau)'$ is the (7 x 1) intercept vector of the VAR, Φ_i is the i^{th} (7 x 7) matrix of autoregressive coefficients for i = 1, 2, …, p, and $\varepsilon_t = (\varepsilon_{1t}, ..., \varepsilon_{\tau t})'$ is the (7 x 1) generalisation of a white noise process.

In this paper I use a quarterly six-variable VAR for each country under study. The variables included, as was mentioned above, are the following: real GDP, REER, real oil price, inflation, short-term interest rate, and EU-15 imports.

Unrestricted VAR treats all values as jointly endogenous and imposes no a priory restrictions on the structural relationship. Because the VAR expresses the dependent variables in terms of only predetermined lagged variables, simultaneity is not an issue and OLS yields consistent estimates. Moreover, even though the innovations ε_t may be contemporaneously correlated, OLS is efficient and equivalent to GLS since all equations have identical regressors. VAR analysis can be also useful to simulate impulse responses to shocks affecting endogenous variables. On the other hand, VARs tend to require the estimation of a great many parameters and, as a result, individual parameters often tend to be estimated quite imprecisely. VARs are also sensitive to lag specification. All these caveats have to be accepted giving restrictions on data availability.

An argument that arises in the context of an unrestricted VAR is whether this model should be used where the variables in the VAR are cointegrated. There is a body of literature (e.g., Khademvatani (2006)) that supports the use of a vector error correction model (VECM), or cointegrating VAR if variables are integrated, I (1).[10] Because the cointegrating vectors bind the long run behavior of the variables, the VECM is expected to produce results in the impulse response analysis and variance decomposition that more accurately reflect the relationship between the variables than the standard unrestricted VAR. It has been argued, however, that in the short run unrestricted VARs perform better than a cointegrating VAR (e.g., Naka and Tufte, 1997). Furthermore, Engle and Yoo (1987), Clements and Hendry (1995), and Hoffman and Rasche (1996) have shown that an unrestricted VAR is superior (in terms of forecast variance) to a restricted VECM at short horizons when the restriction is true. Naka and Tufte (1997) also studied the performance of VECMs and unrestricted VARs for impulse response analysis over the short-run and found that the performance of the two methods is nearly identical. This suggests that abandoning vector autoregressions for short horizon work is premature, especially when one considers their low computational burden. Therefore, given relatively short time series used in this paper, unrestricted VAR seems to be the most relevant model for my purposes.

Before studying the effects of oil price shocks on economic activity, the study proceeds to investigate the stochastic properties of the series considered in the model by analysing their order of integration on the basis of unit root tests. Specifically, Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used.[11] Results of these formal tests are summarized in Tables 6 through 11, indicating that the first differences of all six variables are stationary. Therefore, the vector y_t in equation (1) is identified to be given by the first log-differences of the first four

[10] For more information about an empirical investigation of structural breaks see Pahlavani et al. (2005) and Waheed et al. (2006).
[11] ADF test is based on the work of Dickey and Fuller (1979, 1981) and PP test on the work of Phillips and Perron (1988).

aforementioned variables (real GDP, REER, real oil price, and EU-15 imports), along with the first differences of the remaining ones (inflation and short-term interest rate).

The VAR system can be transformed into its Moving Average representation in order to analyse the system's response to a real oil price shock, that is:

$$y_t = \mu + \sum_{i=0}^{\infty} \psi_i \varepsilon_{t-i} \qquad (2)$$

where ψ_0 is the identity matrix, and μ is the mean of the process $(\mu = (I_n - \sum_{i=1}^{p} \Phi_i)^{-1} c)$. The moving average representation is used to obtain both impulse-response functions and forecast error variance decompositions.

In order to assess the impact of shocks on endogenous variables, both orthogonalised impulse-response functions and accumulated responses are examined. Identification is achieved using Cholesky decomposition. This requires choosing an ordering for the variables in the system, which is assumed to be the following for the baseline model: real GDP, real oil price, inflation, short-term interest rate, REER and EU-15 imports (see Jimenez-Rodriguez and Sanchez (2005)). This ordering assumes, as much of the theory suggests, that real output does not react contemporaneously on innovations to the rest of the variables. Real oil prices are also treated as largely exogenous variable which directly affect the rate of inflation. The latter is then allowed to influence the interest rates, while the rest three variables, namely REER and EU-15 imports, close the system. As robustness check an alternative ordering, namely short-term interest rate, real GDP, REER, EU-15 imports, real oil price and inflation, is used. This allows for sort-interest rates to influence the real activity and the oil price, since the latter is an asset price and treating it as contemporaneously exogenous can be restrictive, while preserving the direct impact of the real oil price on inflation.

I start by estimating the linear specification of the VAR in (1). Furthermore, based on the empirical literature and economic arguments I also consider three non-linear specifications of oil price shocks (see Figure 4) which are the following: 1) asymmetric specification proposed by Mork (1989) considers oil price increases and decreases as separate variables; 2) scaled specification (Lee *et. al.* (1995)), which takes oil price volatility into account; and 3) net specification (Hamilton (1996)), where the relevant oil price variable is defined to be the net amount by which these prices in quarter t exceed the maximum value reached in the previous four quarters.[12]

The asymmetric specification distinguishes between the positive rate of change in the oil price, o_t^+, and its negative rate of change, o_t^-, which are defined as follows:

$$o_t^+ = \begin{cases} o_t & if\ o_t > 0 \\ 0 & \text{otherwise} \end{cases}$$
$$o_t^- = \begin{cases} o_t & if\ o_t < 0 \\ 0 & \text{otherwise} \end{cases}$$

where o_t is the rate of change in the real oil price.

The scaled and net specifications were developed in order to account for the fact that after a period of calm in oil price fluctuations the rapid increase will have larger macroeconomic consequences than those occurred as a result of oil price increases that are merely corrections to greater decreases during the previous quarter. In order to implement this idea in practice, Lee *et. al.* (1995) proposed the following AR (4) – GARCH (1, 1) representation of oil prices:

[12] Hamilton (1996) uses nominal oil prices, while Mork (1989) and Lee *et. al.* (1995) use real oil prices. As it was mentioned previously I follow the latter approach.

$$
\begin{aligned}
& o_t = \alpha_0 + \alpha_1 o_{t-1} + \alpha_2 o_{t-2} + \alpha_3 o_{t-3} + \alpha_4 o_{t-4} + e_t \\
& e_t \mid I_{t-1} \sim N(0, h_t) \\
& h_t = \gamma_0 + \gamma_1 e_{t-1}^2 + \gamma_2 h_{t-1} \\
& SOPI = \max(0, \hat{e}_t \big/ \sqrt{\hat{h}_t}) \\
& SOPD = \min(0, \hat{e}_t \big/ \sqrt{\hat{h}_t})
\end{aligned}
$$

where $SOPI$ stands for scaled oil price increases, while $SOPD$ for scaled oil price decreases. The scaled model builds on the asymmetric model, while it also employs a transformation of the oil price that standardizes the estimated residuals of the autoregressive model by its time-varying (conditional) variability. This transformation seems very plausible in light of the pattern of oil price changes over time, with most changes being rather small and being punctuated by occasional sizable shocks (Jimenez-Rodriguez and Sanchez (2004)).

Hamilton (1996) proposed a different non-linear transformation of oil prices, namely net oil price increase (NOPI). This variable is defined to be the amount by which (the log of) oil prices in quarter t, p_t, exceed the maximum value over the previous four quarters; and zero otherwise. That is:

$$NOPI = \max\left\{0, p_t - \max\left\{p_{t-1}, p_{t-2}, p_{t-3}, p_{t-4}\right\}\right\}$$

Hamilton's definition is also asymmetric in the specific sense that is captures oil price increase-type shocks while neglecting the impact of oil price declines (Jimenez-Rodriguez and Sanchez (2004)). This is inspired by the findings of insignificant impact of oil price decreases on the US economy.

The sample period used is common to all countries under study from 1995:Q1 to 2005:Q1, for a total of 41 available quarterly observations. The empirical results are presented in the next section. To determine the appropriate number of lag length of the VAR model, the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) and the Likelihood

Ratio test are employed. Whenever there is disagreement among the criterions, the optimal lag length is chosen using the AIC. According to the latter 4-lag specification is the most appropriate for all the model's specifications and for all the countries.[13] However, with a small sample size or when the number of fitted parameters is a moderate to large fraction of the sample size, as in the case of the present study, the AIC may be asymptotically inefficient and overshoot the true number of lags (Bedrick and Tsai (1994)). Nevertheless, it is the best criterion to rely upon among the rest in small samples.

[13] The choice was made between two-, three- and four-lag specifications. To check the relevance of further lags was impossible due to the sample size restrictions.

5. Empirical results

In this chapter I analyse the empirical results for the linear and three non-linear models described in the previous section with a sample of net oil importing countries. In section 5.1 I perform Granger-causality analysis in a multivariate context. I next turn in section 5.2 to the assessment of the effects of oil price shocks on GDP growth by presenting the results on impulse-response functions and accumulated responses. I then conclude with the discussion of the variance decomposition analysis.

5.1 Testing for significance and Granger-causality

In this section I investigate the significance of all the variables in the model focusing on the impact of oil prices on real activity by performing different tests for both linear and non-linear specifications for all considered countries.

First, I perform the Wald test statistic, which tests the null hypothesis that all of the oil price coefficients are jointly zero in the GDP equation of the VAR model. Table 12 presents the p-values of the Wald test statistic, indicating that for half of the sample the null hypothesis is rejected at 5% significance level in at least one specification excluding the linear specification. Since Wald test shows the direct impact of oil price shocks on GDP, from the results I conclude that oil prices do not directly Granger cause GDP growth in all countries in the linear specification and in Croatia, Poland, Romania and Slovenia in all specifications. Second, I test for significance of oil price coefficients for the system as a whole, being the null hypothesis that all oil price coefficients are jointly zero in all equations of the VAR model but its own equation (see Table 13). It may very well be that oil prices do not directly affect real activity (as assessed by the Wald test) but act through the other variables in the system. Thus, Wald test statistic shows that oil price variable is significant in at least one specification for all countries but Croatia, Latvia, Poland and Romania. It is interesting to see that negative changes in the asymmetric specification are significant only in Hungary. Therefore, insignificant oil price variables are excluded from further.[14] Combining the results of these two tests I conclude that oil prices have direct or indirect impact on real activity in all countries but Croatia, Poland and Romania.

For better insight on the role of transmission channels in the system I perform the Wald test for joint significance of the other macroeconomic variables in all equations but their own. Table 14 presents the p-values of the statistic indicating that the variables play an important role in the system as a whole and shape the relationship between oil prices and real activity in all countries but Lithuania, Poland and Slovenia. Generally speaking, further investigation is required and it is performed in the next section.

5.2 Macroeconomic impacts of oil price shocks

In this section I assess empirically the impact of oil price shocks on economic activity for each country under study. I first present, under subsection 5.2.1, the results derived from the examination of impulse-response functions and from their corresponding accumulated responses.

[14] I have also tested for the null hypothesis that positive and negative oil price coefficients are equal in either the GDP equation or in the VAR framework for countries where they are statistically significant, obtaining the rejection of the null hypothesis in at least one case for all the countries tested but Latvia (see Table 15). For this reason, in cases where both positive and negative movements are significant I consider positive and negative oil prices as separate variables.

In subsection 5.2.2 I study the sources of variation of each variable of the VARs by means of variance decomposition.

5.2.1 Impulse response functions and accumulated responses

Under this subsection I examine the effects of oil price shocks on economic activity by means of impulse-response functions and accumulated responses. Figure 5 shows the orthogonalised impulse response functions of the GDP growth to a one-standard-deviation oil price innovation with their corresponding two standard error bands in the linear case, while Figures 6 through 10 those for non-linear specifications of the model for each country under consideration. In turn, the first four lines in Table 16 report the accumulated responses of the GDP growth to an oil price shock normalized to correspond to a 1% increase in the linear model, while the last sixteen lines report those obtained in the non-linear models. The results for countries where the corresponding oil price measure is significant are marked in bold. In order to better understand an impact of oil price shocks on economic activity I also analyse impulse-response functions and their accumulated responses for the other variables.[15]

It is quite difficult to judge about the relative importance of different macroeconomic variables which would be the same for all the countries. Thus, I discuss the results obtained for the other macroeconomic variables without stressing particular attention to any of the variables. Tables 17 through 20 report accumulated responses of the change of CPI, short-term interest rate, REER and EU-15 imports, accordingly, to the 1% oil price shock in the corresponding measures under study. Each Table's first four lines are referred to the case of the linear model and the last

[15] In the paper I report impulse response functions for all the countries under study in all specifications of the model only for GDP growth variables. I do not report impulse-response functions for any other macroeconomic variables but summarily highlight the main conclusions.

sixteen lines are referred to the corresponding non-linear specifications of the model. I describe the results for the linear and three non-linear models, namely asymmetric, scaled and net specifications, at the same time, only for countries where the corresponding measure of oil price shock is statistically significant stressing on the difference of the results obtained from different model's specifications. I choose to do this because the results form different specifications are qualitatively similar. As it was mentioned in section 5.1, in the case of asymmetric and scaled specifications the insignificant movements of oil prices are excluded from the analysis. However, if both increases and decreases of the oil price are significant they are treated as separate variables.

In order to evaluate the relative performance of the linear and three non-linear specifications of the VAR model for individual countries I look at two criterions. First, the precision of the estimation can be gauged from the wideness of the confidence bands as shown in Figures 6 through 10. I find that the linear specification performs the impulse responses which are comparatively more precise than those produced by the non-linear specifications. Second, I analyse the goodness of fit of each of the four specifications by looking at the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). Table 21 reports AIC and BIC for individual countries obtained from each econometric specification. This result indicates that for those countries where more than one oil price measure is statistically significant, namely the Czech Republic, Estonia, Hungary, and Lithuania, asymmetric specification is preferred for Estonia and Hungary while net specification for the Czech Republic and Lithuania. For the rest of the countries asymmetric specification is usually preferred as compare to the others saying that it is important to separate positive and negative movements of oil prices.

5.2.1.1. The results from the impulse response functions and accumulated responses for GDP growth

In the case of a positive oil price shock one can observe despite of the fact that each country responds somewhat differently to oil price increases quite similar patterns of impulse-response functions. In fact, I observe that the oil price shock has a negative effect on the GDP growth in the short-term for all the countries under study. This effect, however, is not statistically different from zero in most of the cases. Generally, the largest impact of the oil price shock occurs during the year and a half after the shock depending on a country being reached mostly in either the second or the fourth.[16] Three countries, namely Estonia, Hungary and Slovakia, experience also the second largest fall in the GDP growth around the tenth quarter after the shock. After this the impact of the shock becomes very small, dying out almost completely after two years. Only the Czech Republic in scaled and net specifications seems to react differently from the rest of the countries in that the fall in the GDP growth sustains during the whole second and the third year after the shock. As regard to a few cases where oil price shocks produce significant response of the GDP growth these are the following: asymmetric measure of the negative oil price shock for Hungary and Slovakia as well as the scaled measure of the negative shock for Slovakia, and net measure for Estonia and Lithuania. I investigate these cases below together with accumulated responses of the other macroeconomic variables used in the model.

Table 16 indicates accumulated response of the GDP growth to the 1% oil price shock in the linear and three non-linear specifications. In the former case the oil price shock has a

[16] In comparison, empirical evidence for OECD countries states that the largest negative influence of an oil price shock takes place within the year of the shock with the largest impact being reached at the third-fourth quarter after the shock (e.g. Jimenez-Rodriguez and Sanchez (2004)).

negative accumulated effect for the Czech Republic, Estonia, Poland, Romania and Slovenia and a positive one for Croatia, Hungary, Latvia, Lithuania and Slovakia. However, the oil price shock does have a negative impact on these countries, excluding Hungary and Latvia, being immediate in the case of Croatia and Lithuania, and being reached only by the sixth quarter after the shock in the case of Slovakia.[17] These results are mostly consistent in all specifications. In terms of the magnitude, the results differ across different specifications being the largest for net specification and the smallest for scaled one. As for the medium-sized results these are bigger for asymmetric specification. This finding is consistent with the specific features of the oil price measures. Thus, net specification is expected to produce the largest results since it counts as a shock only an oil price increase which exceeds the price of oil for the whole previous year. Since the volatility of oil prices, which was relatively high during the period under study, is accounted for in scaled specification the anticipation of the shock may very well cushion its effects. The fact that the magnitude of the results obtained from asymmetric specification is bigger as compared to the linear one proves the asymmetry of the oil price shock impact on real activity. Generally speaking, accumulated loss of the GDP growth to the 100% oil price shock after eight quarters ranges from 6.3% for Slovenia to 0.9% for Czech whereas the accumulated gain of the GDP growth varies from 0.2% for Slovakia to 6% for Estonia in linear specification. The corresponding ranges for asymmetric, scaled and net specifications in the case of a positive oil price shock are from 30% for Poland to 0.3% for Czech, from 3% for Slovenia to 0.1% for Hungary, and from 36% for Slovenia to 8% for Czech, respectively, for accumulated loss of the

[17] In Croatia and Lithuania the negative impact of the shock is reached only in the second quarter of the shock while in Estonia it persists only during the year of the shock. The negative impact in Slovakia, though reached by the twelfth quarter after the shock, is negligible.

GDP growth. Further comparative analysis is devoted to the countries where the corresponding oil price shock measures are statistically significant.

For the Czech Republic and Estonia all oil price shock measures, but decreases in asymmetric specification as well as the linear measure for the former country, are significant. Moreover, for the latter, the oil price shock from net specification is also statistically different from zero. Thus, in the Czech Republic the accumulated loss of the GDP growth after eight quarters of the 100% oil price shock equals 0.3% from asymmetric specification, 1.1% from scaled specification where oil price decreases produce equivalent results, and 8.2% from net specification. Estonia experiences the accumulated loss of the GDP growth after the 100% oil price shock during the year of the shock which ranges from 10.8% to 0.2% depending on the specification.[18] However, by the end of the second year after the shock the accumulated gain of the GDP growth which varies from 1.2% in scaled specification to 19.5% in net specification is observed. From scaled specification it is also seen that an impact from oil price decreases generally bigger than that of oil price increases for Estonia.

For Hungary all the measures of the shock, excluding the linear one, are significant and affect the GDP growth positively except for scaled specification, but in the latter case the impact is negligible. Thus, the accumulated gain of the GDP growth after eight quarters of the 100% oil price shock equals around 2% for asymmetric specification and 7.6% for net specification. Surprisingly, oil price decreases from asymmetric specification constitute a significant advert shock to real activity accounting for 2% loss of the GDP growth during the first two quarters of the shock which dies out completely by the end of the year. For Latvia, on contrary, only oil price increases from asymmetric specification significantly impact real activity with accumulated

[18] The loss of GDP growth of 10.8% after 100% oil price shock reached by the second quarter is one of the few cases where the oil price shock is significant.

gain of the GDP growth reaching 9% by the end of the second year after the 100% oil price shock.

According to linear and net specifications Lithuania undergoes immediate significant loss of the GDP growth of 3% and 4.8%, accordingly, after the 100% oil price shock. After this, by the end of the second year after the shock, the accumulated gain of the GDP growth of 7.5% and 17%, accordingly, is observed. Oil price decreases, though statistically significant, do not cause significant changes in economic activity. For Slovakia, a negative oil price shock from scaled specification, produces significant immediate impact of +1.2% of the GDP growth after the 100% oil price shock which oscillates around 1% during the two years. The effects of oil price increases from the same specification are not, economically, different from zero. For Slovenia only the net oil price shock measure is significant but produces unrealistically high results. An explosive impact of inflation on GDP response function as well as serially correlated error terms maybe partly responsible for such results. Therefore, I do not include Slovenian's results into further investigation. There are four other cases in which some variables explosively affect the GDP growth response to the shock as can be seen from the graphs. These variables are short-term interest rate for Estonia and Slovakia and import variable for Hungary and Latvia. For informative purposes Figures 11 through 16 present the impulse-response function of the GDP growth to a one-standard-deviation oil price innovation for these countries obtained from the model with excluded aforementioned variables.

As a robustness check I also report the results of the GDP growth impulse-response function from an alternative ordering, namely: short-term interest rate, real GDP, REER, EU-15 imports, real oil price, and inflation, for the countries where the corresponding oil price shock measure is statistically significant. These impulse-responses to a one-standard-deviation oil price innovation are presented in Figures 21, 23, 25 and 27, while Figures 22, 24, 26 and 28 present those together with the impulse-response function obtained from the baseline ordering for the comparative purposes. These are nearly identical as compared to the impulse-responses obtained from the baseline ordering for all the countries but the Czech Republic in the scaled specification. That means that in the case of the Czech Republic the assumption about the contemporaneous exogeneity of the oil price is implausible and the output is affected by the interest rate shocks. Figure 29 presents the impulse-response functions of the GDP growth to a negative one-standard-deviation oil price innovation with baseline and alternative orderings for the countries where the corresponding measure of the oil price decrease is statistically significant. These are asymmetric measure for Hungary and Lithuania, and scaled measure for the Czech Republic, Hungary, Lithuania and Slovakia. The results are identical with the exception of the Czech Republic for which the effects of the shock are smaller with alternative ordering. One more exception is Hungary where the alternative ordering in net specification makes the positive oil price shock significantly impact the real activity. Thus, after the 100% oil price shock the accumulated gain of the GDP growth with alternative ordering equal around 5% by the end of the second quarter, which is almost twice higher than in the case of the baseline ordering. This again proves that the GDP growth is mostly influenced by interest rate movements which in the case of Hungary respond negatively to the shock. Thus, in net specification the accumulated drop in the short-term interest rate by the end of the second year after the 100% oil price shock is almost 12%, which is the highest result among the ten countries under study. Therefore, policy response plays a significant role in the oil price-GDP growth relationship.

It is useful to compare the oil price-GDP elasticities obtained here with the elasticities calculated with alternative techniques presented in the literature in order to asses relative magnitude of the direct effects of the oil price shock on real economy of net oil importing CEE countries. For example, over the last 15 years, for its policy analyses, the U.S. Department of Energy has used oil price-GDP elasticities varying from -0.025 to -0.055. The latter value matches Mory's (1993)[19] estimate from the log-linear regression of GDP on oil price and money supply, and is very close to the sum of lagged oil price coefficients estimated by Mork et al. (1994)[20] with a VAR, of -0.054 (Mork and Mysen (1994)). For comparison, the sum of lagged oil price coefficients of a positive 100% oil price shock obtained in this paper lies in the range from -0.062 for Croatia to -0.007 for the Czech Republic for the negative sum of elasticities and from +0.018 for Hungary to +0.161 for Lithuania for the positive sum of elasticities, with averages equal -0.031 and +0.064 respectively. Averages of the sums of oil price coefficients from asymmetric, scaled and net specifications equal -0.099 and +0.056, -0.019 and +0.012, -0.120 and +0.122, respectively.

It is also worth comparing cumulative responses obtained in different studies. The sum of the impulse response coefficients over 42 months presented in Hamilton and Herrera (2001) for the US is -0.055. Using VARs, the sum of the impulse response coefficients over 8 quarters presented in Hamilton (2003) is -0.1162 using the 3-year NOPI shock measure and -0.0535 using the LNR (linear) shock measure (Jones, Leiby, and Paik (2003)).[21] The corresponding results for OECD countries presented in Jimenez-Rodriguez and Sanchez (2004) lie in the range from -0.039 to -0.008 using LNR measure and being the largest for the US, from -0.061 to -0.016 using

[19] Estimates were obtained for the US.
[20] Estimates were obtained for OECD countries.
[21] The three-year NOPI approach only records a shock when the price surpasses the highest observed level in the past twelve quarters, and the shock size is only the percentage by which the 3-year high is exceeded. Therefore, NOPI estimate could overstate the expected response after a period of greater variability in prices that does not exceed the three-year high.
In contrast, the LNR estimate uses the current volatility level to scale an oil price shock that would occur now, and accordingly is more in line with what could be expected at the moment.

their preferred scaled specification, and from -0.054 to -0.008 using 1-year NOPI shock measure. For comparison, accumulated response of GDP growth to a 1% positive oil price shock over 8 quarters for each country obtained here using linear specification of a shock varies from -0.063 to -0.009 (see Table 16, Row 5), from -0.03% for Slovenia to -0.001% for Hungary, and -0.082 for the Czech Republic and -0.104 for Poland using one-year NOPI shock measure. Generally speaking, from the comparison results I conclude that oil price shocks have more profound effects on real activity in terms of the magnitude for the countries in Central and Eastern European region than those for the advanced economies, being the most severe for the Czech Republic excluding Slovenia. However, the shock itself is significant only in four cases, namely oil price decreases from asymmetric specification for Hungary, oil price decreases from scaled specification for Slovakia, and net measure of oil price shock for Estonia and Lithuania. Moreover, for half of the countries the impact of oil price shocks is the opposite form the one that is expected leading to the positive response of GDP growth. This requires the closer investigation of the behaviour of the other macroeconomic variables in the model that is performed in the next item.

5.2.1.2. The results from the impulse response functions and accumulated responses for the other macroeconomic variables

One of the most significant transmission channels of an oil price shock to the real economy is inflation, accumulated responses of which are presented in Table 17 and in the first graph of Figures 17 through 20. First four lines of each table report the results obtained form linear specification for all the countries and the last sixteen lines report those obtained from three non-linear specifications for selected countries. The Tables 18 through 20 and the last three graphs of the Figures 17 trough 20 report the accumulated responses for the other variables which play approximately equivalent role in transmission of oil price shocks to the real economy or in mitigation of their impact. When presenting the results I focus on the countries where the corresponding oil price shock measure is statistically significant but I do make the overall conclusion for the rest of the countries. There are five cases, however, in which the causality between GDP growth and the other variables goes in both directions. These variables are imports from the EU-15 Member States for Hungary and Latvia, inflation for Slovenia and the short-term interest rate for Estonia and Slovakia. Their inclusion has an explosive effect on impulse-response function of the GDP growth to the shock. For illustration purposes the latter, for each specification, is presented in Figures 11 through 16 obtained from the model without aforementioned variables for listed countries.[22]

It is found that for the Czech Republic, Estonia, Hungary and Slovakia more than one variable, with the exception of Hungary, is statistically significant in the VAR framework (see Table 14). In Latvia, Lithuania and Slovenia the other macroeconomic variables are insignificant for the model as a whole.[23] That means that they do not transmit oil price shocks to the real economy. It is proved by the fact that Latvia and Lithuania show ones of the largest accumulated gains of the GDP growth after the 100% oil price shock equal 4.5% and 7.5%, respectively, in linear specification, 9% for Latvia in asymmetric specification, and 17% for Lithuania in net specification. This surprising result for Lithuania is partly explained by the significant accumulated decline in the short-term interest rates which is 7% in linear specification and 8% in

[22] The corresponding accumulated responses for these countries where the aforementioned variables are excluded from the model are available upon request. They do not change the results significantly, however, the magnitude of those obtained from the modified model are smaller than the original ones.

[23] As was mentioned at the beginning of this section I do not discuss the results for Slovenia because of the explosive impact of CPI variable on GDP growth impulse-response function.

net specification after the 100% oil price shock. This can be seen as an attempt of policy-makers to restrict the loss of the GDP growth after the shock though at the expense of inflation which accumulates to 7% and 14%, respectively, after the 100% oil price shock. As concerns to Latvia, the country experiences only the direct impact of oil price shocks on real activity which is only marginally significant and the results differ numerically between asymmetric and net specifications due to the specificity of the oil price shock measure. The Czech Republic stands on the other extreme of the policy response to the shock showing the largest accumulated gain in the short-term interest rate after the 100% oil price shock equal 1.3% for linear and scaled specifications and almost 11% for net specification. This is consistent with the fact that the country experiences the largest accumulated loss of the GDP growth, while inflation, on contrary, is one of the highest reaching 1.7% in linear specification, nearly 4% and 40% in scaled and net specifications, accordingly, after the 100% shock.[24] As to the other countries, only Croatia, Latvia and Poland apply restrictive monetary policy after the shock with interest rates rising roughly from 0.4% to 7% by the eighth quarter after the shock. The accumulated drop in the GDP growth, which is found for Estonia, Hungary, Lithuania, Romania and Slovakia, ranges from 0.1% to nearly 12% depending on the country and specification. Generally, all the countries, but Estonia, show accumulated increase of inflation at least during the first or the second year after the shock.[25] Thus, focusing on the countries where corresponding oil price shock measures are significant, accumulated inflation in the Czech Republic and Lithuania equal 1.7% and 7%, respectively, in linear specification, lies between 1% and 2% for Hungary and Latvia in asymmetric specification, reaching 4% in the Czech Republic and 3% in Hungary in

[24] Only asymmetric specification gives somewhat different results, though economically insignificant.

[25] The accumulated deflation in Estonia after 100% shock equals 0.4% in linear specification, 4.4% in asymmetric specification, 1.2% and 15% in scaled and net specifications, respectively.

scaled specification. Net specification show remarkably high inflationary consequences of the shock which are 14% for Lithuania, 38% for Czech and 42% for Hungary (see Table 17, last Row).

The other channels also play their role in transmission of oil price shocks to the real economy or mitigating their impact. Accumulated responses of selected variables to the 1% oil price shock are depicted in Figures 17 through 20. For example, real effective exchange rate is found to be significant in the VAR framework for all the countries except Latvia, Lithuania and Slovenia. Thus, the Czech Republic and Estonia exhibit accumulated real depreciation of their national currencies of 1.7% and 9.4%, respectively, in linear specification, 1.4% and 3%, respectively, in scaled specification, and 13% and 54%, respectively, in net specification.[26] For Hungary the results are somewhat mixed showing the accumulated depreciation of the currency of around 1% in linear, asymmetric and scaled specification, and of around 8% in net specification. With regard to the EU-15 imports variable only Croatia, and partly Latvia and Lithuania, experience accumulated fall in their exports growth which for the former country goes in line with the fact of the currency appreciation. Thus, the accumulated fall of the exports growth to the rest of the EU for Croatia equal 25% in linear specification, 17% in asymmetric specification, 5.3% and 36.4% in scaled and net specifications, accordingly. Latvian's accumulated losses of the exports growth ranges from 2.5% to 8% depending on the specification, while Lithuania shows the loss of 3% in linear specification. Generally, however, the imports from the rest of the EU seem to be relatively stable and irresponsive to oil price shocks mitigating their advert impact on real activity.

[26] Asymmetric specification give opposite results for the Czech Republic according to which accumulated appreciation of the currency reaches 6.4% after 100% shock. Estonia in the same specification shows almost 20% accumulated depreciation of the currency.

In sum, I find that the output growth responds negatively to an increase in oil prices in the Czech Republic, Estonia, Poland, Romania and Slovenia and a positively in Croatia, Hungary, Latvia, Lithuania and Slovakia. The largest negative impact of the oil price shock occurs during the year of the shock depending on an individual country being reached mostly in either the second or the fourth quarter. Only Estonia, Hungary and Slovenia, experience also the second largest fall of the GDP growth around the tenth quarter after the shock and the fall of the Czech's GDP growth persists for the second and the third year after the shock in scaled and net specifications. Thus, the latter country experience the second largest accumulated loss of the GDP growth after a positive 100% oil price shock which ranges from 0.3% to 8% depending on the specification. However, the oil price shock itself is found to be significant only in four cases and these are asymmetric measure of the negative oil price shock for Hungary, scaled measure of the negative shock for Slovakia, and net measure for Estonia and Lithuania. Oil price shocks have inflationary consequences in all countries but Estonia. Short-term interest rates play partly an offsetting role for the consequences of the oil price shock with the exception of the Czech Republic. The same offsetting role plays the real effective exchange rate in all the countries with significant oil price coefficients mitigating the impact of the shock on each country's exports. Further on, I analyse the relative significance of considered macroeconomic variables for the GDP variability.

5.2.2 Variance decomposition analysis

Tables 22 through 25 present the results of the forecast error variance decomposition, which shows how much of the unanticipated changes of the variables are explained by different shocks. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR. The variance decomposition suggests that oil price shocks are a considerable source of volatility for many of the variables in the model. For real GDP oil prices are together with inflation the largest sources of the shock other than the variable itself for most of the countries. The contribution of oil prices and inflation to the GDP variability ranges from 1% to 20% and from 2.5% to 15%, respectively, for linear specification, from 3.3% to 41% and from 3% to 10%, respectively, for asymmetric specification, from 3.5% to 38% and from 4.3% to 22.5%, respectively, for scaled specification, and finally from 8.5% to 30% and from 6% to 18.5%, respectively, for net specification. Several exceptions to the leading role of these variables are Croatia, Latvia and the Czech Republic in linear specification where real effective exchange rate for the former two and short-term interest rate for the latter are the main sources of the shock, also the Czech Republic in asymmetric and Croatia in net specifications with the leading role of the same variables. The EU-15 import variable is found to contribute significantly to the GDP variability in most of the countries only in linear specification.

Furthermore, I find that the majority of the movements in inflation arise from changes in the GDP growth, oil prices and short-term interest rates, whereas inflation itself are together with oil prices and the GDP growth the main sources of short-term interest rates variability. Thus, the oil price variable contributes on average 16% of the volatility in inflation rate in linear specification and around 20% in non-linear specifications. The contribution of the inflation, oil price and the GDP growth variables to the short-term interest rates variability on average lies in the range from 18% to 20%, from 14% to 18%, and from 22% to 28%, respectively, depending on the specification.

In order to compare my results with those obtained in the related literature I focus on the US case while also referring to non-US countries. On the high side of the range, Bjornland (2000) finds that oil price shocks explain 18% of the GDP variance in the US. This author also studies the contribution of oil shocks to GDP variability for some European countries, estimating it at 8% in Germany, 9% in the UK, and 5% in Norway. Dostey and Reid (1992) found that oil prices explain between 5% and 6% of the variation in GNP, whereas the shocks to the federal funds rate explain about 5% and 8% of the variation in GNP in their preferred specification. In the case of these variables, estimates are roughly consistent with the results obtained by Jimenez-Rodriguez and Sanchez (2004) for OECD countries. On the low side of this range, Brown and Yucel (1999) show evidence that oil price shocks explain little of the variation in output, compared with much larger role played by monetary shocks. In terms of magnitude, results obtained in this paper are in line with those found by Bjornland (2000) in his US study of the significance of oil price shocks in GDP variability and with those found by Jimenez-Rodriguez and Sanchez (2004) for the significance of the monetary channel. The findings of this paper for Croatia, Latvia, Romania and Slovakia lie in line with the results for the listed European countries, while for Estonia, Hungary, Lithuania, Poland and Slovakia they are significantly higher ranging between 10% and 40% depending on the specification and the country. There is the only country, namely the Czech Republic, which shows the contribution of oil price shocks to the GDP variability which does not exceed 3.5% with the exception of net specification where it is nearly 9%. In terms of the monetary policy the contribution of the short-term interest rate variable to the GDP variability is a bit higher as compared to the findings of Dostey and Reid (1992) and lies on average between 8% and 10% depending on specification.

It would be interesting to look at the economic prerequisites of the each country's vulnerability to oil price shocks as well as the significance and the direction of policy response to oil price changes. The corresponding analysis is performed in the next chapter.

6. Evaluation of the results: individual countries

In the previous chapter it was shown that oil price shocks have significant negative effects for the Czech Republic, Slovakia and Slovenia, and partly the opposite significant effects for Estonia, Hungary, Latvia and Lithuania, with three countries, namely Croatia, Poland and Romania, which do not experience any significant impact of oil price shocks. Moreover, the largest fall in the GDP growth is observed for the Czech Republic excluding Slovenia while the largest gain is found for Latvia and Lithuania.

It is clear that the structure of the economy as well as the special circumstances underlined by the transition to the market economy undergone by all the countries influence the nature of the oil price-GDP relationship for this region. In fact, as stated in the literature, during the latter half of the 1990s this relationship overall seemed to weaken. Thus, in the late 1990s and early 2000s, rising in oil prices had less effect on economic activity than the previous research suggest might have been expected. This finding generally goes in line with what was found for my ten CEE countries. Among the factors that likely have partly contributed to the weakening relationship between oil prices and economic activity are a reduced energy-to-GDP ratio as a result of modernization in the industrial production sector, the fact that oil price increases were the result of increased demand rather than oil supply shocks, the catching up process with developed economies characterized by the stable and relatively high growth, the stability of the demand for exports as a result of the integrating process to the EU, the huge fall in the GDP, industrial production in particular, at the beginning of the transition, the restructuring of the economy with the industrial sector losing its share in the countries' GDP and, finely, the productivity gains that may have simply obscured the relationship between oil prices and aggregate economic activity.

According to the magnitude of the accumulated impact of oil price shocks to the GDP growth all the countries can be divided into three groups: Croatia, Poland and Romania that do not experience any significant advert impact of oil price increases with different oil price measures, the Czech Republic, Slovakia and Slovenia with significant negative effects of oil price shocks, and Estonia, Hungary, Latvia and Lithuania where the accumulated response of the GDP growth is significantly positive though with some immediate negative impact. The nature of the impact of oil price shocks to real activity for the individual countries is well understood if one looks at the economic situation of these countries during the period of study. Further on, I elaborate on this issue taking each of the groups separately.

The econometric analysis proved that the low dependence ratio on imported oil for Croatia, Poland and Romania prevents these countries form the significant negative consequences of the oil price increases. Nevertheless, I perform the results for these countries since it is worth looking at the magnitudes of its impact on their real economy. Croatia experiences the largest accumulated gain in the GDP growth of 4.3% and 2.3% in linear and scaled specifications, respectively, and 13.1% and 20.5% in asymmetric and net specifications, respectively, after the 100% oil price shock what can be explained by successful reforms and the relatively stable economic growth during the period under investigation. Moreover, the liberalization of the energy market does not allow for the significant inflationary consequences of oil price increases which may intensify the impact of the shock. Poland and Romania despite the insignificance of oil price coefficients still show the accumulated loss of the GDP growth of

5.6% and 1.1%, respectively, after 100% oil price shock in linear specification.[27] The negative effects from the oil price shock for Poland may come as a surprise if one look at its high and stable growth, controlled inflation and low energy dependence ratio of the economy. But it can be explained if to take into consideration growing interest rates following the shock and accelerated inflation. Moreover, these two constituents are considerable sources of GDP variability. Also it should be stressed out again that as of the 2000, the prices of liquid fuels, expressed in US$ by Purchasing Power Parity, were considerably higher than the EU average. However, strong export position to the rest of the EU mitigates the impact of the oil price shock. As it was mentioned in chapter 2 Romania underwent the most abrupt economic transition with the GDP growth being negative for most of the 1990s and showing moderate recovery only since 2000. Moreover, the country is among the most energy-intensive economies what may explain sometimes negative impact of the shock. Insignificance of the shock is partly a result of the relatively low dependence of the country on imported oil as well as of the cushioning effect of the monetary policy response to the shock.

As to the second group of countries, Slovenia experiences the largest accumulated loss in the GDP growth, though the magnitude of this loss is questionable due to the explosive behaviour of the inflation variable, despite its relatively low dependence on imported oil and the lowest in the sample energy consumption per capita. This can be partly explained by the traditional unti-inflationary policy conducted in the country which is shown by the cumulative growth of the short-term interest rate of around 7% after the 100% oil price shock in linear and asymmetric specifications, and 1.7% and 21.5% in scaled and net specifications, respectively,

[27] The results from other specifications, show larger negative consequences of the shock for Polish economy, with the exception of scaled specification, while the results for Romania are practically zero in scaled specification, though positive in asymmetric and net specifications.

(the highest one among the countries under study). In the case of the Czech Republic, the second largely affected country, the vulnerability of the country to oil price shocks is partly a result of the high levels of oil consumption as well as the high energy intensiveness of the economy. Among other things, contributing to the impact of oil price shocks are inflation, which accumulates to 1.7% in linear specification, and 3.8% and 38% in scaled and net specifications by the end of the eighth quarter after the 100% shock, and the restrictive monetary policy during the second and the third years after the shock.[28] The negative impact of oil price shocks on the Slovakia's GDP growth is consistent with the facts that the country is highly dependent on imported oil, though being among the lowest oil consumers in my sample due to the size of the economy, and has one of the highest energy intensity of the economy. However, the highest in the sample positive response of the exports to the rest of the EU partly mitigate an advert impact of the shock. The behaviour of the monetary channel is somewhat mixed. Thus, net and asymmetric specifications show the decline of the short-term interest rate as a response to the shock, while the rest two specifications, on contrary, show the increase in the interest rate variable. However, the latter is relatively small (1.7% for scaled and 5.1% for net specifications after 100% shock) which explains the lowest negative impact of the oil price shock. Moreover, oil price declines have a significant and positive impact on the GDP growth which accumulates to 6% and 1% by the end of the second year in asymmetric and scaled specifications, respectively.

The third, and the last, group consists of the countries which, surprisingly, show the positive impact of oil price shocks on the GDP growth which by the eighth quarter after the

[28] Only asymmetric specification gives somewhat controversial results showing the accumulated, though small, deflation as well as relatively negligible decline in short-term interest rate after the shock.

100% oil price shock equals 7.5% - 17% in Lithuania, 2.5% - 15% in Latvia, 2% - 7.6% in Hungary, and 6% - 19.5% in Estonia depending on the specification.[29] These countries are the lowest oil consumers in my sample with the relatively stable daily consumption during the period under investigation. All of them also had noticeable success in the improvement of the energy effectiveness of their economies as well as general economic reforms resulted in the relatively high and stable growth, which in the case of Estonia has amounted at around 6% since 1995. Monetary policy is also responsible for the mitigation of an oil price shock impact which is shown by the negative accumulated response of the short-term interest rates for these countries In short, monetary policy seems to cushion the real effects of the oil price shock using the short-term interest rate instrument, but at the expense of accelerating inflation in all the countries but Estonia which has had a Currency Board Arrangement (CBA) since 1992.[30] Also Estonia is the least energy dependent country in my sample and the one that has made significant progress in reforming its energy sector and meeting the corresponding requirements of the European Union energy *acquis* which among other things includes price transparency, security stock obligations (in Estonia it equals to 90 days), energy efficiency and environmental rules. The smaller dimension of the accumulated responses is more informative for these countries. Thus, Hungary shows some negligible negative response of the economy to the shock while Lithuania experiences significant, though immediate, negative impact of the shock. To be precise, the loss of the GDP growth by the end of the second quarter equals 3% and 4.8% in linear and net specifications, respectively. Estonia does experience the negative consequences of the oil price shock but only during the year of the shock which normally do not exceed 3% loss of the GDP

[29] The ranges do not include the results from scaled specification for Hungary and Estonia since they are numerically negligible.
[30] Interest rates may be not a good way to assess the stance of monetary policy when there is a supply shock. For more information see Brown and Yücel (1997).

growth. Such a small and one-time effect of the shock is a result of the effective structural reforms of the county's economy, particularly of the energy sector, as well as of its low energy dependence ratio.

In sum, the econometric analysis shows that the economic background and the dependence on energy sources as well as the monetary response to oil price increases play an important role in the responsiveness of the countries' GDP growth to oil price shocks. Due to the fact that for three countries oil prices are found to be insignificant for the GDP growth in all specifications of the model and for four countries they have a positive impact on real activity, I fail to reject the hypothesis of the weakening relationship between oil prices and the GDP growth stated in the introduction. Moreover, the shock itself is found to be statistically insignificant for majority of the cases and these results are generally robust to the ordering of the variables.

7. Conclusion

The present paper studies the effects of oil price shocks on the real economy of the ten net oil importing CEE countries as well as identifies the significance and the behaviour of the main transmission channels. In particular, I focus on the relationship between oil prices and the GDP growth which is analysed by a six-variable Vector Autoregressive Model. I find evidence of non-linear effects of oil price shocks on real economic activity for most of the countries under study with oil price increases having greater negative impact in terms of the magnitude than that of oil price decreases.

As the first step, form the Granger-type analysis I conclude that oil price increases do not have direct impact on the GDP growth in all the countries in linear specification and in Croatia, Poland, Romania and Slovenia in all specifications. However, the results of the Wald test show that the oil price shock is significant in the VAR framework in at least one specification for all the countries but Croatia, Latvia, Poland and Romania, suggesting an important role of the other variables in transmission or mitigation of the effects of the shock. Combining the results of the two tests I conclude that oil prices have direct or indirect impact on real activity in all the countries but Croatia, Poland and Romania.

From vector autoregressions I obtain the results that are only partly consistent with the expectations showing the positive impact of oil price shocks roughly for four countries out of the ten considered, namely Estonia, Hungary, Latvia and Lithuania. These opposite results can be partly explained by the low dependence of these countries on imported oil as well as expansionary monetary policy and growing exports to the EU-15 Member States which contributes to the stability and low responsiveness of the GDP growth to oil price increases.

However, in the case of Latvia and Lithuania, which exhibit ones of the largest positive responses of the GDP growth, the result sensitive to the order of the VAR.

The distinction between oil price increases and decreases is possible in the case of asymmetric and scaled specifications only for the Czech Republic, Hungary and Slovakia where they are statistically significant. By using these approaches I find that oil price declines produce economically negligible effect on real activity in Lithuania and equivalent impact to that of oil price increases in the Czech Republic and Hungary in scaled specification. However, for the latter country, a negative 100% oil price shock from asymmetric specification causes the significant immediate loss of the GDP growth of 2% while for Slovakia in scaled specification the same shock leads to the immediate gain of 1.2%.

From the inspection of the confident bands I conclude that in most cases linear model yields results that are slightly more precise than that obtained from non-linear models. However, information criterions indicate that for those countries where more than one oil price measure is statistically significant, namely the Czech Republic, Estonia, Hungary, and Lithuania, asymmetric specification is preferred for Estonia and Hungary while net specification for the Czech Republic and Lithuania. For the rest of the countries asymmetric specification is usually preferred as compare to the others saying that it is important to separate positive and negative movements of oil prices.

In regard to the magnitude, non-linear specifications generally tend to produce larger effects on real activity than the linear model with the exception of scaled specification. For the sake of concreteness, let me focus on the countries where the corresponding oil price shock measures are found to be statistically significant. Thus, by the end of the second year after the 100% oil price shock accumulated loss of the GDP growth in the Czech Republic equals 0.3% in asymmetric specification, and 8.2% in net specification. Estonia experiences the accumulated loss of the GDP growth only during the year of the shock which ranges from 10.8% to 0.2% depending on the specification which starting from the second year accumulates to +1.2% and 6% in scaled and linear specifications, respectively, and to 10% and 19.5% in asymmetric and net specifications, respectively. For Hungary the accumulated gain of the GDP growth after the 100% shock is around 2% for asymmetric specification and 7.6% for net specification. For Latvia only oil price increases from asymmetric specification significantly impact real activity with accumulated gain of the GDP growth reaching 9% by the end of the second year after the 100% oil price shock. Linear and net specifications show that Lithuania undergoes the immediate significant loss of the GDP growth of 3% and 4.8%, accordingly. After this, by the end of the second year after the shock, the accumulated gain of the GDP growth of 7.5% and 17%, accordingly, is observed.

The oil price shock itself is found to be statistically significant only in four cases, namely asymmetric measure of the negative oil price shock for Hungary, scaled measure of the negative oil price shock for Slovakia, and net measure of the positive oil price shock for Estonia and Lithuania, which produce an immediate significant impact on real activity of these countries. Numerically, the accumulated response of the GDP growth after the 100% oil price shock by the end of the second quarter equal -2% for Hungary, +1.2% for Slovakia, -10.8% for Estonia and -4.8% for Lithuania.

My variance decomposition analysis indicates that the oil price shock are together with inflation and short-term interest rate the mane sources of variability for all the macroeconomic variables considered in the model including the real GDP itself. For the letter two other variables, namely real effective exchange rate and EU-15 imports, also account for a big share of the GDP variability. Finally, despite the differences in the magnitude of the effects of oil price shocks stemming from different measures of the shock, the results are quite robust to the lag and model specification.

Several caveats concerning current work have to be mentioned, however. First, small time series does not allow, in some cases, to determine an appropriate order of the VAR model making selection criterions asymptotically inefficient, more precisely, to be biased to a greater lag. Second, I do not control for reverse causality which seems to be the case for some countries contributing to the explosive impulse-response function of the GDP growth to the oil price shock. My choice of the order of the VAR is, therefore, based on the Akaike Information Criteria in the case when there are disparities between the criterions. Thus, giving the sensitivity of the VAR models to lag specification, my results are not robust in some of the cases. Third, it would have been informative to see the impact of the Current Account to the oil price-GDP relationship separating between the oil- and non-oil trade balances. For example, it was found for middle-income countries that the response of the latter to the demand oil price shock is not statistically different from zero.[31] Since non-oil trade balances play an important role in transmission of oil price shocks to the real economy its share in the current account position of a country may mitigate the impact of the shock (Kilian *et. al.* (2007)). However, since quarterly data for current account is available only from late 1990s for majority of the countries, I did not include this variable for the sake of the number of observations.

Overall, the econometric results obtained for the ten CEE net oil importing countries state that they are more vulnerable to oil price shocks as compared to advanced economies. However, the consequences of oil price shocks differ considerably among the countries under study having

[31] It should be taken into account that recent oil price decreases are seen as a result of strong world economy and the increasing demand for oil.

for some of them a positive effect on the GDP growth. The latter occurs for the countries which are relatively less dependent on imported oil and reached noticeable success in the transition to a market economy and, in particular, in reforms of the energy sector. Moreover, policy response is found to be a significant transmission channel of the impact of the shock to real activity. Thus, the countries which apply restrictive monetary policy, characterized partly by increasing interest rates, after the shock manage to curb inflation but at the expense of the output growth. Two other things which make the GDP growth of some countries irresponsive to a positive oil price shock are the stable and high growth as a result of the catching up process and increasing export demand from the rest of the EU. Therefore, in order for the economies to be less vulnerable to oil price volatility in the future, structural reforms, which aim among other things the stability of the growth, should be completed and the compliance with the European Union energy *acquis* which among other things includes price transparency, security stock obligations as a part of energy security, energy efficiency and environmental rules should become one of the major objectives.

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Appendix I – Tables

Table 1

Average Annual Growth of Oil Consumption

Country	1974 – 1980	1981 – 1990	1991 – 2000	2001 – 2003	1974 – 2003
	Change in %				
North America	0.2	0.1	1.5	0.8	0.7
Europe	-0.7	-0.7	1.1	0.2	0.0
Pacific	-0.1	1.4	1.9	0.0	1.1
Total OECD	-0.2	0.0	1.4	0.5	0.5
China	8.2	3.2	7.8	4.8	6.0
Other Asia	5.3	5.0	5.2	2.7	4.9
Latin America	3.0	0.9	3.5	-1.4	2.0
Middle East	7.4	3.8	4.7	34	4.9
Africa	5.0	3.1	2.4	2.7	3.3
Total	1.3	0.5	1.5	1.1	1.1

Source: IEA Annual Statistical supplements to the Oil Market Report 2002 and 1998, Monthly Oil Market Report (May 2004), NIESR calculations.

Table 2

Inflation and Economic Growth, 1991-1997 (%)

Country	**Inflation**		**GDP growth**	
	Average	Volatility	Average	Volatility
Czech Republic	17.0	15.8	0.01	5.7
Estonia	26.7	12.7	1.6	7.3
Hungary	23.2	5.0	-0.75	5.5
Latvia	20.9	11.0	-0.6	8.7
Lithuania	58.2	74.5	-2.1	10.3
Poland	32.2	16.5	3.5	4.8
Romania	145.0	100.1	-1.6	7.6
Slovakia	17.6	19.2	-0.11	8.3
Slovenia	66.0	94.0	0.84	5.63

Source: IMF International Financial Statistic

Table 3

Features of dependence

Country	Total	Gas	Oil	Electricity
Croatia	80.6	37.4	80.6	24.8
Czech Republic	46.2	102.0	98.7	14.6
Estonia	39.4	100.0	100.0	5.3
Hungary	70.6	80.6	81.8	31.2
Latvia	65.2	88.6	102.5	44.9
Lithuania	109.5	100.0	94.7	40.3
Poland	34.9	66.4	100.4	3.3
Romania	29.3	23.5	52.4	1.0
Slovakia	87.9	100.1	98.9	23.7
Slovenia	58.9	99.4	101.4	28.0
EU-15	78.7	64.9	92.5	8.7

Note: Values over 100 include re-export. Domestic consumption = production + import – export.
Source: OECD database http://www.iea.org/dbtw-wpd/Textbase/stats/index.asp

Table 4

GDP Energy Intensity, Primary Energy Consumption and Energy Dependence

Selected Countries

Country	GDP energy intensity in 2004 (toe/GDP $ 2000)	Change of energy intensity during 1993-2003 (toe/M euro 95), (%)	Primary energy consumption per capita in 2004	Dependence on imported energy sources (%)
Croatia	-	-	-	52.4
Czech Republic	0.73	-7	4.5	38
Estonia	0.51	-56	3.8	34
Hungary	0.48	-28	2.7	66
Latvia	0.46	-37	2.0	93
Lithuania	0.61	-43	2.8	63
Poland	0.49	-47	2.3	19
Slovakia	0.75	-20	3.5	69
Slovenia	0.33	-20	3.6	57

Source: Ministry of Economic Affairs and Communications. Estonia 2004. Energy intensity is measured as a ton of oil equivalent (toe) to GDP in constant 2000 prices.

Table 5

Variables' Description

Real GDP	Real GDP in volume indices (2000=100) on a quarterly basis
REER	Real Effective Exchange Rate Index (100%) measured on a quarterly basis as a weighted average exchange rate of the local currency vis-à-vis a basket of foreign currencies adjusted for inflation rate differentials with a country's trading partners
Real Oil Price	Nominal price of an internationally traded UK Brent in US dollars deflated by the US Producer Price Index on a monthly basis
Inflation	Measured by the Consumer Price Index on a quarterly basis
Short-term Interest Rates	Measured by the Treasury Bill Rate or Money Market Rate on a quarterly basis
EU-15 Imports	Total imports for 15 EU countries measured in volume indices (2000=100) on a monthly basis

Note: The primary data sources are the International Financial Statistics of the IMF, local central banks, statistical offices and research institutes, the OECD and Eurostat databases, the ILO and the WIIW databases.

Appendix II – Tests

Table 6

Results of Unit Root Tests (Output Variable)

Country	No constant, no trend		Constant, no trend		Constant, trend	
	ADF	PP	ADF	PP	ADF	PP
Real GDP in levels						
Croatia	3.78	4.45	-1.78	-2.00	-3.09	-3.06
Czech Republic	2.78	3.67	1.91	-0.25	-2.22	-1.60
Estonia	5.20	4.88	1.44	1.43	-2.70	-2.70
Hungary	3.82	7.12	-0.35	0.52	-2.45	-3.60**
Latvia	6.88	6.04	1.23	1.36	-1.34	-1.27
Lithuania	4.03	5.25	0.29	0.48	-2.00	-1.90
Poland	4.03	5.42	-1.57	-1.86	-3.17	-3.10
Romania	1.04	1.52	-0.10	-0.01	-0.97	-0.89
Slovakia	7.47	7.47	-0.57	-0.59	-1.78	-1.62
Slovenia	3.70	3.60	-1.33	-1.44	-1.73	-3.83**
Real GDP in First Log-differences						
Croatia	-5.63***	-5.68***	-7.28***	-7.40***	-7.40***	-7.57***
Czech Republic	-1.90*	-2.19**	-3.83***	-4.04***	-2.66	-3.99**
Estonia	-2.53**	-4.57***	-6.31***	-6.32***	-6.64***	-6.64***
Hungary	-0.71	-2.68***	-4.29***	-6.02***	-4.12**	-5.79***
Latvia	-2.28**	-4.00***	-6.00***	-6.00***	-6.75***	-6.80***
Lithuania	-5.53***	-5.84***	-8.03***	-8.09***	-8.03***	-8.13***
Poland	-2.11**	-5.85***	-8.09***	-8.22***	-8.24***	-8.24***
Romania	-6.42***	-6.41***	-6.50***	-6.49***	-6.87***	-6.92***
Slovakia	-0.56	-4.59***	-9.07***	-8.91***	-9.05***	-8.93***
Slovenia	-9.76***	-8.99***	-11.87***	-11.87***	-11.90***	-12.29***

Note: Sample is 1995:Q1-2005:Q1 for the variables in levels and starts one quarter later for the variables in first differences. I use Schwarz Info Criterion (SIC) for the Augmented Dickey-Fuller Tests taking 9 as the maximum number of lags allowed in these procedures into account. I use Default (Bartlett kernel) method for the Phillips-Perron tests using Newey-West Bandwidth selection. I define with one/two/three asterisks the rejection of the null hypothesis at a 10%/5%/1% critical levels.

Critical levels used for ADF test are the following:

- In the model with No constant, No trend: -2.63 (1%), -1.95 (5%), -1.61 (10%).
- In the model with Constant, No trend: -3.61 (1%), -2.94 (5%), -2.61 (10%).
- In the model with Constant and Trend: -4.21 (1%), -3.53 (5%), -3.19 (10%).

Critical levels used for PP test are the following:

- In the model with No constant, No trend: -2.62 (1%), -1.95 (5%), -1.61 (10%).
- In the model with Constant, No trend: -3.61 (1%), -2.94 (5%), -2.61 (10%).
- In the model with Constant and Trend: -4.21 (1%), -3.53 (5%), -3.19 (10%).

Tables 7

Results of Unit Root Tests (Real Effective Exchange Rate Variable)

Country	No constant, no trend		Constant, no trend		Constant, trend	
	ADF	PP	ADF	PP	ADF	PP
REER in levels						
Croatia	0.55	0.75	-1.74	-1.76	-2.78	-2.87
Czech Republic	2.46	2.69	-0.56	-0.49	-3.68**	-2.89
Estonia	0.27	0.78	-1.72	-1.72	-2.30	-1.15
Hungary	2.98	2.89	1.14	1.08	-1.79	-1.90
Latvia	0.54	0.99	-2.20	-2.45	-1.07	-1.28
Lithuania	2.39	1.96	-1.83	-1.77	-0.34	-0.33
Poland	1.63	1.35	-1.74	-1.86	-2.04	-2.34
Romania	1.26	1.01	-0.65	-1.04	-1.96	-2.47
Slovakia	0.25	0.24	-2.31	-2.31	-2.65	-2.65
Slovenia	0.42	0.40	-0.86	-1.02	-2.63	-2.66
REER in First Log-differences						
Croatia	-6.91***	-7.02***	-6.93***	-7.13***	-6.84***	-7.03***
Czech Republic	-4.52***	-4.51***	-4.99***	-4.80***	-4.93***	-4.71***
Estonia	-3.36***	-3.40***	-3.77***	-3.79***	-4.05**	-3.81**
Hungary	-4.94***	-5.11***	-6.36***	-6.32***	-3.70**	-6.27***
Latvia	-3.97***	-3.88***	-3.98***	-3.77***	-4.29***	-4.11**
Lithuania	-5.08***	-5.33***	-5.90***	-5.97***	-6.82***	-6.91***
Poland	-5.04***	-5.13***	-5.25***	-5.33***	-5.16***	-5.26***
Romania	-4.94***	-5.05***	-5.03***	-5.13***	-5.02***	-5.11***
Slovakia	-6.66***	-6.67***	-6.59***	-6.60***	-6.56***	-6.56***
Slovenia	-5.76***	-5.75***	-5.72***	-5.72***	-6.03***	-6.03***

Tables 8

Results of Unit Root Tests (Inflation Variable: CPI)

Country	No constant, no trend		Constant, no trend		Constant, trend	
	ADF	PP	ADF	PP	ADF	PP
CPI in levels						
Croatia	8.32	7.06	-0.96	-0.95	-1.01	-1.15
Czech Republic	0.95	3.80	-4.10***	-3.16**	-0.78	-0.57
Estonia	0.55	2.46	-4.29***	-6.94***	-2.95	-2.14
Hungary	0.72	4.77	-2.75*	-5.49***	-0.71	-1.05
Latvia	1.12	2.92	-1.91	-3.97***	-3.17	-3.64**
Lithuania	0.29	1.58	-5.14***	-14.38***	-5.05***	-8.84***
Poland	0.67	3.19	-2.82*	-5.08***	-1.02	-0.94
Romania	0.32	4.47	0.07	1.85	-2.84	-3.11
Slovakia	9.42	7.62	0.31	0.22	-1.48	-1.78
Slovenia	0.09	7.41	-0.61	-0.63	-1.51	-1.65
CPI in First Log-differences						
Croatia	-0.96	-2.78***	-6.47***	-6.49***	-6.59***	-6.59***
Czech Republic	-1.44	-1.93*	-1.98	-3.63***	-4.17**	-4.61***
Estonia	-1.43	-1.36	-2.02	-2.02	-3.73**	-3.79**
Hungary	-1.49	-1.55	-2.16	-2.10	-3.51*	-3.52*
Latvia	-1.75*	-1.73*	-2.23	-2.06	-2.19	-2.01
Lithuania	-2.32**	-2.62**	-2.20	-2.05	-2.40	-2.09
Poland	-1.60	-1.56	-1.88	-1.72	-3.28*	-3.31*
Romania	-0.78	-0.57	-2.09	-1.91	-1.98	-1.79
Slovakia	-1.56	-2.51**	-5.70***	-5.80***	-5.66***	-5.76***
Slovenia	-0.82	-2.04**	-6.95***	-6.94***	-1.47	-7.03***
CPI in Second Log-differences						
Croatia	-8.126***	-17.905***	-8.007***	-17.364***	-7.868***	-17.257***
Czech Republic	-10.683***	-10.392***	-4.488***	-10.280***	-4.426***	-10.154***
Estonia	-7.536***	-7.756***	-7.543***	-8.226***	-5.601***	-9.727***
Hungary	-6.743***	-7.249***	-6.769***	-7.510***	-6.691***	-7.366***
Latvia	-7.677***	-8.626***	-7.583***	-8.572***	-5.796***	-11.918***
Lithuania	-6.659***	-6.947***	-6.702***	-7.371***	-6.585***	-13.138***
Poland	-7.559***	-7.559***	-7.553***	-7.553***	-7.448***	-7.448***
Romania	-7.986***	-7.986***	-7.800***	-7.900***	-8.159***	-9.605***
Slovakia	-12.265***	-13.814***	-12.108***	-13.604***	-12.031***	-13.696***
Slovenia	-8.641***	-14.558***	-8.560***	-14.348***	-8.721***	-17.232***

Tables 9

Results of Unit Root Tests (Monetary Variable: Short-term interest rate)

Country	No constant, no trend		Constant, no trend		Constant, trend	
	ADF	PP	ADF	PP	ADF	PP
Short-term interest rate in levels						
Croatia	-2.94***	-2.76***	-6.90***	-5.92***	-8.64***	-7.23***
Czech Republic	-0.83	-0.85	-0.79	-0.95	-2.17	-2.22
Estonia	-5.28***	-5.30***	-4.60***	-4.91***	-4.19***	-4.34***
Hungary	-4.54***	-3.98***	-3.09**	-3.41**	-1.49	-1.48
Latvia	-6.25***	-6.02***	-5.76***	-8.25***	-4.12**	-5.66***
Lithuania	-5.61***	-4.82***	-3.96***	-3.59**	-3.03	-2.42
Poland	-1.86*	-3.05***	-1.04	-2.13	-3.82**	-3.02
Romania	-1.94*	-1.93*	-2.44	-2.46	-3.21*	-3.30*
Slovakia	-0.90	-0.80	-0.52	-0.71	-1.39	-1.57
Slovenia	-2.15**	-2.66***	-0.62	-2.80*	-2.92	-4.62***
Short-term interest rate in First Log-differences						
Croatia	-18.85***	-15.26***	-18.45***	-14.97***	-17.67***	-14.43***
Czech Republic	-6.71***	-6.74***	-6.68***	-6.69***	-6.75***	-6.75***
Estonia	-6.15***	-6.15***	-6.86***	-6.85***	-7.50***	-7.51***
Hungary	-3.46***	-3.50***	-4.16***	-4.24***	-4.97***	-4.97***
Latvia	-3.75***	-3.75***	-4.09***	-4.09***	-4.86***	-4.89***
Lithuania	-1.75*	-4.48***	-1.98	-5.32***	-2.28	-5.97***
Poland	-3.15***	-3.15***	-3.53**	-3.28**	-3.48*	-3.25*
Romania	-6.14***	-6.15***	-6.24***	-6.23***	-6.21***	-6.21***
Slovakia	-5.84***	-5.99***	-5.86***	-6.00***	-6.01***	-6.12***
Slovenia	-9.73***	-9.16***	-9.72***	-9.16***	-9.43***	-9.43***

Tables 10

Results of Unit Root Tests (EU-15 Imports Variable)

Country	No constant, no trend		Constant, no trend		Constant, trend	
	ADF	PP	ADF	PP	ADF	PP
EU-15 Real Import in levels						
All	3.70	3.33	-2.03	-2.05	-0.83	-0.82
EU-15 Real Import in First Log-differences						
All	-4.50***	-4.73***	-5.70***	-5.77***	-6.13***	-6.13***

Tables 11

Results of Unit Root Tests (Real Oil Price Variable)

Country	No constant, no trend		Constant, no trend		Constant, trend	
	ADF	PP	ADF	PP	ADF	PP
Real Oil Price in levels						
All	-0.44	-0.44	-2.28	-2.32	-1.73	-1.63
Real Oil Price in First Log-differences						
All	-8.70***	-9.72***	-8.66***	-9.67***	-9.00***	-10.81***

Table 12

Granger Causality/Block Exogeneity Wald Tests

P-values of the asymptotic distribution Chi-Squared are reported for the different countries considered.
H_0*: The oil price coefficients are jointly equal to zero in GDP equation of the VAR model.*

Country	Linear	Asymmetric		Scaled		Net
	o_t	o_t^+	o_t^-	$SOPI_t$	$SOPD_t$	$NOPI_t$
Croatia	0.3073	0.7248	0.8455	0.4545	0.7925	0.1853
Czech Republic	0.5087	0.1357	0.5503	0.0090***	0.2748	0.4262
Estonia	0.1503	0.0085***	0.4539	0.3725	0.9774	0.0007***
Hungary	0.2710	0.0001***	0.0042***	0.0000***	0.0003***	0.0020***
Latvia	0.5108	0.0640*	0.8463	0.1928	0.6021	0.5754
Lithuania	0.1066	0.1072	0.0249**	0.1060	0.0556*	0.0243**
Poland	0.2343	0.1196	0.3371	0.2339	0.6011	0.8187
Romania	0.7017	0.9553	0.8418	0.6427	0.8066	0.7427
Slovakia	0.7023	0.1136	0.1048	0.0315**	0.0037***	0.6033
Slovenia	0.9157	0.4940	0.5674	0.6911	0.9516	0.6393

Note: One/two/tree asterisks mean a p-value less than 10%/5%/1%.

Table 13

Wald Test

P-values of the asymptotic distribution Chi-Squared are reported for the different countries considered.
H_0: The oil price coefficients are jointly equal to zero in all equations of the VAR model but its own equation.

Country	Linear	Asymmetric		Scaled		Net
	o_t	o_t^+	o_t^-	$SOPI_t$	$SOPD_t$	$NOPI_t$
Croatia	0.4629	0.4310	0.8233	0.9399	0.9327	0.6539
Czech Republic	0.0143**	0.0537*	0.1370	0.0000***	0.0018***	0.0001***
Estonia	0.0848*	0.0296**	0.7962	0.5224	0.9704	0.0155**
Hungary	0.5148	0.0069***	0.0038***	0.0000***	0.0011***	0.0257**
Latvia	0.7169	0.3191	0.9449	0.5890	0.9744	0.8608
Lithuania	0.0706*	0.6352	0.3186	0.4977	0.2979	0.0511*
Poland	0.4564	0.9077	0.9144	0.9597	0.8791	0.9820
Romania	0.9620	0.9695	0.9832	0.9982	0.9997	0.9623
Slovakia	0.4095	0.4805	0.1108	0.3494	0.0024***	0.1751
Slovenia	0.1943	0.1498	0.8598	0.4113	0.9625	0.0698*

Note: One/two/tree asterisks mean a p-value less than 10%/5%/1%.

Table 14: Wald Test (Selected Variables)

H_0 : All inflation coefficients are jointly zero in all equations of the system but its own equation.

Country	Linear	Asymmetric		Scaled		Net
	o_t	o_t^+	o_t^-	$SOPI_t$	$SOPD_t$	$NOPI_t$
Croatia	0.0251**	0.1693	0.2295	0.2753	0.5089	0.2758
Czech Republic	0.0001***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Estonia	0.0775*	0.0812*	0.0892*	0.5922	0.4883	0.0020***
Hungary	0.6612	0.2998	0.2476	0.0040***	0.0032***	0.3039
Latvia	0.7270	0.7913	0.7330	0.7657	0.7420	0.8320
Lithuania	0.3232	0.4066	0.4263	0.3716	0.3481	0.4408
Poland	0.1570	0.6102	0.6112	0.2046	0.2745	0.2060
Romania	0.4944	0.8067	0.8535	0.9156	0.6988	0.4125
Slovakia	0.0003***	0.0018***	0.0229**	0.0028***	0.0255***	0.0010***
Slovenia	0.4116	0.7577	0.6260	0.6146	0.4326	0.5367

H_0 : All short-term interest rate coefficients are jointly zero in all equations of the system but its own equation.

Country	Linear	Asymmetric		Scaled		Net
	o_t	o_t^+	o_t^-	$SOPI_t$	$SOPD_t$	$NOPI_t$
Croatia	0.1163	0.7345	0.4982	0.7977	0.7315	0.6595
Czech Republic	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***	0.0000***
Estonia	0.0483**	0.1942	0.2680	0.5978	0.5180	0.0068***
Hungary	0.3683	0.1526	0.1652	0.0001***	0.0002***	0.1698
Latvia	0.0307**	0.2067	0.0691*	0.0466**	0.2062	0.5481
Lithuania	0.3215	0.3787	0.1074	0.4063	0.5267	0.4135
Poland	0.4722	0.7082	0.5445	0.6140	0.5824	0.6687
Romania	0.7790	0.9693	0.9239	0.9698	0.9302	0.7928
Slovakia	0.0010***	0.0022***	0.0130**	0.0066***	0.0227**	0.0004***
Slovenia	0.7615	0.9020	0.9023	0.9691	0.9118	0.5522

H_0 : All real effective exchange rate coefficients are jointly zero in all equations of the system but its own equation.

Country	Linear	Asymmetric		Scaled		Net
	o_t	o_t^+	o_t^-	$SOPI_t$	$SOPD_t$	$NOPI_t$
Croatia	0.0000***	0.0283**	0.0048***	0.0409**	0.0128**	0.0020***
Czech Republic	0.1382	0.0054***	0.0596*	0.0000***	0.0000***	0.0000***
Estonia	0.5728	0.2374	0.6716	0.9719	0.9897	0.0288**
Hungary	0.1026	0.0144**	0.0217**	0.0001***	0.0001***	0.0641*
Latvia	0.3119	0.2570	0.5076	0.5753	0.6279	0.3004
Lithuania	0.6488	0.1558	0.8705	0.2557	0.5232	0.3781
Poland	0.4713	0.5610	0.5072	0.5966	0.5001	0.8007
Romania	0.0174**	0.1718	0.3780	0.4603	0.3260	0.0807*
Slovakia	0.2999	0.0957*	0.1436	0.0889*	0.1144	0.0307**
Slovenia	0.7701	0.8941	0.8395	0.9462	0.5415	0.9262

H_0 : All EU-15 imports coefficients are jointly zero in all equations of the system but its own equation.

Country	Linear	Asymmetric		Scaled		Net
	o_t	o_t^+	o_t^-	$SOPI_t$	$SOPD_t$	$NOPI_t$
Croatia	0.2428	0.0780*	0.1013	0.7473	0.8090	0.1551
Czech Republic	0.0823*	0.0061***	0.1055	0.0000***	0.0023***	0.0784*
Estonia	0.1502	0.0800*	0.0981*	0.8121	0.5786	0.2446
Hungary	0.6192	0.5259	0.6075	0.0249**	0.0358**	0.5071
Latvia	0.5379	0.3042	0.8079	0.2999	0.8088	0.6684
Lithuania	0.5756	0.5751	0.8760	0.6969	0.8787	0.3604
Poland	0.6428	0.9219	0.8844	0.8361	0.8542	0.7920
Romania	0.4039	0.7946	0.2921	0.9591	0.7545	0.4798
Slovakia	0.0418**	0.0042***	0.0188**	0.0056***	0.0078***	0.0566*
Slovenia	0.6583	0.6506	0.7106	0.8567	0.7226	0.8572

Note: One/two/tree asterisks mean a p-value less than 10%/5%/1%.

Table 15

Test for equality of positive and negative oil price coefficients

H_0 : *All positive and negative oil price coefficients are jointly equal in GDP equation and the VAR system as a whole.*

Country	**Asymmetric**		**Scaled**	
	GDP-equation	Whole system	GDP-equation	Whole system
Czech Republic	0.6601	0.3588	0.0000***	0.0442**
Estonia	0.2417	0.0263**	0.6951	0.7303
Hungary	0.0053***	0.0111**	0.0544*	0.1320
Latvia	0.3242	0.1829	0.2534	0.7492
Slovakia	0.2689	0.0241**	0.0431**	0.0284**

Note: One/two/tree asterisks mean a p-value less than 10%/5%/1%. Test for the system as a whole does not include oil price-equations.
The test is done only for asymmetric and scaled oil price specifications for countries where the corresponding oil price coefficients are significant.

Appendix III – Accumulated Responses

Table 16
Accumulated Response of GDP growth to a 1% oil price shock

Accumulated response of GDP growth to a 1% oil price shock: LINEAR CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	-0.025	**-0.005**	**-0.010**	0.0002	0.015	**-0.030**	0.005	0.014	0.004	-0.027
4	0.023	**-0.011**	**-0.003**	0.003	0.024	**0.058**	-0.045	0.006	0.010	-0.027
6	0.026	**-0.013**	**0.043**	0.001	0.028	**0.068**	-0.049	-0.030	-0.001	-0.029
8	0.043	**-0.009**	**0.060**	0.021	0.045	**0.075**	-0.056	-0.011	0.002	-0.063

Accumulated Response of GDP growth to a 1% oil price shock: ASYMMETRIC CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	-0.002	-0.079	**-0.016**	-	**-0.026**	-	**0.004**	**-0.020**	**0.015**	-	-	**-0.01**	-0.014	0.032	-0.024	0.051	-0.060	0.059	-0.154	0.154
4	0.063	0.006	**-0.027**	-	**-0.018**	-	**0.012**	**-0.011**	**0.054**	-	-	**0.0004**	-0.140	-0.008	0.052	-0.052	-0.024	0.077	-0.171	0.042
6	0.026	-0.005	**-0.028**	-	**0.075**	-	**-0.015**	**0.003**	**0.065**	-	-	**-0.005**	-0.182	-0.040	0.013	-0.221	-0.083	0.082	0.078	0.327
8	0.131	-0.044	**-0.003**	-	**0.100**	-	**0.022**	**-0.003**	**0.091**	-	-	**0.005**	-0.302	-0.053	0.058	-0.256	-0.024	0.061	-0.009	0.080

Accumulated Response of GDP growth to a 1% oil price shock: SCALED CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	-0.001	-0.011	**-0.002**	**-0.0001**	-0.002	0.006	**0.0005**	**-0.002**	0.005	0.009	-	**-0.015**	0.0002	0.006	0.005	0.005	**0.001**	**0.012**	-0.020	0.004
4	0.008	-0.002	**-0.004**	**-0.003**	0.003	0.009	**0.001**	**-0.001**	0.012	0.014	-	**-0.006**	-0.014	0.0003	0.007	-0.004	**0.003**	**0.010**	-0.002	-0.047
6	0.0004	-0.004	**-0.007**	**-0.007**	0.005	0.010	**-0.005**	**0.001**	0.017	0.016	-	**-0.015**	-0.019	0.004	-0.003	-0.029	**-4.40E-05**	**0.011**	0.016	0.068
8	0.023	-0.013	**-0.011**	**-0.011**	0.012	0.002	**-0.001**	**-0.001**	0.025	0.021	-	**-0.007**	-0.019	0.004	0.001	-0.038	**-0.006**	**0.010**	-0.030	0.084

Accumulated Response of GDP growth to a 1% oil price shock: NET CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	0.060	**-0.024**	**-0.108**	**0.027**	0.034	**-0.048**	0.005	0.045	-0.004	**-0.223**
4	0.032	**-0.037**	**-0.009**	**0.048**	0.080	**0.203**	-0.102	0.068	-0.015	**0.145**
6	0.019	**-0.049**	**0.015**	**0.034**	0.118	**0.145**	-0.064	0.013	-0.068	**0.120**
8	0.205	**-0.082**	**0.195**	**0.076**	0.152	**0.169**	-0.104	0.117	0.003	**-0.357**

Note: In the asymmetric and scaled cases missing values mean that the corresponding measure of the oil price shock is statistically insignificant. Bold numbers show whether the corresponding oil price shock measure is significant for a country.

Table 17

Accumulated Response of the change of CPI to a 1% oil price shock

Accumulated response of the change of CPI to a 1% oil price shock: LINEAR CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	0.041	**-0.003**	**-0.006**	-0.013	0.018	**0.019**	0.029	-0.020	0.012	0.004
4	0.014	**0.007**	**-0.028**	-0.059	0.041	**0.058**	0.031	-0.050	0.020	0.018
6	-0.016	**0.013**	**-0.036**	-0.034	0.055	**0.064**	0.001	0.0002	-0.036	0.037
8	-0.057	**0.017**	**-0.004**	-0.030	0.092	**0.070**	-0.023	0.031	-0.038	0.027

Accumulated response of the change of CPI to a 1% oil price shock: ASYMMETRIC CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	-0.084	-0.072	**0.003**	-	**-0.058**	-	**-0.053**	**-0.026**	**0.067**	-	-	**0.011**	0.058	0.031	0.160	-0.051	0.026	0.009	0.039	-0.065
4	-0.066	0.060	**-0.018**	-	**-0.117**	-	**-0.132**	**-0.051**	**0.053**	-	-	**-0.061**	0.078	-0.031	-0.303	-0.086	-0.093	0.025	0.056	-0.007
6	-0.036	0.091	**-0.013**	-	**-0.065**	-	**-0.056**	**0.018**	**0.017**	-	-	**-0.083**	0.066	-0.057	0.189	-0.250	-0.096	0.116	0.023	-0.057
8	0.019	0.096	**-0.008**	-	**-0.044**	-	**0.008**	**0.013**	**-0.002**	-	-	**-0.129**	-0.001	-0.068	-0.205	0.133	-0.093	0.144	0.064	-0.022

Accumulated Response of the change of CPI to a 1% oil price shock: SCALED CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	0.013	-0.002	**-0.001**	**0.008**	-0.004	0.012	**0.008**	**-0.008**	0.010	0.011	-	**0.005**	0.006	-0.003	0.005	-0.023	**0.013**	**0.006**	0.001	-0.001
4	0.007	-0.012	**0.002**	**0.015**	-0.011	0.017	**-0.001**	**0.003**	0.017	0.022	-	**0.013**	0.004	-0.007	0.002	-0.059	**0.026**	**0.006**	-0.001	-0.027
6	0.006	-0.019	**0.020**	**0.022**	-0.017	0.011	**0.005**	**0.009**	0.030	0.033	-	**0.012**	-0.006	-0.013	0.024	-0.091	**0.006**	**-0.006**	0.009	-0.016
8	-0.011	-0.018	**0.038**	**0.028**	-0.012	0.006	**0.028**	**0.012**	0.040	0.041	-	**0.013**	-0.016	-0.015	0.040	-0.123	**0.001**	**-0.010**	-0.004	-0.017

Accumulated Response of the change of CPI to a 1% oil price shock: NET CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	0.095	**-0.029**	**-0.137**	**0.077**	0.060	**0.059**	0.095	0.114	-0.020	**-0.029**
4	0.092	**0.086**	**-0.305**	**0.036**	0.107	**0.092**	0.106	0.121	-0.015	**-0.029**
6	0.094	**0.256**	**-0.245**	**0.232**	0.148	**0.116**	0.095	0.345	-0.059	**-0.045**
8	-0.031	**0.382**	**-0.150**	**0.419**	0.240	**0.141**	0.079	0.634	0.022	**-0.216**

Note: In the asymmetric and scaled cases missing values mean that the corresponding measure of oil price shock is statistically insignificant. Bold numbers show whether the corresponding oil price shock measure is significant for a country.

Table 18

Accumulated Response of the change of short-term interest rate to a 1% oil price shock

Accumulated response of the change of short-term interest rate to a 1% oil price shock: LINEAR CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	-0.047	**-0.001**	**-0.029**	-0.034	0.057	**-0.003**	0.057	-0.058	0.021	0.026
4	0.021	**0.008**	**-0.068**	-0.074	0.058	**-0.031**	0.066	-0.119	-0.011	0.079
6	0.045	**0.011**	**-0.033**	-0.035	0.033	**-0.043**	0.046	-0.190	-0.008	0.103
8	0.046	**0.013**	**-0.012**	-0.006	0.006	**-0.067**	0.018	-0.104	-0.001	0.073

Accumulated response of the change of short-term interest rate to a 1% oil price shock: ASYMMETRIC CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	-0.084	-0.072	**0.003**	-	**-0.058**	-	**-0.053**	**-0.026**	**0.067**	-	-	**0.011**	0.058	0.031	0.160	-0.051	0.026	0.009	0.039	-0.065
4	-0.066	0.060	**-0.018**	-	**-0.117**	-	**-0.132**	**-0.051**	**0.053**	-	-	**-0.061**	0.078	-0.031	-0.303	-0.086	-0.093	0.025	0.056	-0.007
6	-0.036	0.091	**-0.013**	-	**-0.065**	-	**-0.056**	**0.018**	**0.017**	-	-	**-0.083**	0.066	-0.057	0.189	-0.250	-0.096	0.116	0.023	-0.057
8	0.019	0.096	**-0.008**	-	**-0.044**	-	**0.008**	**0.013**	**-0.002**	-	-	**-0.129**	-0.001	-0.068	-0.205	0.133	-0.099	0.144	0.064	-0.022

Accumulated response of the change of short-term interest rate to a 1% oil price shock: SCALED CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	-0.010	-0.003	**-0.002**	**0.004**	-0.005	0.002	**-0.008**	**-0.003**	0.017	0.001	-	**-0.002**	0.014	0.002	0.013	-0.018	**0.012**	**-0.004**	0.011	-0.015
4	-0.001	0.014	**-0.004**	**0.012**	-0.015	0.001	**-0.019**	**-0.006**	0.027	0.001	-	**-0.012**	0.017	-0.006	-0.022	-0.024	**0.017**	**-0.003**	0.008	-0.006
6	0.006	0.021	**0.006**	**0.014**	-0.005	0.008	**-0.009**	**0.001**	0.004	-0.013	-	**-0.014**	0.008	-0.009	0.029	0.022	**0.014**	**0.017**	0.009	-0.018
8	0.010	0.018	**0.013**	**0.013**	-0.006	0.006	**-0.002**	**-0.003**	-0.016	-0.027	-	**-0.019**	0.0004	-0.011	-0.015	0.007	**0.017**	**0.022**	0.012	-0.009

Accumulated response of the change of short-term interest rate to a 1% oil price shock: NET CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	0.006	**-0.071**	**-0.083**	**-0.142**	0.080	**-0.034**	0.109	0.206	0.049	**0.119**
4	0.090	**-0.021**	**-0.215**	**-0.197**	0.031	**-0.031**	0.150	-0.146	0.016	**0.196**
6	0.066	**0.065**	**-0.130**	**-0.145**	0.030	**-0.082**	0.158	0.330	0.112	**0.245**
8	0.063	**0.108**	**-0.088**	**-0.118**	0.060	**-0.080**	0.138	-0.253	0.051	**0.215**

Note: In the asymmetric and scaled cases missing values mean that the corresponding measure of oil price shock is statistically insignificant. Bold numbers show whether the corresponding oil price shock measure is significant for a country.

Table 19

Accumulated Response of the rate of change in REER to a 1% oil price shock

Accumulated response of the rate of change in REER to a 1% oil price shock: LINEAR CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	0.074	**-0.008**	**-0.022**	0.062	-0.093	**-0.098**	0.147	0.139	0.079	-0.037
4	0.101	**-0.052**	**-0.098**	0.044	-0.065	**-0.112**	0.333	0.171	0.173	-0.096
6	0.108	**-0.017**	**-0.111**	-0.009	-0.120	**-0.158**	0.238	0.048	0.004	-0.084
8	0.095	**0.002**	**-0.094**	0.021	-0.165	**-0.112**	0.118	0.060	-0.021	-0.078

Accumulated response of the rate of change in REER to a 1% oil price shock: ASYMMETRIC CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	0.119	0.118	**0.093**	-	**-0.060**	-	**0.152**	**-0.006**	**-0.103**	-	-	**-0.255**	0.217	0.197	-0.088	0.583	0.060	0.132	0.066	-0.007
4	0.115	0.118	**0.059**	-	**-0.173**	-	**0.080**	**0.029**	**-0.075**	-	-	**-0.280**	0.684	0.200	-0.024	1.047	0.139	0.315	-0.026	-0.018
6	0.180	0.143	**0.049**	-	**-0.207**	-	**-0.008**	**-0.076**	**-0.137**	-	-	**-0.404**	0.654	0.240	-0.058	1.083	-0.056	0.047	-0.114	-0.149
8	0.157	0.175	**0.064**	-	**-0.199**	-	**0.144**	**-0.072**	**-0.212**	-	-	**-0.319**	0.643	0.175	-0.136	0.841	0.224	-0.211	0.031	0.249

Accumulated response of the rate of change in REER to a 1% oil price shock: SCALED CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	0.026	0.010	**-0.001**	**-0.008**	-0.011	-0.001	**0.022**	**-0.008**	-0.001	0.009	-	**-0.028**	0.035	0.024	0.006	0.069	**0.013**	**-0.004**	0.009	0.008
4	0.029	0.004	**-0.043**	**-0.007**	-0.020	-0.006	**0.010**	**-0.008**	0.0002	-0.005	-	**-0.044**	0.084	0.029	0.009	0.135	**0.046**	**0.021**	-0.015	0.028
6	0.038	-0.001	**-0.050**	**-0.002**	-0.032	0.011	**-0.010**	**-0.021**	-0.002	-0.015	-	**-0.053**	0.058	0.007	-0.002	0.127	**0.011**	**-0.002**	-0.011	-0.058
8	0.032	0.006	**-0.014**	**-0.007**	-0.029	0.009	**0.012**	**-0.020**	-0.008	-0.010	-	**-0.040**	0.024	-0.009	-0.001	0.106	**-0.010**	**-0.028**	0.016	0.017

Accumulated response of the rate of change in REER to a 1% oil price shock: NET CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	0.130	**-0.089**	**-0.235**	**0.0853**	-0.194	**-0.014**	0.292	0.039	0.167	**-0.021**
4	0.200	**-0.447**	**-0.367**	**-0.143**	-0.168	**0.054**	0.673	-0.012	0.369	**-0.341**
6	0.314	**-0.382**	**-0.526**	**-0.221**	-0.292	**0.052**	0.447	-0.300	0.416	**-0.311**
8	0.296	**-0.130**	**-0.542**	**-0.082**	-0.411	**0.067**	0.483	-0.208	0.433	**-0.338**

Note: In the asymmetric and scaled cases missing values mean that the corresponding measure of oil price shock is statistically insignificant. Bold numbers show whether the corresponding oil price shock measure is significant for a country.

Table 20

Accumulated Response of the EU-15 imports growth to a 1% oil price shock

Accumulated response of EU-15 imports growth to a 1% oil price shock: LINEAR CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	-0.026	**0.050**	**0.050**	0.036	0.100	**0.048**	0.055	0.122	0.107	0.034
4	-0.160	**0.0124**	**-0.002**	0.005	0.021	**0.033**	-0.015	0.100	0.139	0.011
6	-0.207	**0.010**	**0.006**	0.024	-0.031	**-0.011**	-0.073	0.093	0.122	0.031
8	-0.247	**0.020**	**0.012**	0.077	-0.036	**-0.030**	-0.068	0.117	0.125	-0.004

Accumulated response of EU-15 imports growth to a 1% oil price shock: ASYMMETRIC CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	0.097	-0.162	**-0.029**	-	**0.105**	-	**0.105**	**-0.040**	**0.119**	-	-	**-0.024**	0.099	-0.058	0.195	0.055	0.073	0.071	0.130	0.052
4	-0.039	-0.323	**-0.155**	-	**-0.001**	-	**0.043**	**0.022**	**0.050**	-	-	**-0.043**	-0.037	-0.194	0.178	0.024	0.085	0.219	0.114	0.137
6	-0.086	-0.404	**-0.140**	-	**0.043**	-	**0.048**	**0.080**	**-0.037**	-	-	**-0.110**	-0.219	-0.226	0.151	0.003	0.093	0.239	0.260	0.370
8	-0.170	-0.471	**-0.104**	-	**0.045**	-	**0.091**	**0.116**	**-0.067**	-	-	**-0.118**	-0.385	-0.298	0.089	0.058	0.110	0.299	0.076	0.191

Accumulated response of EU-15 imports growth to a 1% oil price shock: SCALED CASE

Q	Croatia		Czech		Estonia		Hungary		Latvia		Lithuania		Poland		Romania		Slovakia		Slovenia	
	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-	o_t^+	o_t^-
2	0.008	-0.016	**0.032**	**0.008**	0.012	-0.005	**0.023**	**-0.004**	0.021	-0.016	-	**-0.005**	0.010	-0.008	0.027	0.004	**0.035**	**0.005**	0.012	0.011
4	-0.024	-0.039	**0.048**	**0.023**	-0.0001	-0.005	**0.017**	**0.012**	0.017	-0.014	-	**-0.010**	-0.007	-0.034	0.025	-0.005	**0.054**	**0.016**	0.015	0.007
6	-0.044	-0.045	**0.036**	**0.015**	0.001	-0.004	**0.014**	**0.021**	-0.017	-0.021	-	**-0.017**	-0.028	-0.031	0.021	-0.001	**0.063**	**0.007**	0.015	0.080
8	-0.053	-0.042	**0.056**	**0.018**	0.003	-0.011	**0.021**	**0.019**	-0.025	-0.032	-	**-0.021**	-0.031	-0.030	0.024	0.005	**0.063**	**0.032**	0.0004	0.032

Accumulated response of EU-15 imports growth to a 1% oil price shock: NET CASE

Quarters	Croatia	Czech	Estonia	Hungary	Latvia	Lithuania	Poland	Romania	Slovakia	Slovenia
2	-0.108	**0.282**	**0.043**	**0.244**	0.117	**0.210**	0.160	0.307	0.301	**-0.055**
4	-0.108	**0.414**	**-0.153**	**0.282**	-0.030	**0.234**	0.089	0.261	0.421	**-0.013**
6	-0.186	**0.538**	**-0.096**	**0.360**	-0.040	**0.291**	0.021	0.338	0.574	**-0.021**
8	-0.364	**0.532**	**-0.198**	**0.453**	-0.083	**0.178**	0.058	0.349	0.588	**-0.072**

Note: In the asymmetric and scaled cases missing values mean that the corresponding measure of oil price shock is statistically insignificant. Bold numbers show whether the corresponding oil price shock measure is significant for a country.

Table 21

Relative Performance of the Models

Country		Linear	Asymmetric	Scaled	Net
Croatia	AIC	-13.78	-22.89	-13.62	-15.65
	BIC	-7.19	-13.96	-4.70	-9.05
Czech Republic	AIC	**-16.10**	**-17.57**	**-20.86**	**-17.89**
	BIC	**-9.50**	**-10.98**	**-11.93**	**-11.29**
Estonia	AIC	**-11.82**	**-14.88**	-8.47	**-14.80**
	BIC	**-5.22**	**-8.28**	0.46	**-8.21**
Hungary	AIC	-13.59	**-21.97**	**-18.55**	**-16.56**
	BIC	-7.00	**-13.04**	**-9.62**	**-9.96**
Latvia	AIC	-13.44	**-14.62**	-17.91	-15.26
	BIC	-6.84	**-8.02**	-8.98	-8.66
Lithuania	AIC	**-11.02**	**-12.06**	**-8.32**	**-12.97**
	BIC	**-4.42**	**-5.46**	**-1.72**	**-6.37**
Poland	AIC	-12.72	-22.17	-12.34	-14.21
	BIC	-6.12	-13.24	-3.41	-7.62
Romania	AIC	-5.72	-13.42	-2.22	-7.13
	BIC	0.87	-4.49	6.71	-0.53
Slovakia	AIC	-14.26	-21.67	**-14.61**	-15.12
	BIC	-7.67	-12.74	**-5.68**	-8.52
Slovenia	AIC	-10.79	-16.72	-9.87	**-12.83**
	BIC	-4.19	-7.79	-0.94	**-6.23**

Note: According to the AIC and SIC asymmetric specification performs somewhat better for all the countries but Lithuania where net specification is preferred (the smaller AIC and SC criteria the better). In asymmetric specification six-variable model is used for the Czech Republic, Estonia, Latvia and Lithuania. For the latter country it is also the case in scaled specification. Bold numbers indicate the significance of the corresponding oil price shock measure for a country.

Appendix IV – Variance Decomposition

Table 22
Estimated Variance Decomposition at the 12-period horizon: Linear Case

	Innovation in	GDP	O	Inflation	SR	REER	EU-15 imp
	Croatia	46.71	8.54	5.15	10.00	27.05	2.56
VAR (GDP)	Czech Republic	**68.66**	**1.07**	**5.10**	**18.15**	**3.71**	**3.31**
	Estonia	**43.17**	**20.27**	**8.51**	**4.68**	**9.42**	**13.96**
	Hungary	44.86	17.19	17.69	6.51	5.38	8.37
	Latvia	68.29	5.60	2.55	10.71	11.12	1.74
	Lithuania	**48.99**	**15.78**	**11.60**	**3.91**	**6.63**	**13.09**
	Poland	50.35	13.58	8.68	9.13	7.95	10.32
	Romania	44.75	6.42	14.96	4.93	15.30	13.64
	Slovakia	51.24	18.22	7.66	8.22	6.26	8.41
	Slovenia	5.47	2.10	84.96	2.02	2.31	3.15
	Croatia	36.13	21.29	15.62	12.89	11.05	3.02
VAR (O)	Czech Republic	**33.40**	**33.95**	**3.20**	**20.63**	**4.78**	**4.05**
	Estonia	**14.17**	**54.06**	**9.09**	**3.59**	**6.76**	**12.33**
	Hungary	6.89	56.30	14.29	12.21	5.73	4.57
	Latvia	35.87	24.77	11.87	18.67	5.69	3.13
	Lithuania	**18.52**	**43.35**	**8.36**	**9.56**	**10.72**	**9.49**
	Poland	8.20	64.72	11.02	8.67	4.78	2.61
	Romania	28.12	25.75	11.58	10.75	15.54	8.27
	Slovakia	21.34	50.02	13.56	7.41	4.82	2.84
	Slovenia	25.19	11.46	49.99	1.88	3.75	7.73
	Croatia	8.13	16.65	25.73	9.78	35.12	4.59
VAR (Inflation)	Czech Republic	**56.25**	**1.60**	**6.92**	**25.65**	**4.97**	**4.62**
	Estonia	**12.46**	**19.46**	**52.67**	**3.90**	**6.17**	**5.35**
	Hungary	7.96	31.04	28.90	24.48	4.16	3.46
	Latvia	10.32	11.59	44.00	28.71	2.13	3.25
	Lithuania	**33.99**	**15.32**	**36.76**	**1.86**	**4.21**	**7.87**
	Poland	17.84	36.04	20.39	16.65	7.75	1.33
	Romania	11.56	8.79	30.13	4.37	34.78	10.37
	Slovakia	15.89	18.58	37.27	16.80	3.71	7.75
	Slovenia	15.36	1.38	77.52	1.42	1.29	3.03
	Croatia	25.06	11.15	5.95	32.31	18.98	6.55
VAR (SR)	Czech Republic	**39.44**	**2.14**	**10.51**	**38.62**	**5.31**	**3.96**
	Estonia	**26.96**	**29.06**	**15.95**	**14.66**	**3.63**	**9.74**
	Hungary	4.99	38.43	16.35	29.75	5.52	4.97
	Latvia	37.50	7.91	11.77	35.10	1.17	6.56
	Lithuania	**14.69**	**15.89**	**15.75**	**18.11**	**10.94**	**24.62**
	Poland	30.00	22.29	12.80	24.46	7.88	2.56
	Romania	26.46	9.03	29.56	20.35	6.63	7.97
	Slovakia	34.53	18.29	12.80	20.45	8.83	5.10
	Slovenia	20.94	7.12	59.85	4.83	3.95	3.30
	Croatia	21.04	16.30	12.11	4.48	43.73	2.75
VAR (REER)	Czech Republic	**39.61**	**4.09**	**6.46**	**33.90**	**10.13**	**5.81**
	Estonia	**13.58**	**23.51**	**15.93**	**11.56**	**21.22**	**14.21**
	Hungary	12.20	26.62	18.49	19.54	16.63	6.51
	Latvia	27.53	13.13	20.05	17.87	18.50	2.93
	Lithuania	**11.23**	**15.92**	**16.24**	**9.40**	**29.85**	**17.37**
	Poland	8.13	41.25	10.25	15.00	23.52	1.83
	Romania	26.40	8.10	21.12	13.02	25.89	5.46
	Slovakia	19.62	28.39	13.24	18.02	15.17	5.57
	Slovenia	19.19	3.81	67.40	1.30	4.58	3.71
	Croatia	15.86	17.08	11.95	7.72	37.78	9.61
VAR (EU-15 imp)	Czech Republic	**44.39**	**6.62**	**3.38**	**31.23**	**5.30**	**9.07**
	Estonia	**17.15**	**20.94**	**9.72**	**8.61**	**8.81**	**34.78**
	Hungary	21.22	18.78	8.88	16.45	6.52	28.15
	Latvia	25.10	17.74	12.44	14.77	8.31	21.64
	Lithuania	**17.85**	**7.17**	**5.82**	**2.74**	**7.87**	**58.55**
	Poland	20.29	26.56	17.03	11.74	15.21	9.16
	Romania	25.17	24.14	11.44	10.48	7.67	21.10
	Slovakia	30.32	18.62	18.51	13.14	5.31	14.09
	Slovenia	12.29	2.07	77.13	1.74	2.54	4.23

Note: Columns 3-8 give the percentage of the forecast variance due to each innovation, with each row adding up to 100.

Table 23
Estimated Variance Decomposition at the 12-period horizon: Asymmetric Case

	Innovation in	GDP	O (+)	O (-)	Inflation	SR	REER	EU-15 imp
	Croatia	41.31	5.33	12.80	6.97	13.47	20.09	0.02
VAR (GDP)	Czech Republic	**60.10**	**3.32**	-	**6.87**	**21.83**	**6.31**	**1.57**
	Estonia	**35.81**	**22.62**	-	**14.81**	**9.13**	**4.48**	**13.16**
	Hungary	**23.01**	**28.37**	**12.83**	**8.50**	**9.34**	**12.78**	**5.16**
	Latvia	**48.63**	**8.03**	-	**15.02**	**12.26**	**12.47**	**3.59**
	Lithuania	**40.16**	-	**13.59**	**12.87**	**9.83**	**7.77**	**15.78**
	Poland	30.11	41.35	13.37	3.13	7.12	4.04	0.88
	Romania	48.51	8.88	10.04	8.64	8.75	5.06	10.12
	Slovakia	26.55	15.76	28.46	7.98	2.50	8.15	10.60
	Slovenia	14.18	7.49	14.43	60.56	0.77	0.88	1.70
	Croatia	34.19	28.82	7.01	13.11	9.10	7.76	0.02
VAR (O +)	Czech Republic	**31.19**	**28.89**	-	**8.89**	**21.45**	**6.40**	**3.18**
	Estonia	**15.17**	**43.87**	-	**15.83**	**5.18**	**5.37**	**14.58**
	Hungary	**6.50**	**50.73**	**18.78**	**4.50**	**10.69**	**5.82**	**2.97**
	Latvia	**26.07**	**29.09**	-	**10.23**	**14.68**	**15.81**	**4.12**
	Poland	18.27	39.51	23.30	10.24	3.80	4.49	0.40
	Romania	32.54	25.05	12.57	8.91	8.98	6.34	5.59
	Slovakia	29.32	16.79	20.66	13.23	2.27	10.63	7.11
	Slovenia	58.71	4.52	4.78	21.06	1.13	6.78	3.03
	Croatia	36.43	8.62	27.57	15.69	5.68	5.98	0.03
VAR (O -)	Hungary	**3.70**	**32.30**	**45.15**	**5.94**	**8.34**	**3.25**	**1.31**
	Lithuania	**8.77**	-	**61.18**	**3.57**	**14.82**	**5.68**	**5.97**
	Poland	12.13	35.32	33.77	6.95	6.61	4.82	0.40
	Romania	40.77	9.27	14.72	17.75	9.38	2.33	5.79
	Slovakia	30.26	11.70	38.55	9.85	2.16	3.92	3.56
	Slovenia	20.81	6.80	11.49	58.26	0.53	1.56	0.55
	Croatia	8.45	24.84	11.81	28.30	6.25	20.31	0.03
VAR (Inflation)	Czech Republic	**55.50**	**2.24**	-	**8.66**	**23.88**	**7.26**	**2.45**
	Estonia	**10.25**	**18.63**	-	**58.77**	**5.04**	**1.46**	**5.85**
	Hungary	**14.19**	**40.89**	**11.58**	**13.98**	**13.15**	**4.96**	**1.25**
	Latvia	**6.07**	**8.89**	-	**60.90**	**18.37**	**1.87**	**3.89**
	Lithuania	**18.25**	-	**20.70**	**35.86**	**5.40**	**7.49**	**12.30**
	Poland	6.77	64.09	17.76	2.67	6.27	2.31	0.14
	Romania	12.91	27.85	21.95	10.20	11.42	7.44	8.23
	Slovakia	20.01	7.71	29.15	20.39	2.88	5.70	14.16
	Slovenia	14.97	5.57	9.58	67.08	0.72	0.82	1.26
	Croatia	34.00	7.36	13.59	7.50	21.81	15.69	0.05
VAR (SR)	Czech Republic	**40.08**	**2.02**	-	**9.31**	**38.48**	**7.28**	**2.84**
	Estonia	**23.61**	**31.87**	-	**22.25**	**12.19**	**4.22**	**5.86**
	Hungary	**13.84**	**44.86**	**14.12**	**5.21**	**14.11**	**5.91**	**1.96**
	Latvia	**25.60**	**7.91**	-	**19.10**	**38.52**	**2.51**	**6.36**
	Lithuania	**9.03**	-	**16.67**	**20.05**	**27.96**	**10.00**	**16.28**
	Poland	56.32	15.49	8.59	7.32	8.09	4.01	0.19
	Romania	35.73	14.77	7.60	27.74	6.89	3.60	3.67
	Slovakia	29.32	11.66	29.46	11.46	3.69	9.50	4.90
	Slovenia	16.05	7.95	17.44	52.73	1.41	1.91	2.50
	Croatia	23.36	16.16	15.99	11.62	7.26	25.59	0.01
VAR (REER)	Czech Republic	**38.41**	**4.36**	-	**9.04**	**28.29**	**16.60**	**3.30**
	Estonia	**16.30**	**25.32**	-	**21.63**	**14.51**	**8.84**	**13.40**
	Hungary	**4.08**	**42.85**	**22.66**	**10.55**	**8.96**	**8.34**	**2.56**
	Latvia	**27.79**	**12.31**	-	**16.60**	**15.40**	**24.68**	**3.62**
	Lithuania	**6.50**	-	**25.79**	**13.17**	**21.84**	**21.46**	**11.24**
	Poland	20.60	39.56	14.40	7.01	6.05	12.06	0.32
	Romania	24.14	5.66	25.62	21.60	11.62	7.22	4.14
	Slovakia	31.32	9.76	29.12	7.19	2.90	10.85	8.85
	Slovenia	21.02	6.79	12.74	56.83	0.47	1.52	0.62
	Croatia	24.07	10.94	22.17	18.21	6.54	18.02	0.06
VAR (EU-15 imp)	Czech Republic	**48.53**	**5.59**	-	**3.27**	**30.71**	**6.09**	**5.81**
	Estonia	**19.63**	**21.53**	-	**13.34**	**12.64**	**3.29**	**29.57**
	Hungary	**12.25**	**17.92**	**12.19**	**8.17**	**14.72**	**20.97**	**13.79**
	Latvia	**18.24**	**15.81**	-	**20.70**	**20.39**	**9.63**	**15.23**
	Lithuania	**11.29**	-	**7.96**	**4.64**	**9.93**	**17.36**	**48.83**
	Poland	14.20	54.17	16.08	4.63	6.11	4.35	0.46
	Romania	31.51	22.86	12.34	4.55	16.03	2.81	9.90
	Slovakia	39.69	2.03	23.05	15.87	1.24	6.27	11.87
	Slovenia	15.06	8.82	16.71	56.32	0.67	0.95	1.46

Note: Columns 3-8 give the percentage of the forecast variance due to each innovation, with each row adding up to 100.

Table 24
Estimated Variance Decomposition at the 12-period horizon: Scaled Case

	Innovation in	GDP	O (+)	O (-)	Inflation	SR	REER	EU-15 imp
	Croatia	37.25	11.72	18.16	4.33	14.67	13.72	0.14
VAR (GDP)	Czech Republic	**36.09**	**3.45**	**5.81**	**22.53**	**31.18**	**0.84**	**0.10**
	Estonia	37.65	25.82	6.88	7.06	6.45	8.26	7.87
	Hungary	**18.23**	**29.21**	**11.58**	**7.20**	**14.81**	**18.86**	**0.12**
	Latvia	54.65	15.39	6.04	14.19	5.29	4.37	0.07
	Lithuania	**39.93**	-	**14.62**	**17.63**	**7.38**	**8.96**	**11.47**
	Poland	28.45	38.17	14.83	9.00	3.79	2.88	2.69
	Romania	35.05	9.54	7.13	17.01	8.45	8.60	14.22
	Slovakia	**21.63**	**16.62**	**37.27**	**10.16**	**7.78**	**5.01**	**1.53**
	Slovenia	15.71	7.81	39.92	31.10	1.36	1.35	2.74
	Croatia	26.31	34.91	13.38	5.21	12.43	7.62	0.14
VAR (O +)	Czech Republic	**20.49**	**12.12**	**8.38**	**21.84**	**31.85**	**4.57**	**0.75**
	Estonia	21.23	44.15	4.84	10.53	5.75	5.12	8.37
	Hungary	**13.31**	**42.39**	**20.38**	**8.17**	**9.54**	**6.16**	**0.05**
	Latvia	28.50	25.39	12.58	24.43	7.16	1.88	0.07
	Poland	9.61	58.95	18.92	7.71	2.56	1.48	0.76
	Romania	9.26	40.43	9.10	5.48	19.49	11.96	4.29
	Slovakia	**22.79**	**17.86**	**35.75**	**12.02**	**8.18**	**3.04**	**0.36**
	Slovenia	35.08	6.48	22.75	26.42	1.28	4.00	4.00
	Croatia	25.78	19.12	26.11	8.57	6.54	13.69	0.18
VAR (O -)	Czech Republic	**20.98**	**18.10**	**14.93**	**17.86**	**26.23**	**1.70**	**0.20**
	Estonia	10.42	30.90	25.63	17.27	2.23	2.04	11.50
	Hungary	**6.87**	**30.38**	**41.73**	**12.09**	**5.95**	**2.96**	**0.02**
	Latvia	39.08	17.92	13.66	17.67	10.53	0.99	0.15
	Lithuania	**7.74**	-	**64.08**	**4.01**	**9.83**	**7.38**	**6.96**
	Poland	9.29	34.21	40.67	9.61	3.06	1.86	1.29
	Romania	23.85	12.21	11.12	22.49	18.37	6.30	5.66
	Slovakia	**21.90**	**20.77**	**40.01**	**8.07**	**6.18**	**2.64**	**0.43**
	Slovenia	10.72	4.00	44.11	36.85	1.16	1.54	1.62
	Croatia	11.73	35.92	16.70	11.79	14.40	9.35	0.11
VAR (Inflation)	Czech Republic	**26.14**	**6.11**	**5.72**	**25.12**	**35.85**	**0.89**	**0.17**
	Estonia	12.09	13.05	13.61	36.56	7.14	5.60	11.96
	Hungary	**14.45**	**35.84**	**9.96**	**14.37**	**20.50**	**4.86**	**0.02**
	Latvia	12.97	26.19	14.94	34.64	10.13	1.04	0.10
	Lithuania	**13.73**	-	**24.12**	**34.95**	**5.94**	**9.38**	**11.88**
	Poland	20.64	53.21	10.60	8.73	5.61	0.92	0.30
	Romania	6.78	17.56	24.75	24.74	11.39	10.66	4.12
	Slovakia	**17.10**	**31.23**	**13.02**	**22.15**	**14.29**	**1.39**	**0.82**
	Slovenia	9.21	8.03	43.77	34.80	0.93	1.22	2.04
	Croatia	20.44	15.93	13.41	6.03	27.65	16.30	0.24
VAR (SR)	Czech Republic	**26.77**	**9.12**	**5.05**	**18.96**	**37.49**	**2.19**	**0.41**
	Estonia	20.87	31.65	4.70	15.53	19.97	2.73	4.55
	Hungary	**19.28**	**38.57**	**13.08**	**6.59**	**18.91**	**3.54**	**0.02**
	Latvia	27.36	20.66	4.03	31.95	14.87	0.98	0.15
	Lithuania	**9.15**	-	**28.69**	**13.86**	**23.16**	**12.81**	**12.32**
	Poland	47.19	31.23	5.95	4.54	6.46	3.76	0.88
	Romania	22.59	11.67	1.63	34.97	15.64	8.13	5.37
	Slovakia	**13.10**	**16.62**	**41.11**	**9.73**	**13.59**	**5.05**	**0.82**
	Slovenia	12.40	3.58	42.39	35.50	1.82	2.12	2.20
	Croatia	26.11	25.65	18.72	2.37	9.45	17.59	0.10
VAR (REER)	Czech Republic	**15.16**	**11.24**	**9.67**	**21.30**	**37.16**	**4.72**	**0.76**
	Estonia	18.65	30.61	6.38	11.94	14.52	11.21	6.68
	Hungary	**4.32**	**40.09**	**18.77**	**15.36**	**15.99**	**5.44**	**0.02**
	Latvia	46.16	7.82	3.70	33.86	4.10	4.32	0.04
	Lithuania	**7.44**	-	**35.40**	**8.57**	**17.04**	**23.46**	**8.09**
	Poland	12.42	46.91	18.76	8.46	4.35	8.25	0.85
	Romania	14.35	4.94	11.80	34.40	18.00	12.47	4.04
	Slovakia	**12.51**	**28.03**	**25.47**	**8.55**	**18.98**	**6.01**	**0.44**
	Slovenia	12.91	4.52	42.84	35.32	1.18	1.51	1.72
	Croatia	17.04	20.07	28.67	9.39	14.90	9.63	0.29
VAR (EU-15 imp)	Czech Republic	**20.31**	**8.44**	**5.81**	**22.08**	**41.35**	**1.48**	**0.53**
	Estonia	18.05	25.87	8.83	5.61	18.10	6.74	16.80
	Hungary	**7.66**	**26.31**	**13.24**	**5.45**	**28.72**	**18.42**	**0.20**
	Latvia	26.91	14.65	9.27	38.76	6.96	3.27	0.19
	Lithuania	**12.08**	-	**11.42**	**5.05**	**8.25**	**19.92**	**43.28**
	Poland	23.33	32.77	20.35	13.51	3.22	4.77	2.05
	Romania	15.37	28.76	8.70	6.57	19.27	4.75	16.57
	Slovakia	**23.51**	**26.88**	**23.45**	**11.56**	**10.79**	**2.62**	**1.19**
	Slovenia	11.67	4.54	43.63	35.28	1.26	1.54	2.08

Note: Columns 3-8 give the percentage of the forecast variance due to each innovation, with each row adding up to 100.

Table 25
Estimated Variance Decomposition at the 12-period horizon: Net Case

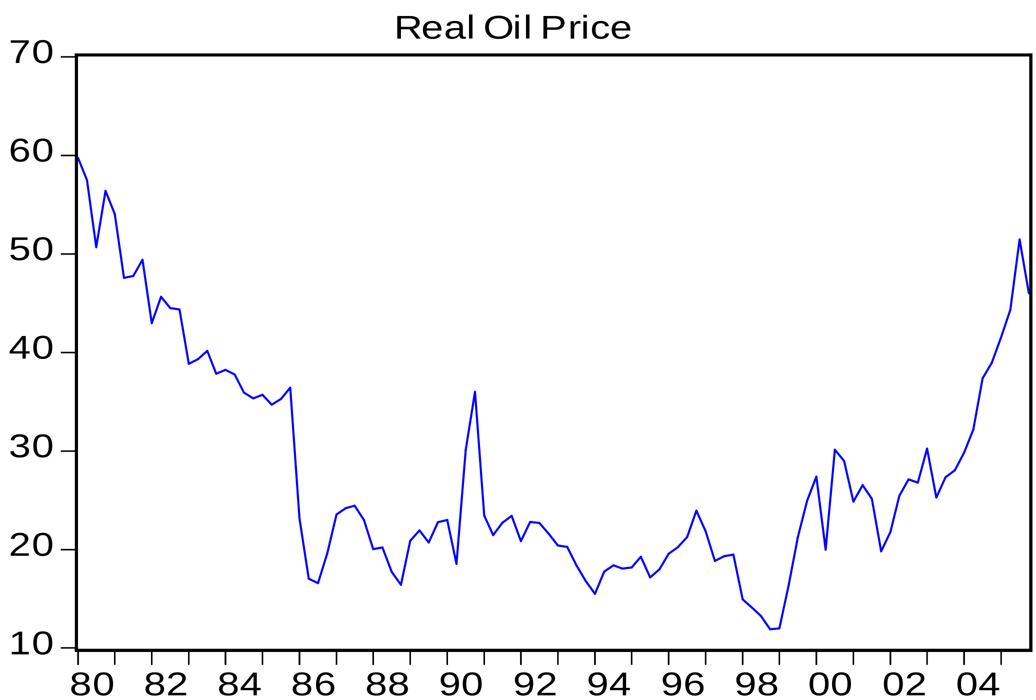
	Innovation in	GDP	O	Inflation	SR	REER	EU-15 imp
	Croatia	45.20	8.47	5.61	9.74	29.36	1.63
VAR (GDP)	Czech Republic	**53.62**	**8.83**	**15.34**	**11.74**	**9.57**	**0.90**
	Estonia	**35.36**	**29.57**	**11.87**	**12.65**	**7.92**	**2.63**
	Hungary	**35.78**	**22.79**	**14.55**	**6.92**	**9.02**	**10.94**
	Latvia	60.86	11.43	5.73	8.12	11.90	1.96
	Lithuania	**39.10**	**13.68**	**12.46**	**8.44**	**16.34**	**9.98**
	Poland	56.34	10.20	12.07	10.23	6.13	5.04
	Romania	40.59	10.93	18.49	5.20	11.72	13.07
	Slovakia	47.42	15.28	12.94	10.56	9.93	3.87
	Slovenia	**4.51**	**12.76**	**71.70**	**3.03**	**5.37**	**2.63**
	Croatia	22.75	37.48	7.29	11.33	18.38	2.76
VAR (O)	Czech Republic	**21.24**	**20.39**	**6.57**	**41.45**	**8.12**	**2.23**
	Estonia	**7.67**	**42.59**	**11.58**	**18.18**	**13.25**	**6.74**
	Hungary	**10.68**	**62.95**	**7.73**	**2.48**	**10.53**	**5.63**
	Latvia	34.47	36.24	9.29	7.61	4.93	7.47
	Lithuania	**10.63**	**37.63**	**6.11**	**5.23**	**25.17**	**15.23**
	Poland	8.93	49.98	24.06	11.41	2.86	2.76
	Romania	9.44	45.43	8.46	8.19	17.53	10.96
	Slovakia	16.09	44.65	10.03	14.56	9.71	4.96
	Slovenia	**48.39**	**9.30**	**33.83**	**2.42**	**3.83**	**2.23**
	Croatia	13.89	19.80	25.29	7.71	30.62	2.70
VAR (Inflation)	Czech Republic	**32.55**	**15.02**	**17.61**	**21.06**	**11.83**	**1.93**
	Estonia	**16.85**	**22.08**	**41.21**	**10.69**	**4.12**	**5.05**
	Hungary	**10.53**	**38.31**	**27.00**	**7.70**	**11.21**	**5.24**
	Latvia	13.33	13.36	44.74	22.46	2.32	3.79
	Lithuania	**32.23**	**8.20**	**44.16**	**2.20**	**5.46**	**7.75**
	Poland	19.98	21.77	33.43	21.76	2.03	1.03
	Romania	9.02	34.53	24.00	9.85	17.81	4.78
	Slovakia	14.12	8.79	37.40	19.37	13.52	6.80
	Slovenia	**14.48**	**9.97**	**70.98**	**1.80**	**1.56**	**1.21**
	Croatia	27.53	9.43	2.72	37.17	17.65	5.51
VAR (SR)	Czech Republic	**30.39**	**10.97**	**12.26**	**32.64**	**7.08**	**6.66**
	Estonia	**31.75**	**24.46**	**14.18**	**23.82**	**3.57**	**2.23**
	Hungary	**3.48**	**38.21**	**23.01**	**16.11**	**12.95**	**6.23**
	Latvia	40.81	7.67	10.09	32.97	2.58	5.87
	Lithuania	**15.09**	**7.10**	**21.46**	**19.23**	**15.82**	**21.30**
	Poland	31.57	10.70	26.42	25.97	3.67	1.66
	Romania	16.43	15.47	24.11	22.74	7.06	14.19
	Slovakia	27.14	8.39	20.30	23.85	16.36	3.95
	Slovenia	**27.32**	**11.12**	**43.98**	**11.39**	**3.83**	**2.37**
	Croatia	27.93	11.41	9.05	5.87	44.16	1.58
VAR (REER)	Czech Republic	**31.09**	**19.08**	**9.20**	**19.25**	**18.50**	**2.88**
	Estonia	**10.02**	**21.24**	**16.61**	**25.85**	**18.65**	**7.62**
	Hungary	**13.68**	**39.85**	**10.92**	**8.29**	**21.45**	**5.80**
	Latvia	29.14	16.36	24.21	12.72	14.15	3.41
	Lithuania	**10.70**	**6.16**	**22.26**	**13.82**	**38.45**	**8.61**
	Poland	17.57	16.86	27.51	16.73	19.48	1.84
	Romania	23.80	10.36	19.77	18.15	19.51	8.41
	Slovakia	10.85	14.52	24.90	19.90	24.19	5.64
	Slovenia	**17.50**	**10.41**	**61.23**	**3.14**	**5.50**	**2.22**
	Croatia	16.91	12.47	11.71	8.57	43.48	6.85
VAR (EU-15 imp)	Czech Republic	**23.37**	**14.84**	**12.65**	**26.15**	**13.36**	**9.64**
	Estonia	**24.88**	**17.82**	**10.99**	**13.51**	**9.92**	**22.88**
	Hungary	**19.03**	**27.55**	**8.93**	**4.22**	**8.34**	**31.94**
	Latvia	22.66	15.07	12.91	14.96	13.53	20.89
	Lithuania	**18.40**	**13.73**	**5.75**	**5.96**	**12.01**	**44.15**
	Poland	26.79	19.36	15.20	16.90	8.40	13.35
	Romania	12.95	32.97	4.44	11.54	7.09	31.01
	Slovakia	15.27	27.69	21.27	7.82	16.35	11.60
	Slovenia	**13.88**	**11.49**	**66.58**	**2.24**	**2.69**	**3.13**

Note: Columns 3-8 give the percentage of the forecast variance due to each innovation, with each row adding up to 100.

Appendix V – Oil Price Dynamics and Measures

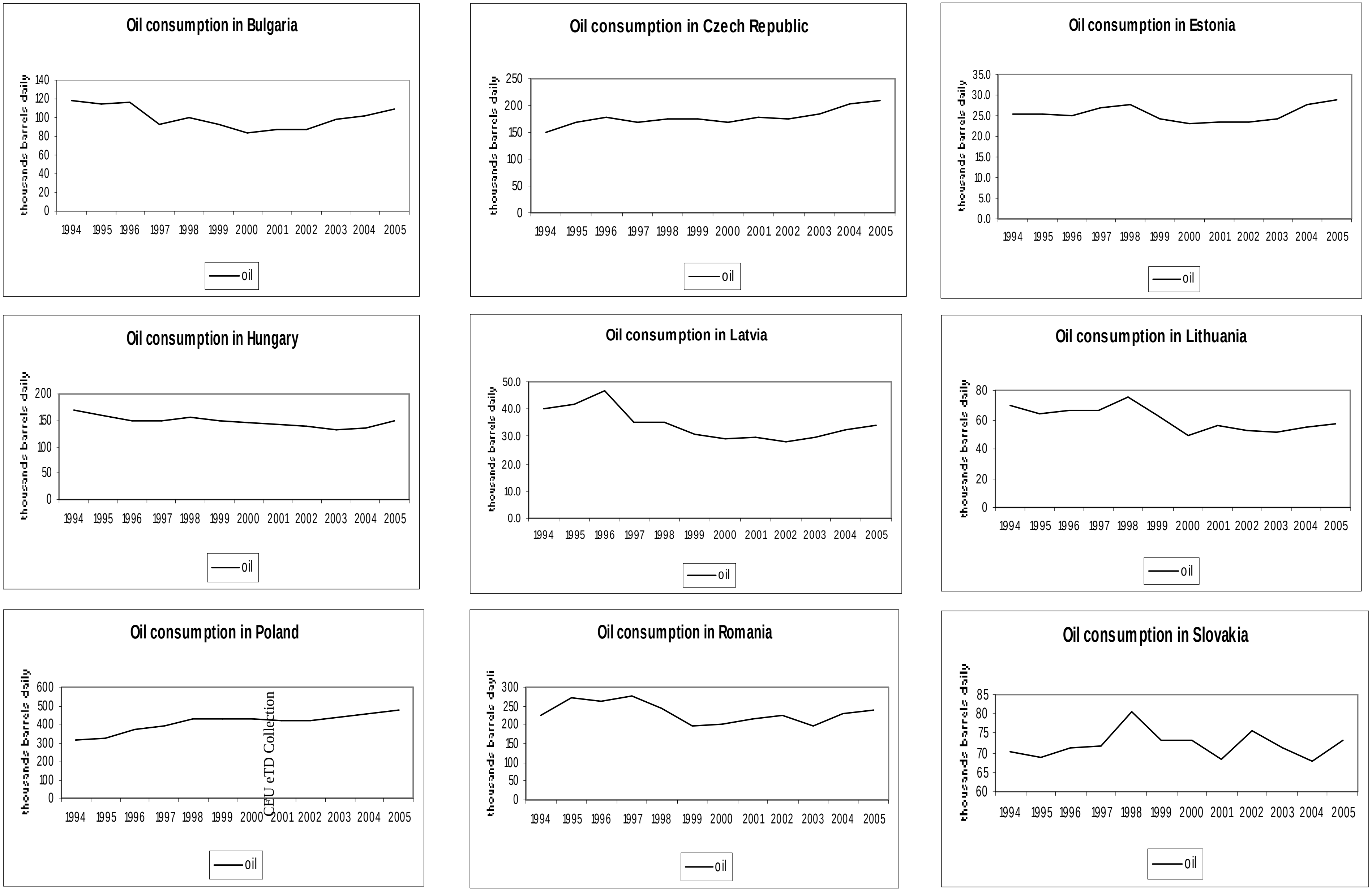
Figure 1

Real Oil Price Dynamics: 1980-2005



Source: IMF International Financial Statistic (IFS)

Figure 2: Daily Oil Consumption during 1994-2005: Selected Countries (thousands barrels)

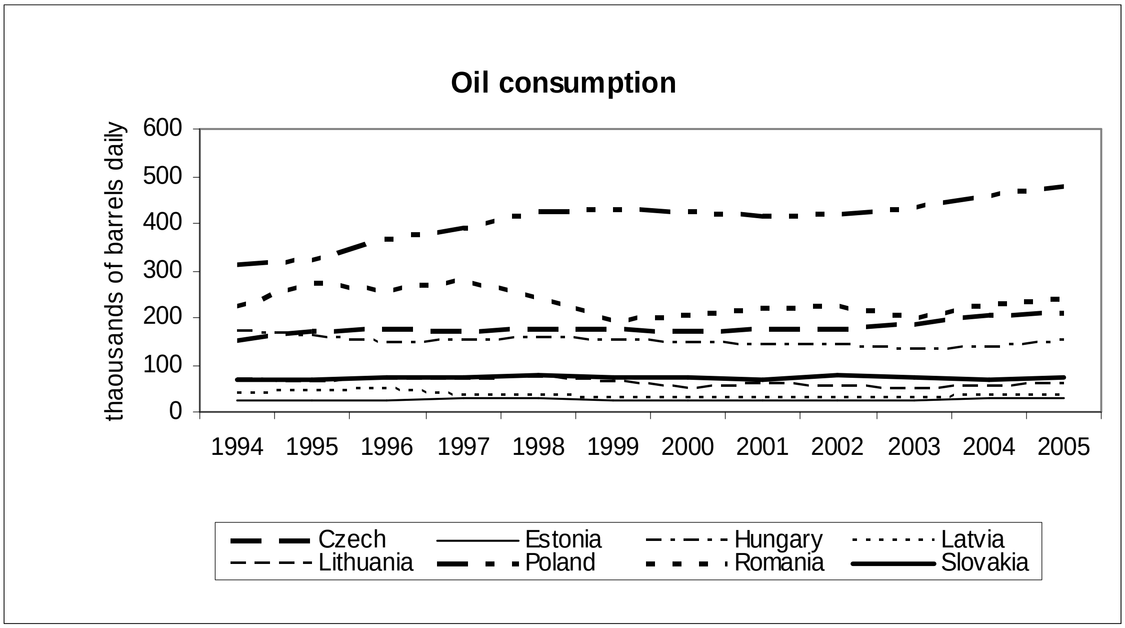


Note: Daily oil consumption for Croatia and Slovenia is not presented since I did not find relevant data for these countries during considered period. Source: BP statistical review of World Energy, June 2005.

Figure 3

Oil Consumption from 1994 to 1995 (thousands of barrels daily)

All Countries

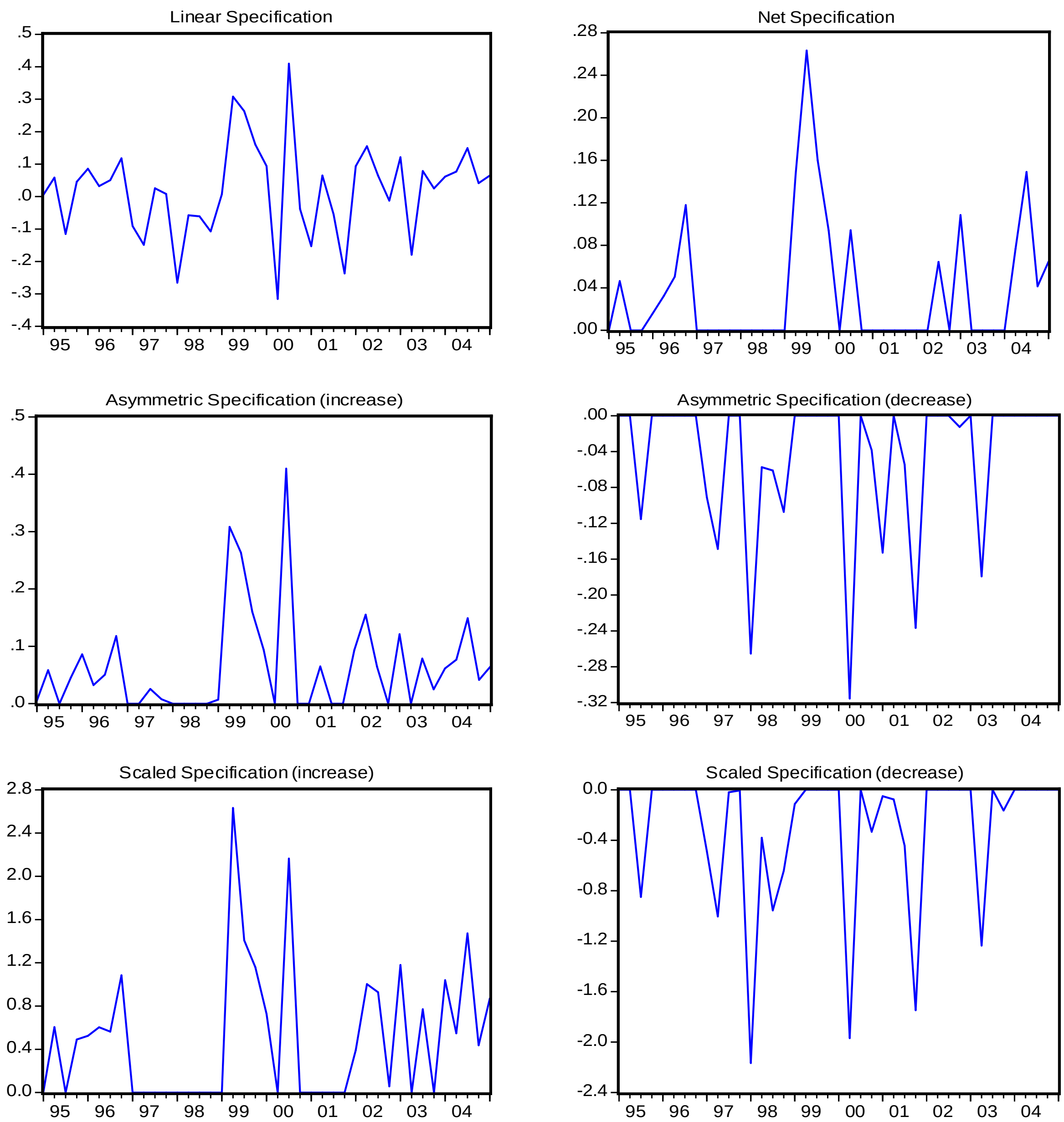


Note: The Figure presents daily oil consumption for all countries under study but Croatia and Slovenia because of the lack of the corresponding information.

Figure 4

Oil price shock: 1995-2004

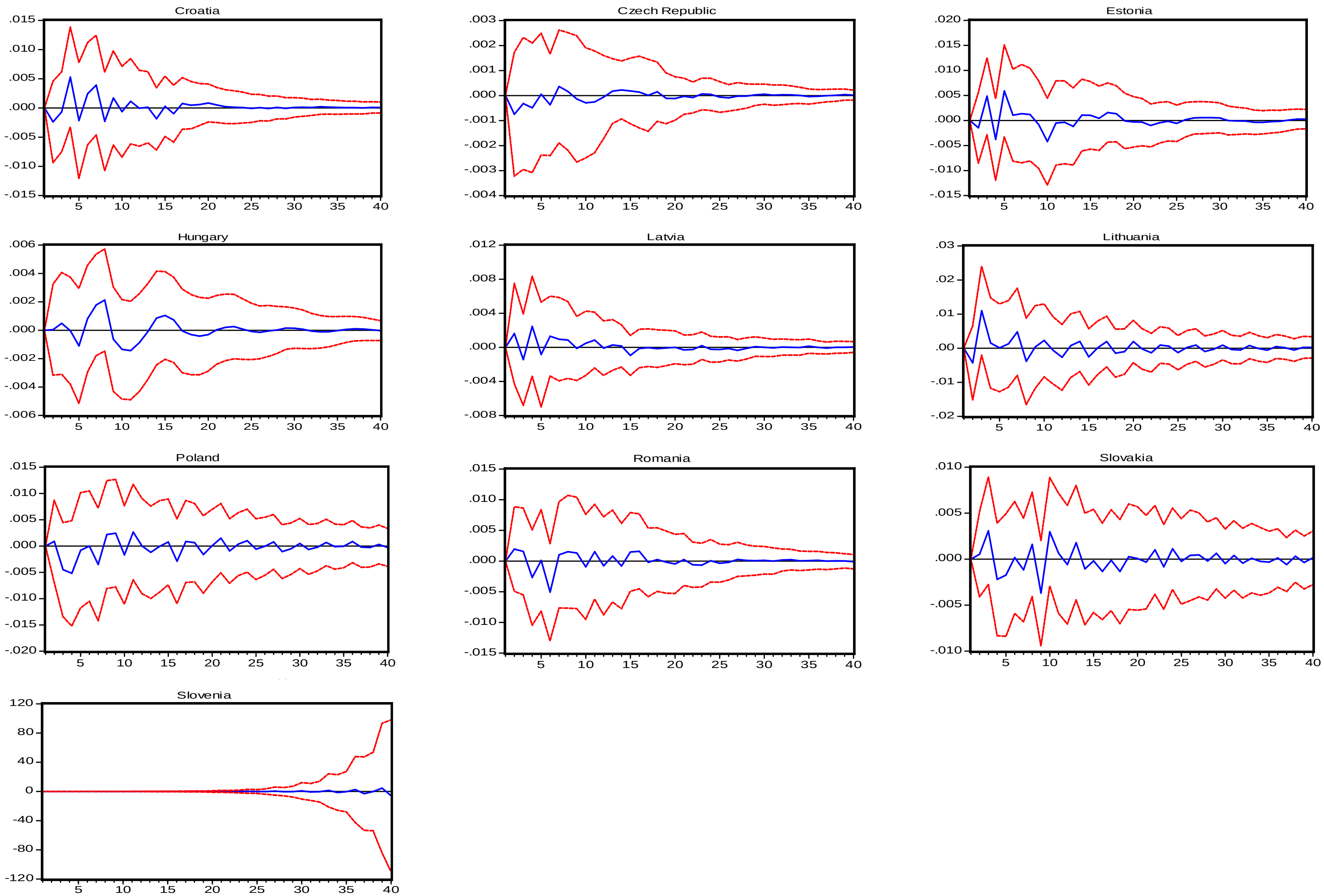
Linear, Asymmetric, Scaled, and Net Specifications



Note: This Figure presents linear and three non-linear oil price specifications, namely Asymmetric, Scaled and Net specifications. In the case of Asymmetric and Scaled specifications oil price increases and decreases are considered as separate variables.

Appendix VI – Impulse-response Functions

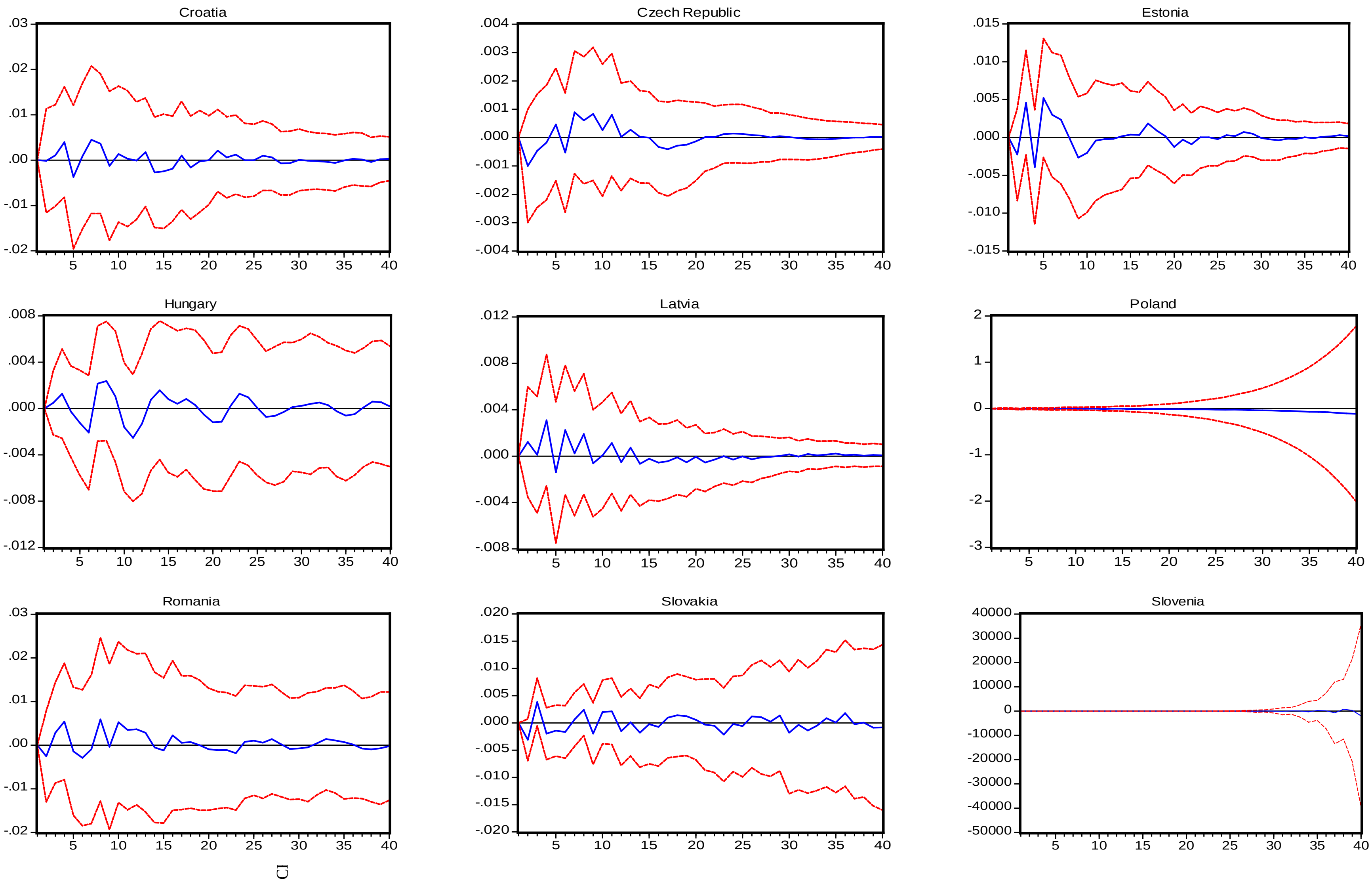
Figure 5
Orthogonalised impulse-response function of the GDP growth to a one-standard-deviation oil price innovation: Linear Specification



Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a one-standard deviation oil price innovation in the linear specification.

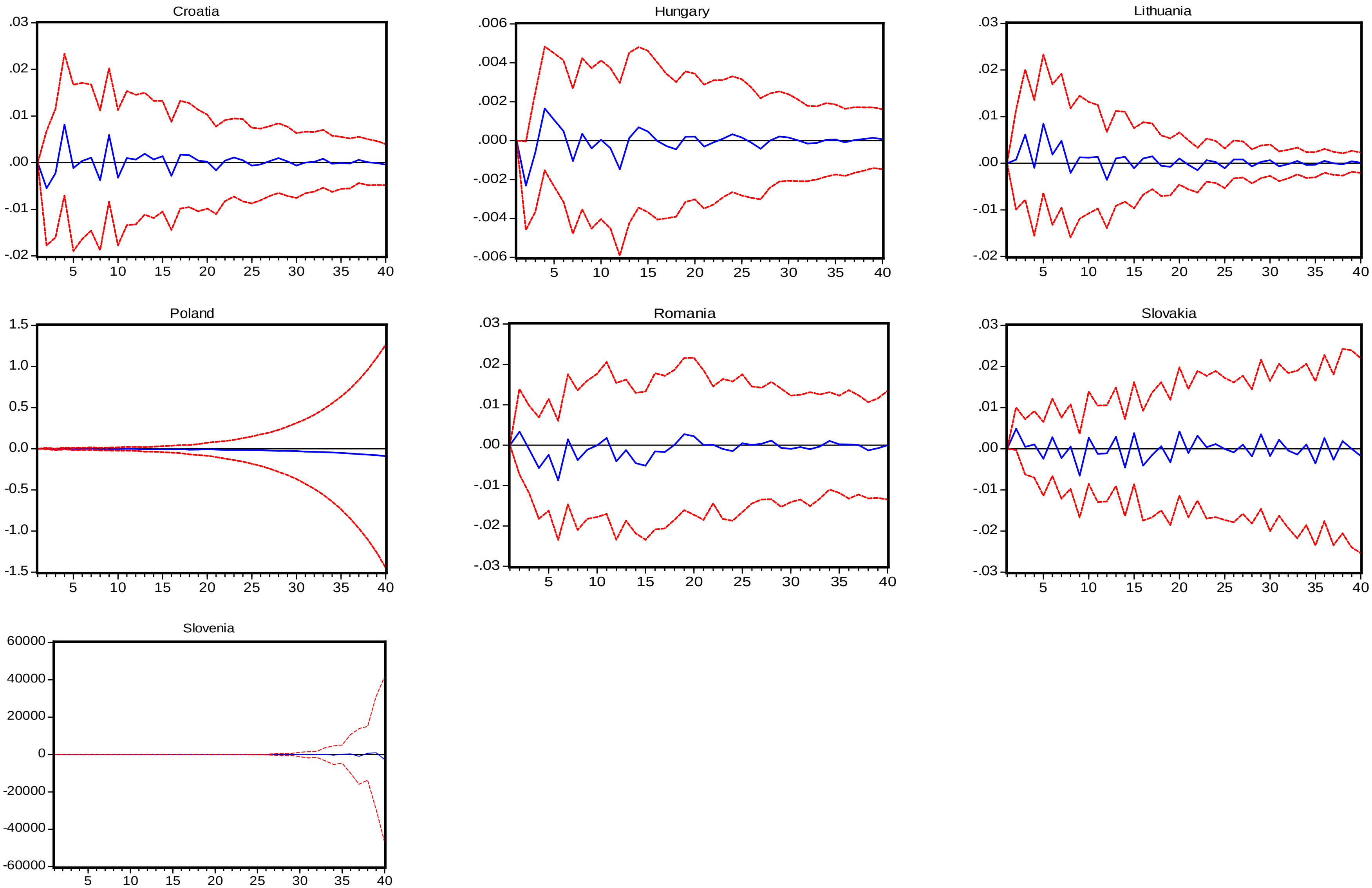
Figure 6

Orthogonalised impulse-response function of the GDP growth to a positive one-standard-deviation oil price innovation: Asymmetric Specification



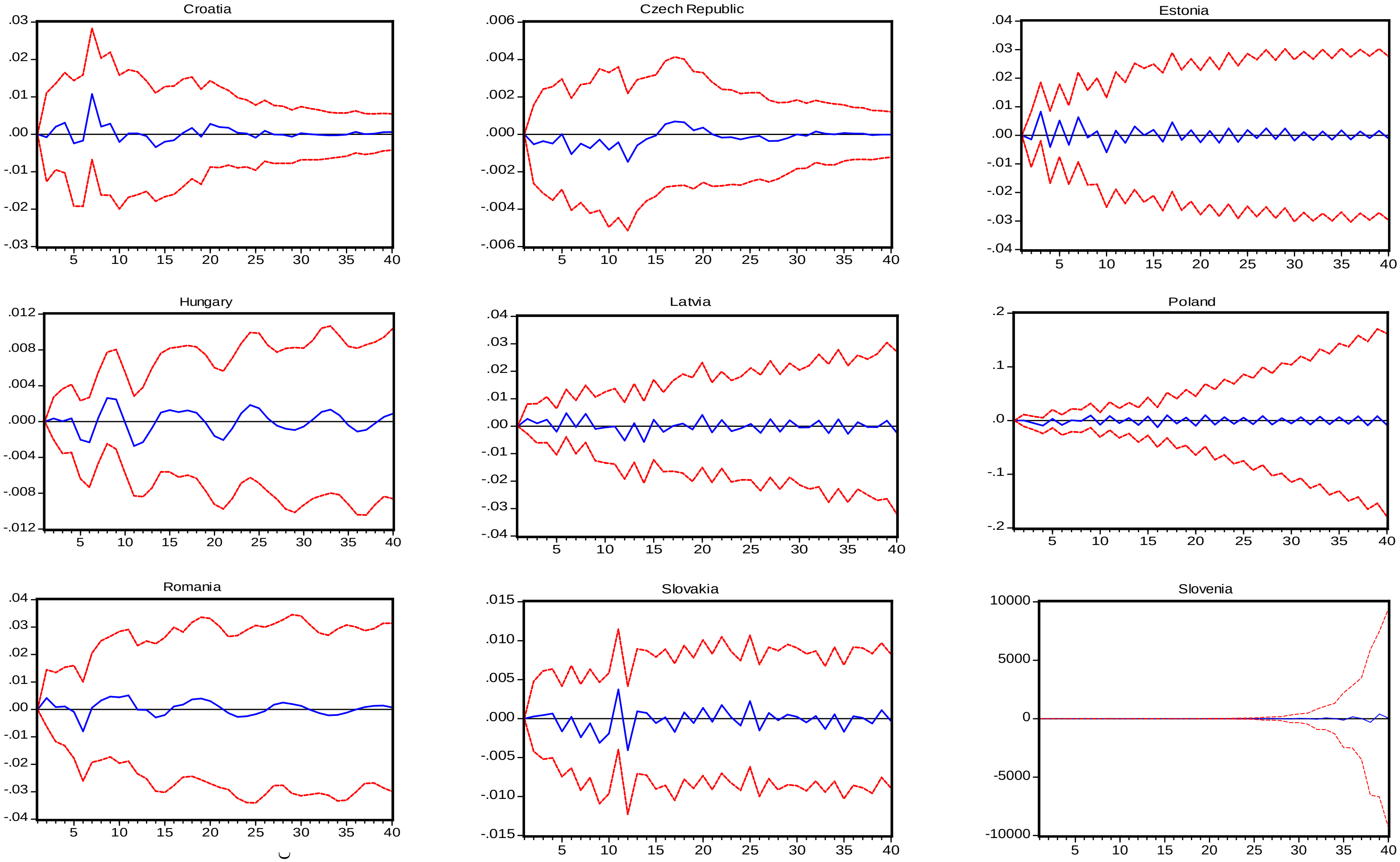
Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a positive one-standard deviation oil price innovation in the asymmetric specification. The result for Lithuania is not presented since the corresponding measure of oil price increase is found insignificant.

Figure 7
Orthogonalised impulse-response function of the GDP growth to a negative one-standard-deviation oil price innovation: Asymmetric Specification



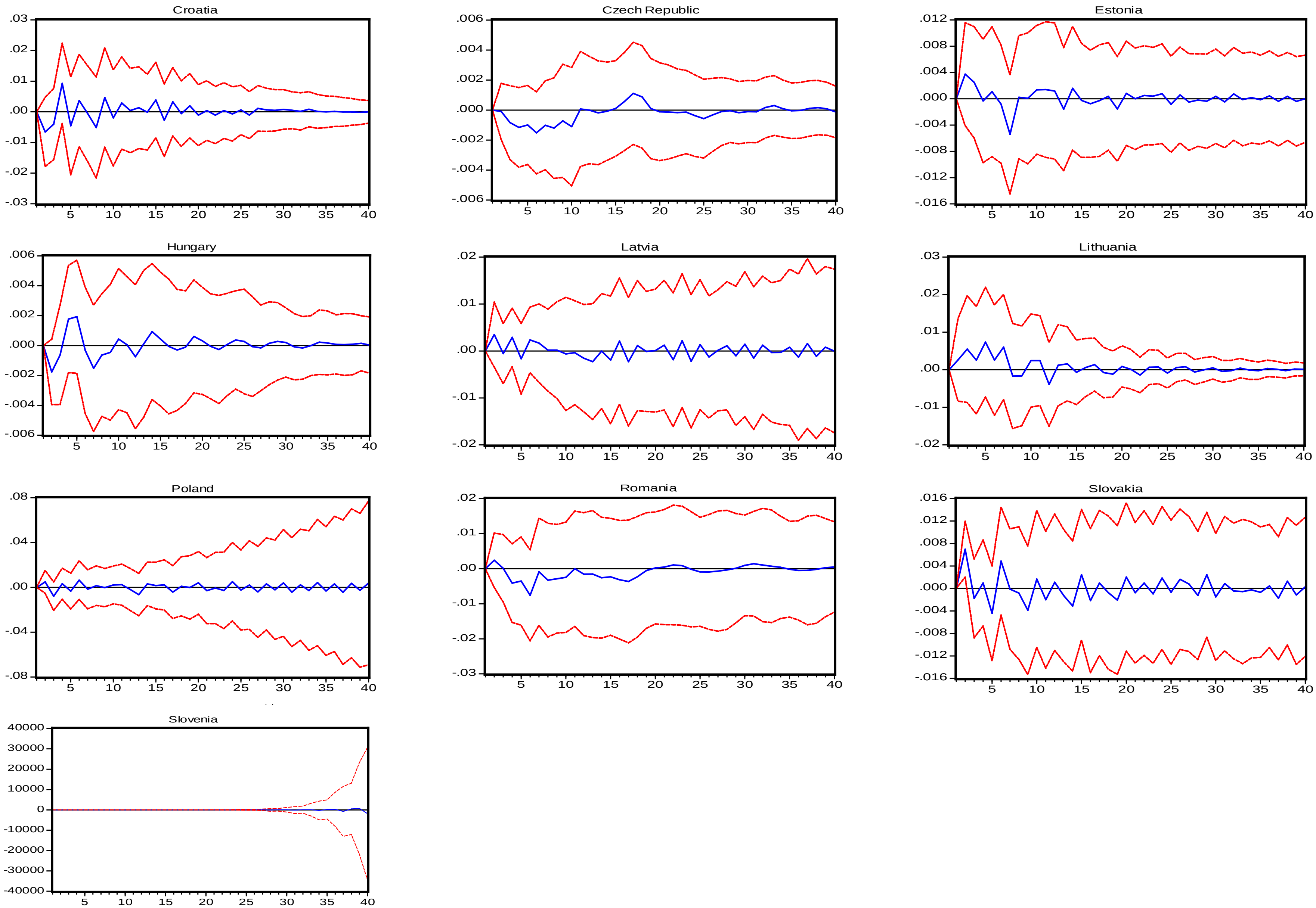
Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a negative one-standard deviation oil price innovation in the asymmetric specification. The results for the Czech Republic, Estonia and Latvia are not presented since the corresponding measure of oil price decrease is found insignificant.

Figure 8
Orthogonalised impulse-response function of the GDP growth to a positive one-standard-deviation oil price innovation: Scaled Specification



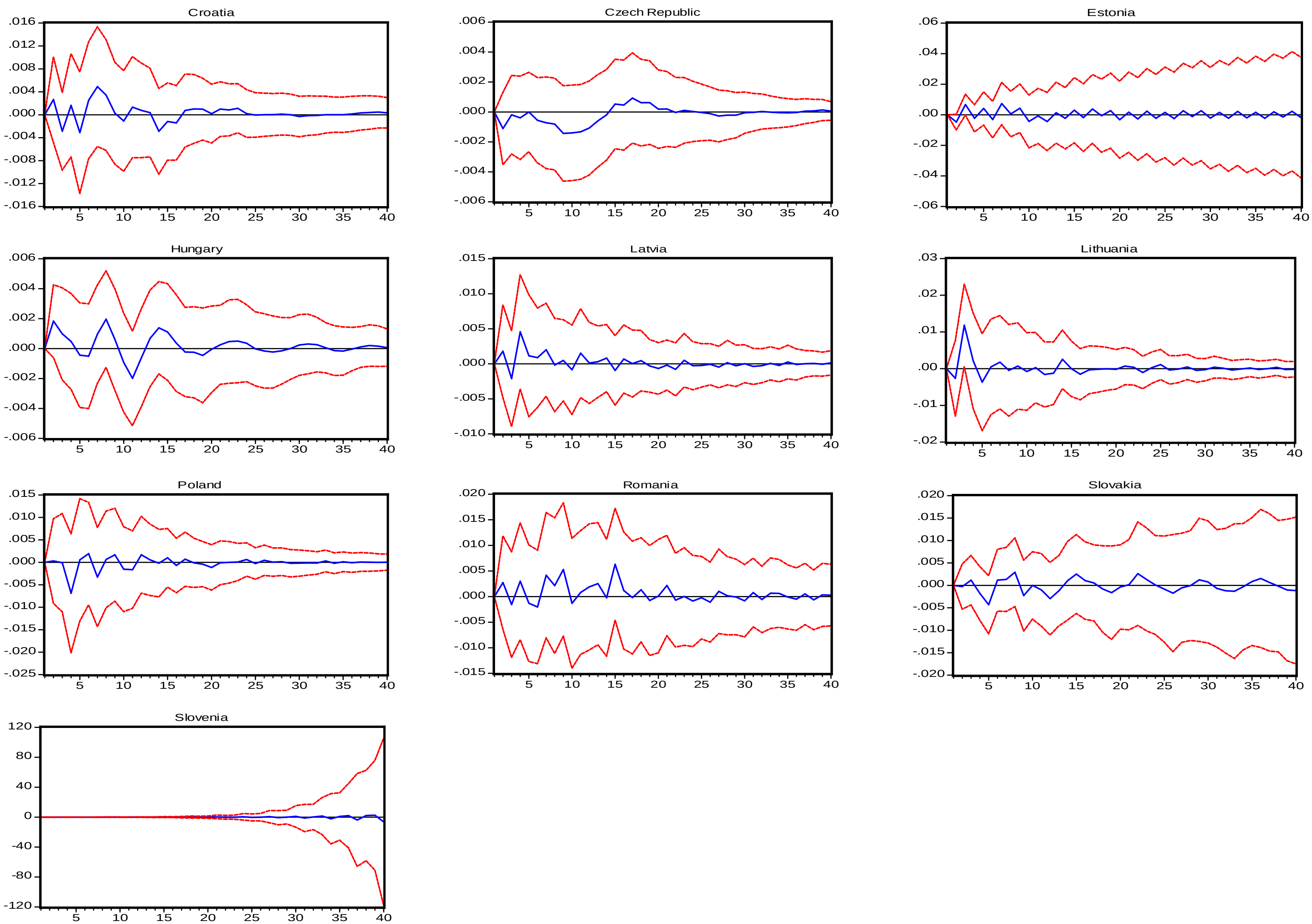
Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a positive one-standard deviation oil price innovation in the scaled specification. The result for Lithuania is not presented since the corresponding measure of oil price increase is found insignificant.

Figure 9
Orthogonalised impulse-response function of the GDP growth to a negative one-standard-deviation oil price innovation: Scaled Specification



Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a negative one-standard-deviation oil price innovation in the scaled specification.

Figure 10
Orthogonalised impulse-response function of the GDP growth to a one-standard-deviation oil price innovation: Net Specification

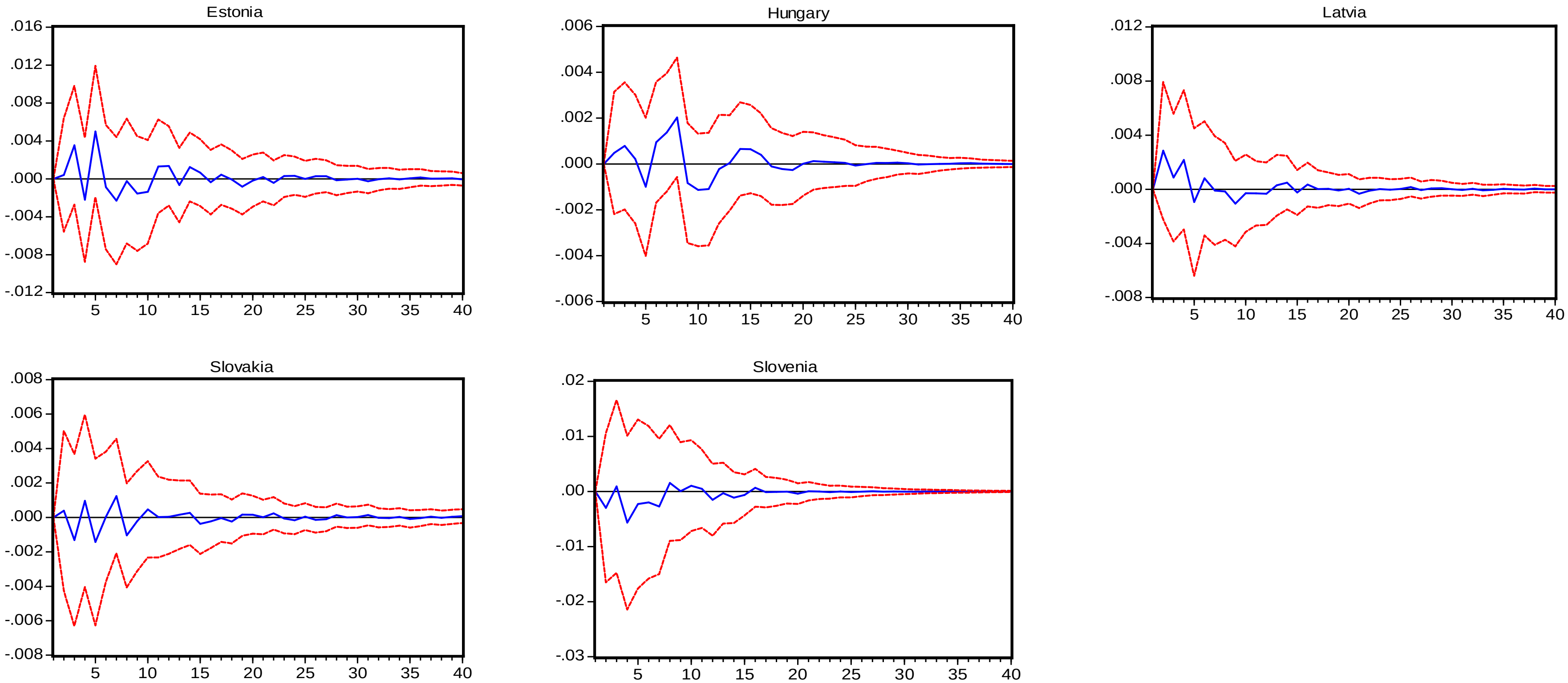


Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a one-standard deviation oil price innovation in the net specification.

Figure 11

Orthogonalised impulse-response function of the GDP growth to a one-standard-deviation oil price innovation: Linear Specification

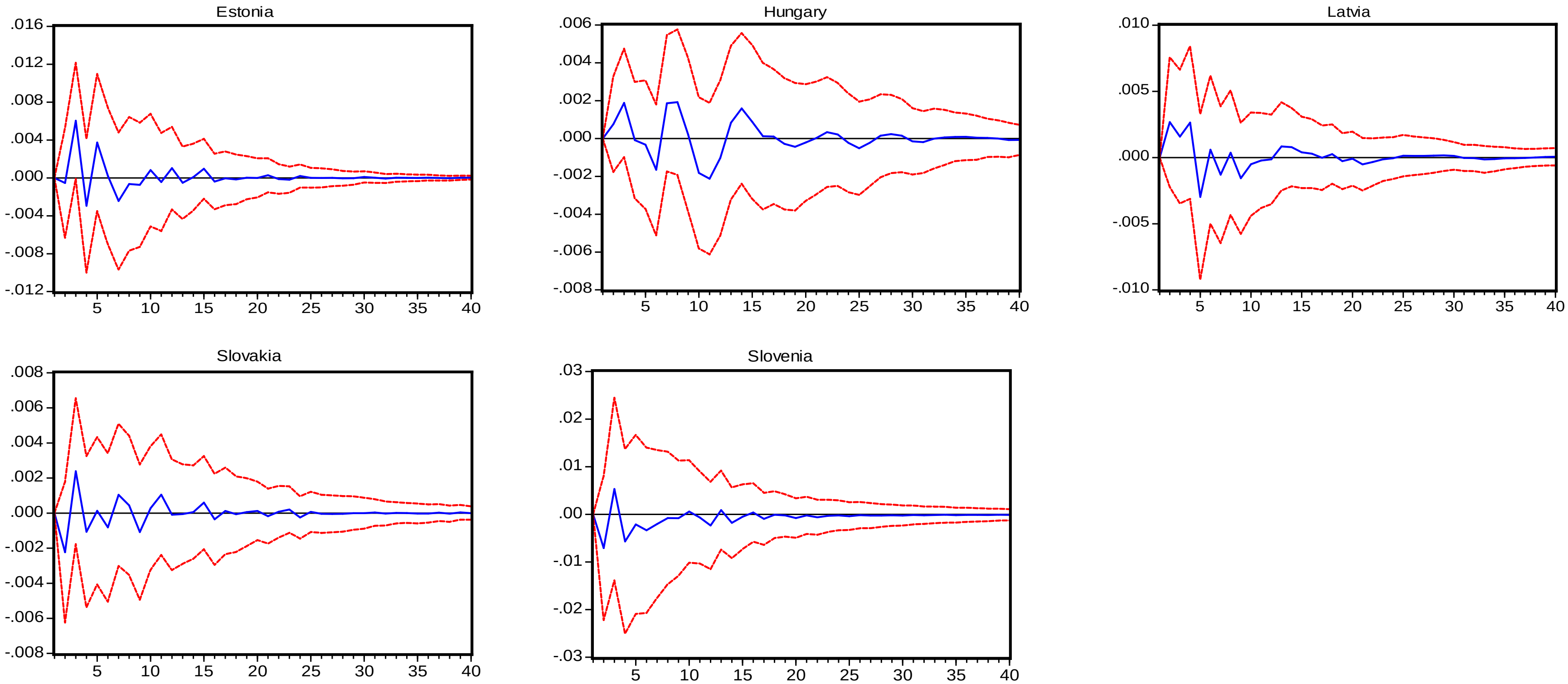
Modified Model



Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a one-standard deviation oil price innovation for Estonia, Hungary, Latvia, Slovakia and Slovenia in the linear specification of the model with short-term interest rate variable excluded for Estonia and Slovakia, imports variable for Hungary and Latvia, and inflation variable for Slovenia.

Figure 12

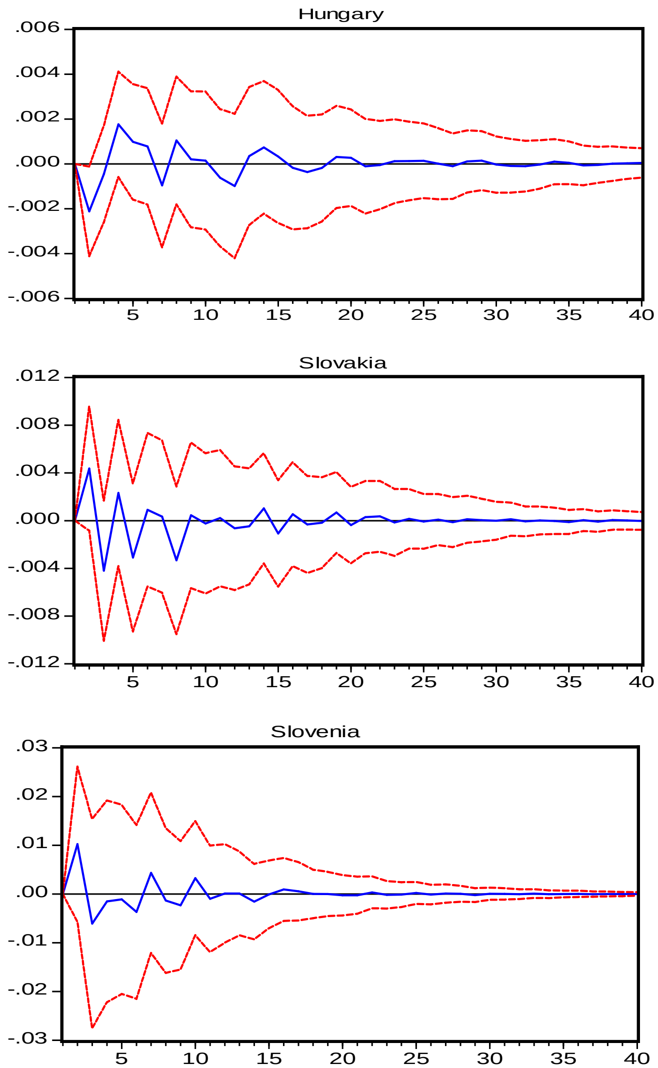
Orthogonalised impulse-response function of the GDP growth to a positive one-standard-deviation oil price innovation: Asymmetric Specification



Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a positive one-standard deviation oil price innovation for Estonia, Hungary, Latvia, Slovakia and Slovenia in the asymmetric specification of the model with short-term interest rate variable excluded for Estonia and Slovakia, imports variable for Hungary and Latvia, and inflation variable for Slovenia.

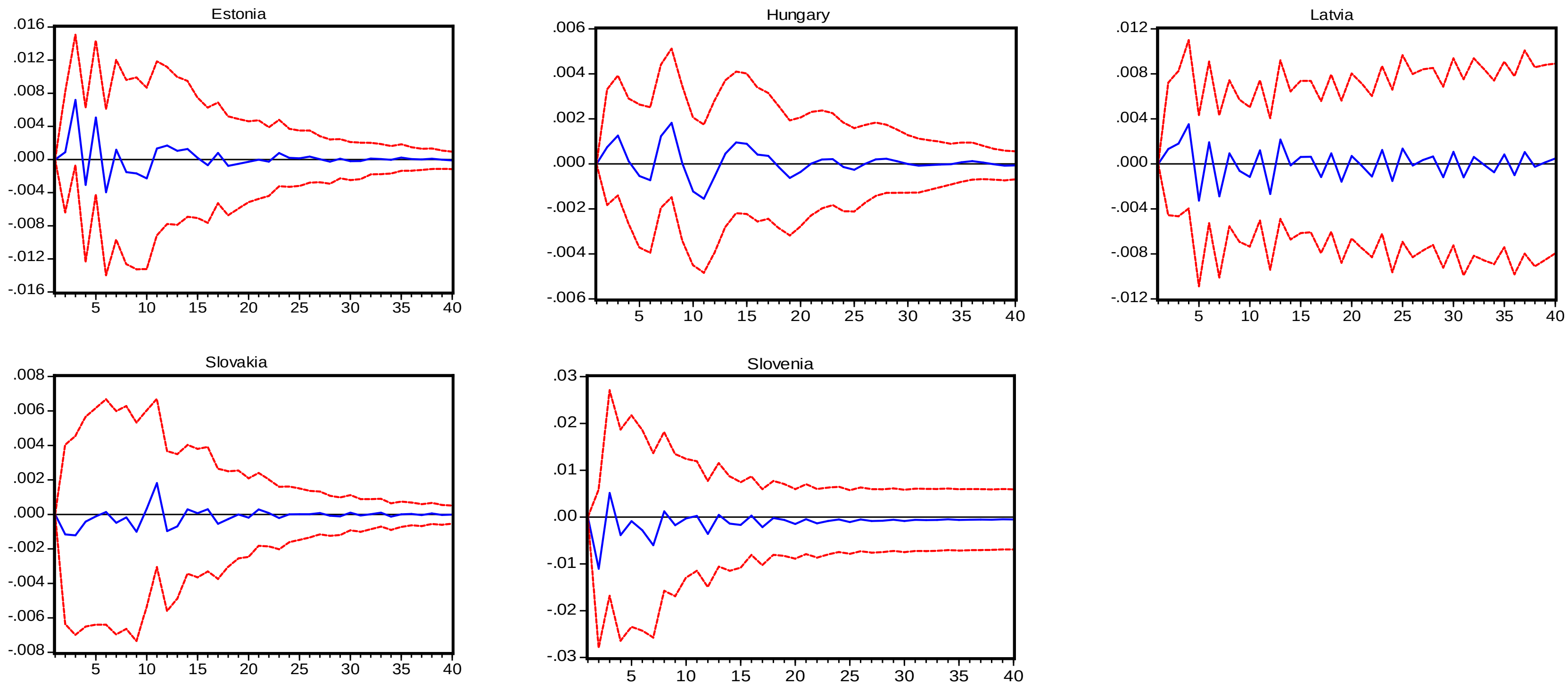
Figure 13

Orthogonalised impulse-response function of GDP growth to a negative one-standard-deviation oil price innovation: Asymmetric Specification



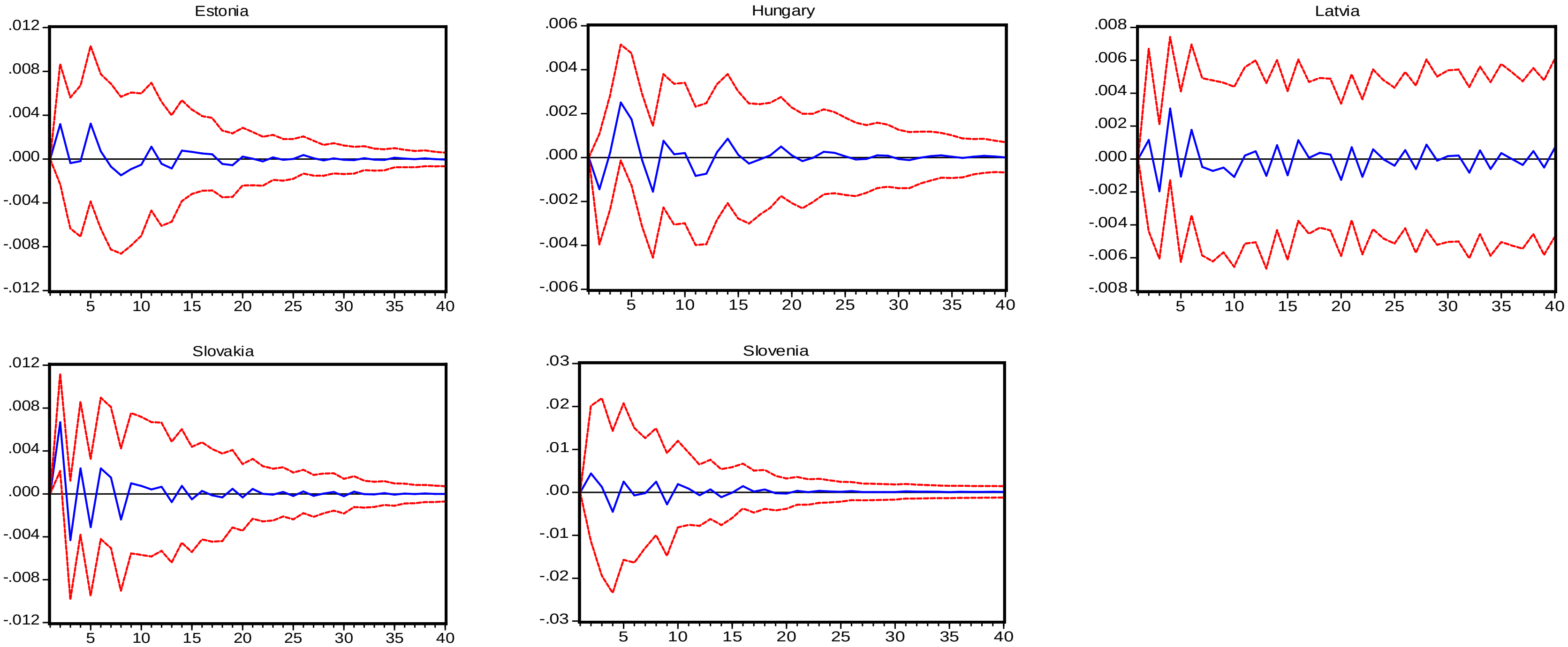
Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a negative one-standard deviation oil price innovation for Hungary, Slovakia and Slovenia (where it is statistically significant) in the asymmetric specification of the model with short-term interest rate variable excluded for Slovakia, imports variable for Hungary, and inflation variable for Slovenia.

Figure 14
Orthogonalised impulse-response function of the GDP growth to a positive one-standard-deviation oil price innovation: Scaled Specification



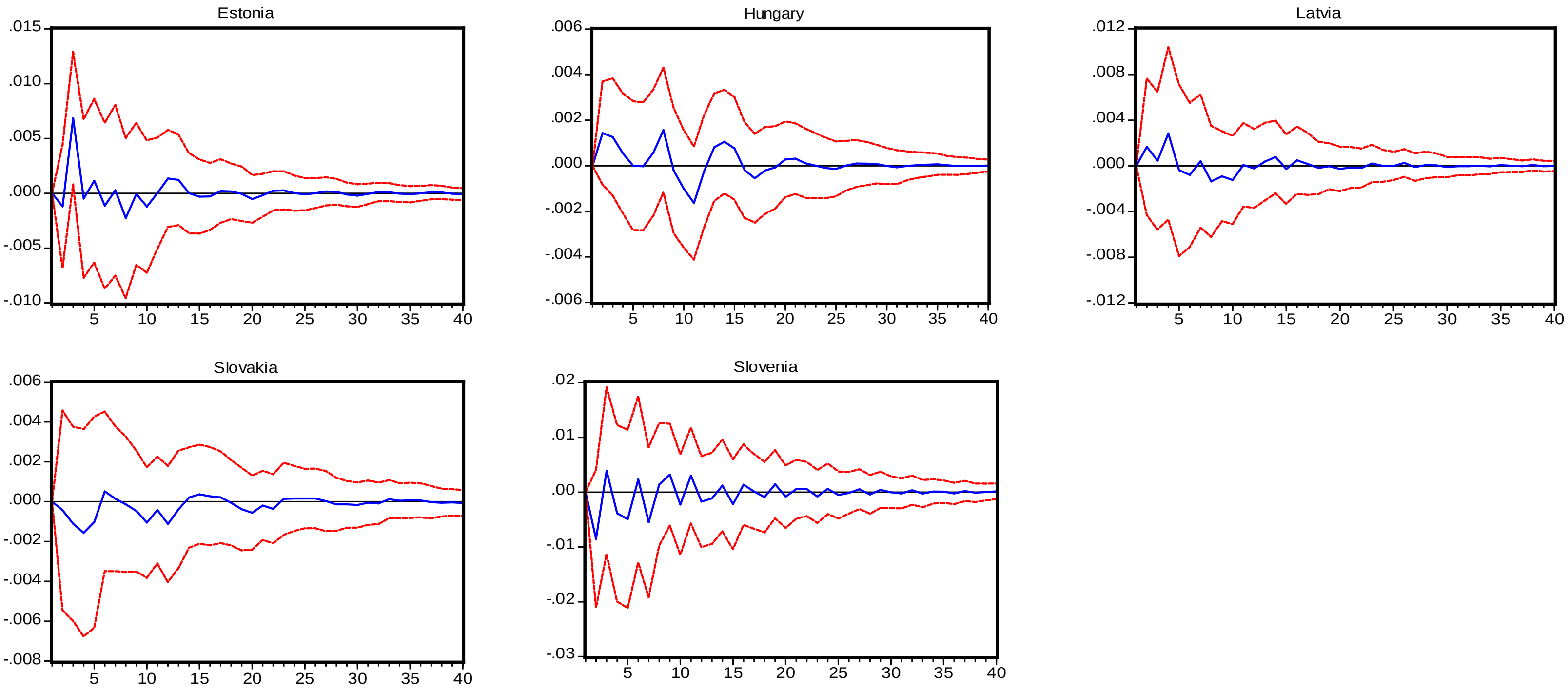
Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a positive one-standard deviation oil price innovation for Estonia, Hungary, Latvia, Slovakia and Slovenia in the scaled specification of the model with short-term interest rate variable excluded for Estonia and Slovakia, imports variable for Hungary and Latvia, and inflation variable for Slovenia.

Figure 15
Orthogonalised impulse-response function of the GDP growth to a negative one-standard-deviation oil price innovation: Scaled Specification



Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a negative one-standard deviation oil price innovation for Estonia, Hungary, Latvia, Slovakia and Slovenia in the scaled specification of the model with short-term interest rate variable excluded for Estonia and Slovakia, imports variable for Hungary and Latvia, and inflation variable for Slovenia.

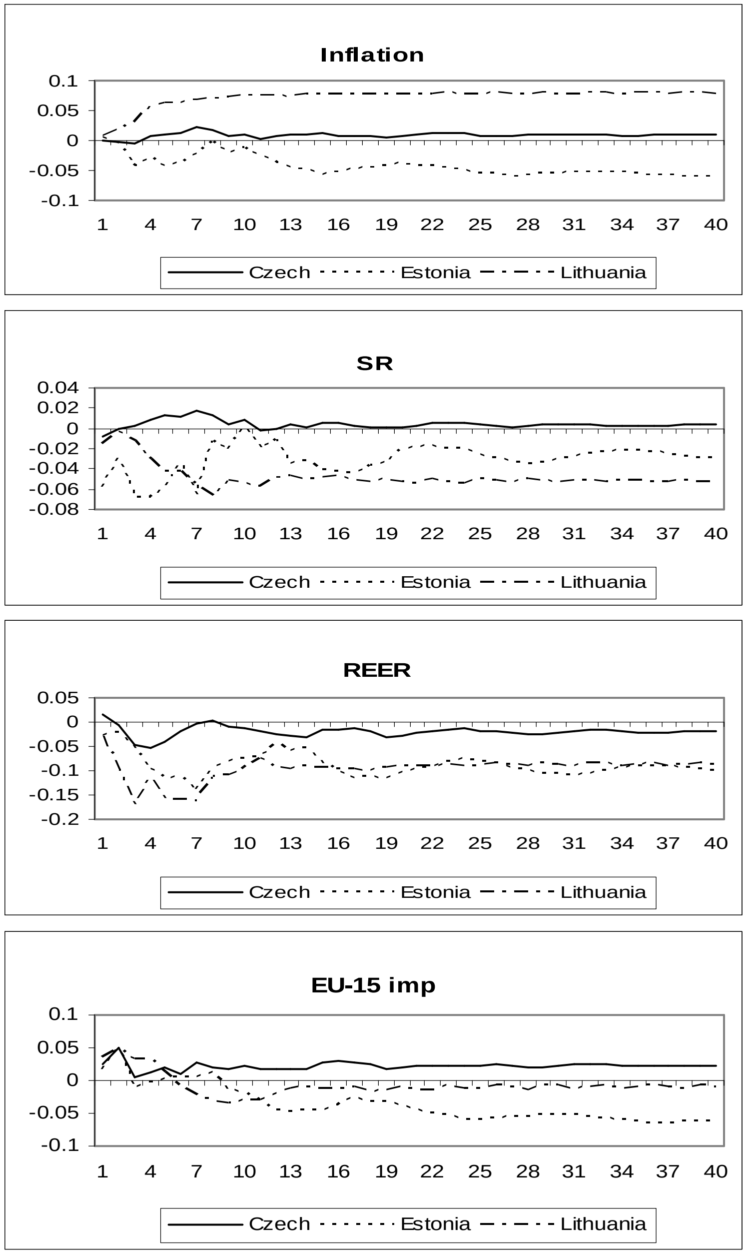
Figure 16
Orthogonalised impulse-response function of GDP growth to a one-standard-deviation oil price innovation: Net Specification



Note: The Figure presents orthogonalised impulse-response function of the GDP growth to a one-standard deviation oil price innovation for Estonia, Hungary, Latvia, Slovakia and Slovenia in the net specification of the model with short-term interest rate variable excluded for Estonia and Slovakia, imports variable for Hungary and Latvia, and inflation variable for Slovenia.

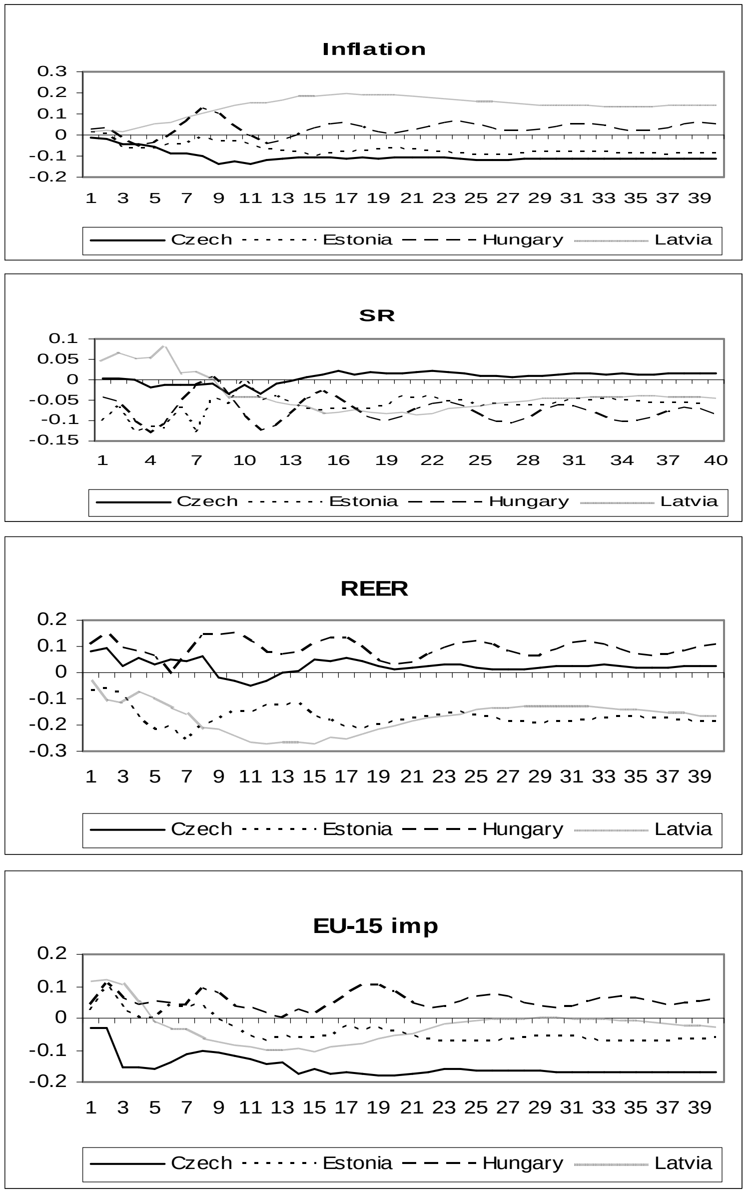
Appendix VII – Accumulated Responses (Graphs)

Figure 17
Accumulated Responses to a positive 1% oil price shock (Selected variables): Linear specification
The Czech Republic, Estonia and Lithuania



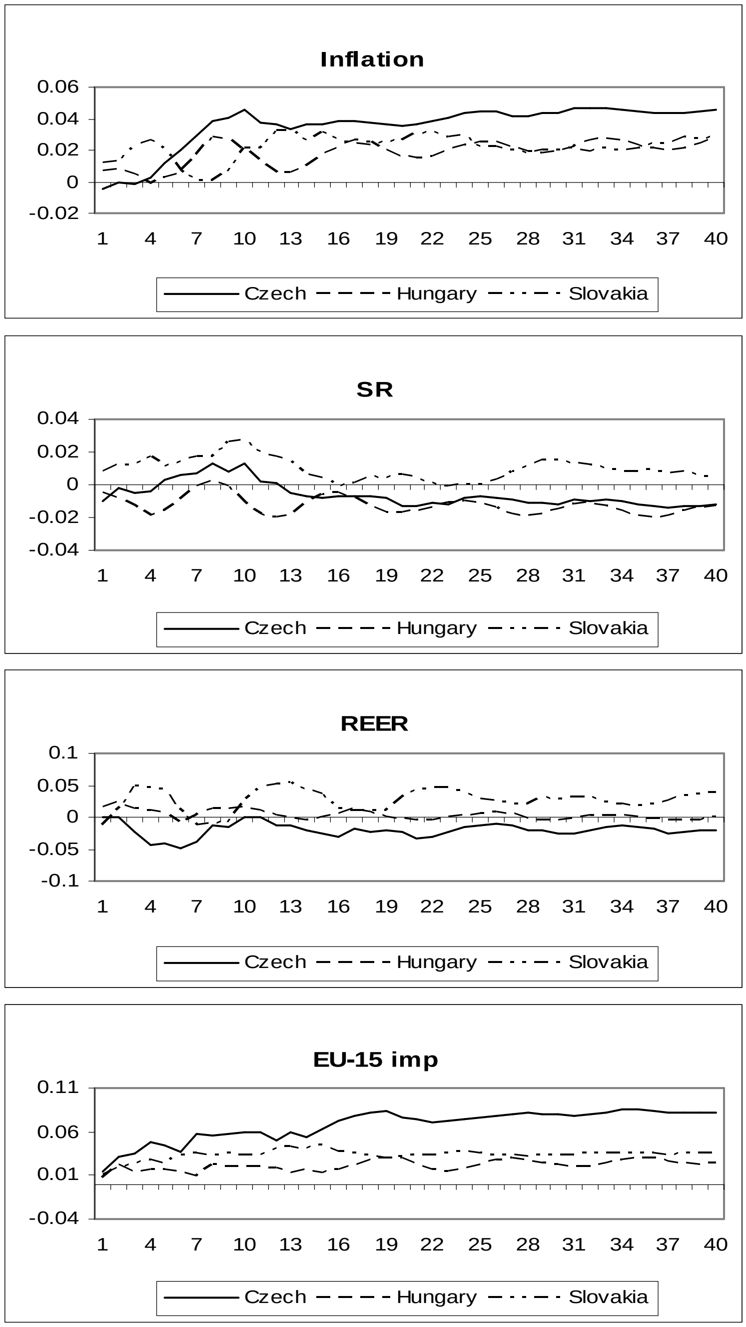
Note: The Figure presents accumulated responses of inflation, short-term interest rate, REER and EU-15 imports for the Czech Republic, Estonia and Lithuania to a positive 1% oil price shock in linear specification.

Figure 18
Accumulated Responses to a positive 1% oil price shock (Selected variables): Asymmetric specification
The Czech Republic, Estonia, Hungary and Latvia



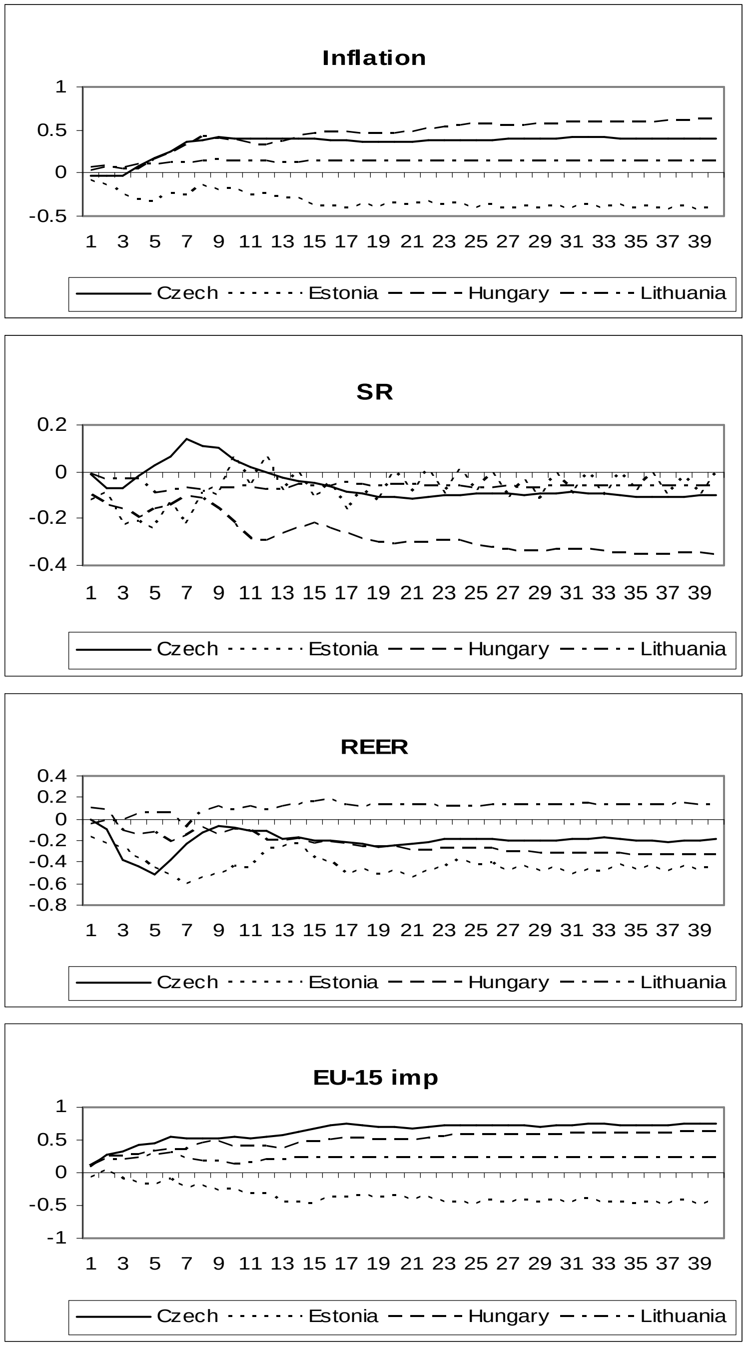
Note: The Figure presents accumulated responses of inflation, short-term interest rate, REER and EU-15 imports for the Czech Republic, Estonia, Hungary and Lithuania to a positive 1% oil price shock in asymmetric specification.

Figure 19
Accumulated Responses to a positive 1% oil price shock (Selected variables): Scaled specification
The Czech Republic, Hungary and Slovakia



Note: The Figure presents accumulated responses of inflation, short-term interest rate, REER and EU-15 imports for the Czech Republic, Hungary and Slovakia to a positive 1% oil price shock in scaled specification.

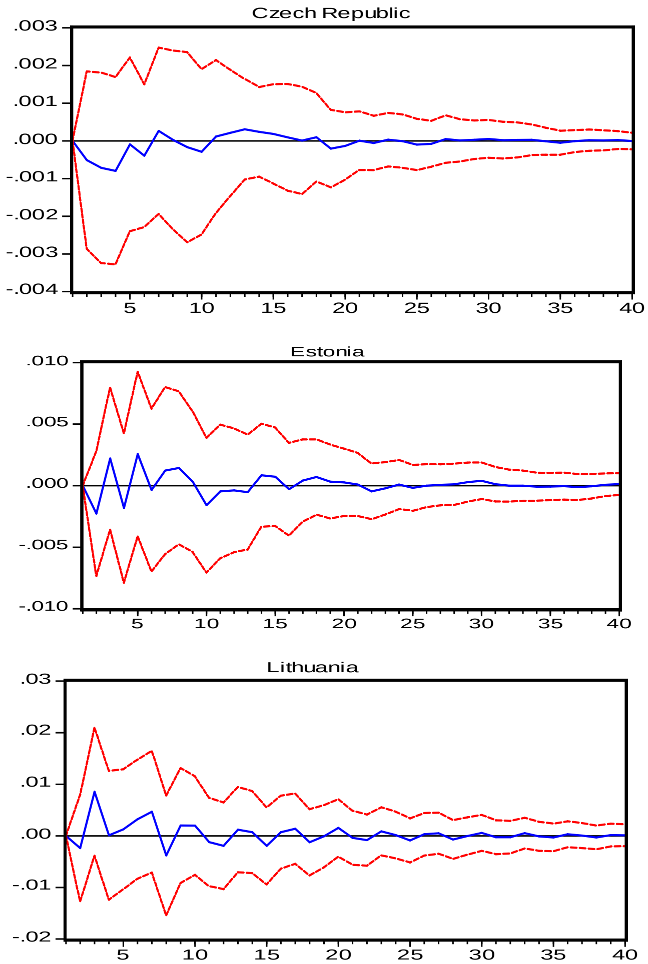
Figure 20
Accumulated Responses to a positive 1% oil price shock (Selected variables): Net specification
Czech Republic, Estonia, Hungary and Lithuania



Note: The Figure presents accumulated responses of inflation, short-term interest rate, REER and EU-15 imports for the Czech Republic, Estonia, Hungary and Lithuania to a positive 1% oil price shock in net specification.

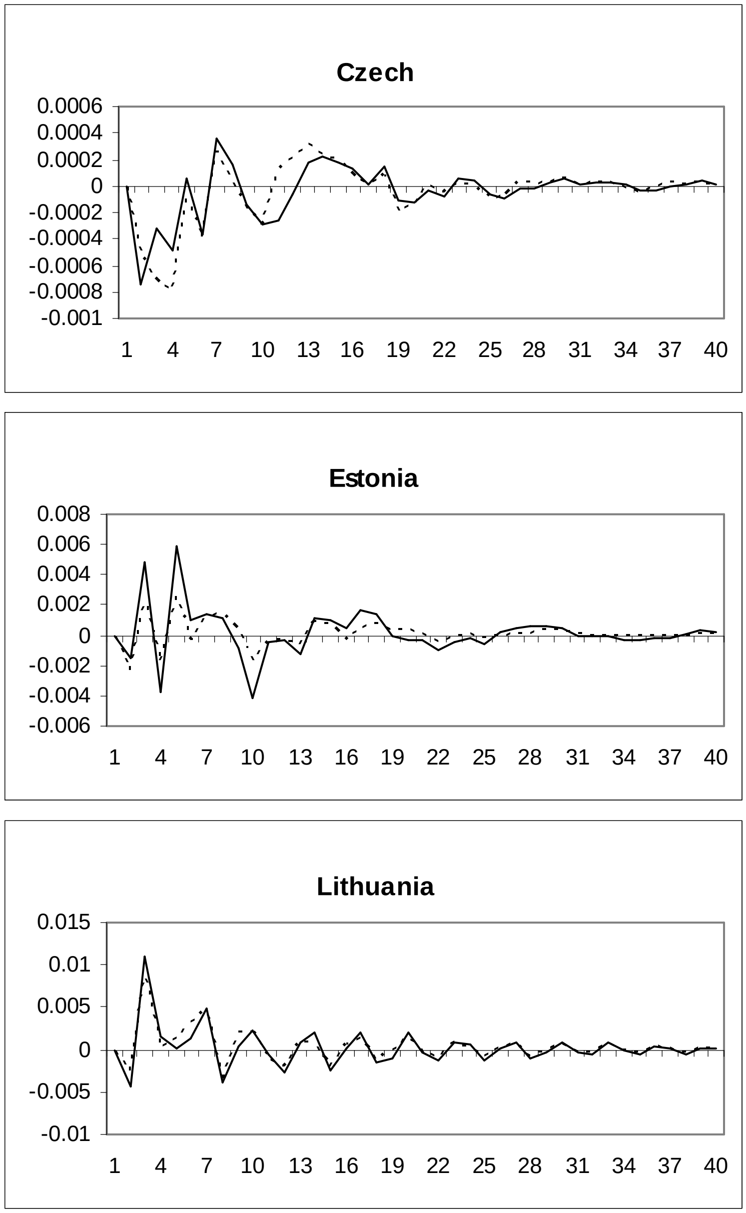
Appendix VIII – Impulse-response Functions: Alternative Ordering

Figure 21
Orthogonalised impulse-response function of GDP growth to a one-standard-deviation oil price innovation
Alternative ordering: Linear specification
The Czech Republic, Estonia and Lithuania



Note: This Figure presents orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation for Czech, Estonia and Lithuania. The model used is linear specification. The orthogonalised impulse-response function is referred to a six-variable system. The ordering of the variables is the following: short-term interest rate, real GDP, REER, EU-15 imports, DLROPI, and inflation. The results are presented for the countries where the corresponding oil price shock measure is found statistically significant.

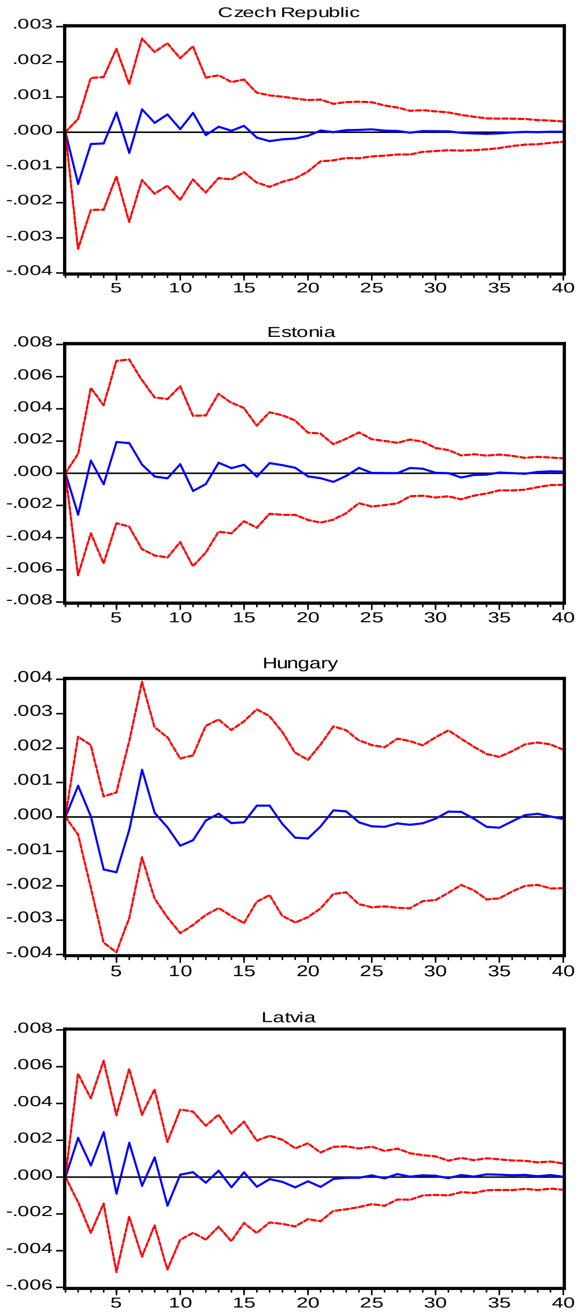
Figure 22
Orthogonalised impulse-response function of GDP growth to a one-standard-deviation oil price innovation
Baseline and Alternative ordering: Linear specification
The Czech Republic, Estonia and Lithuania



Note: Note: This Figure presents orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation for Czech, Estonia and Lithuania. The model used is linear specification. The orthogonalised impulse-response function is referred to a six-variable system. The ordering of the variables is the following:

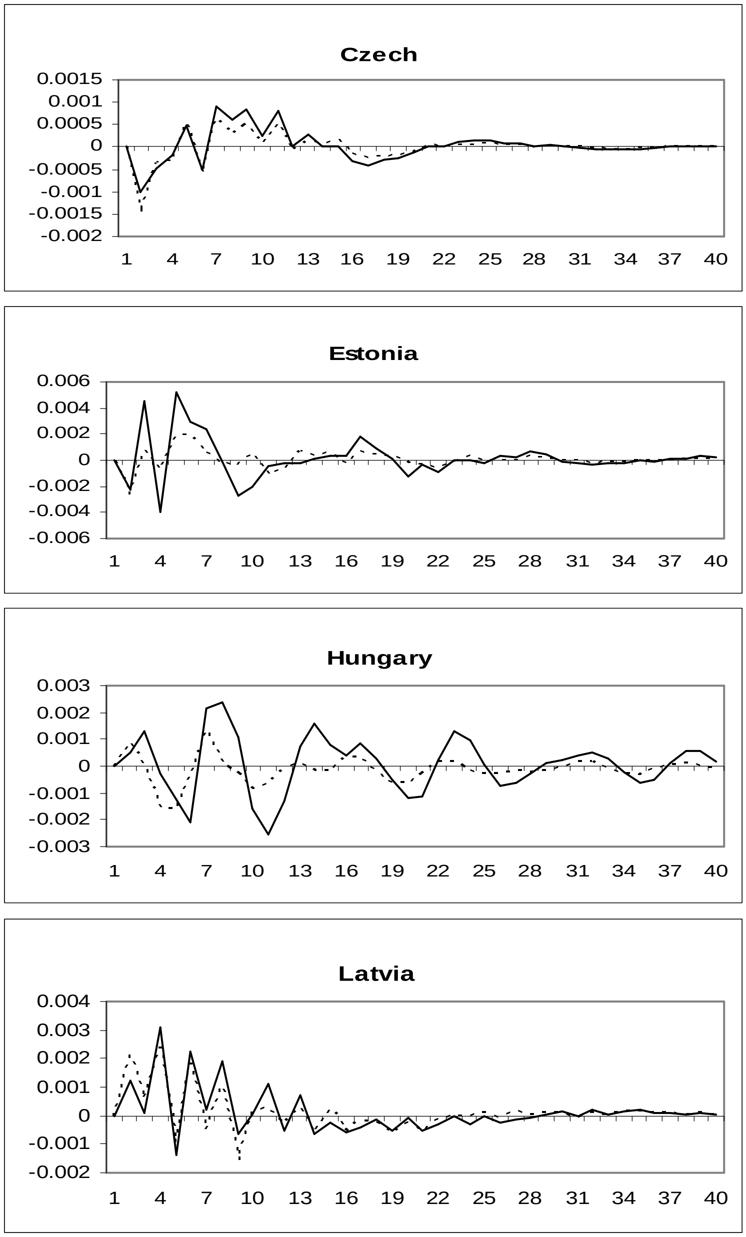
- GDP, oil price, inflation, short-term interest rate, REER, and EU-15 imports (solid line)
- Short-term interest rate, real GDP, REER, EU-15 imports, DLROPI, and inflation (dashed line).

Figure 23
Orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation
Alternative ordering: Asymmetric specification
The Czech Republic, Estonia, Hungary and Latvia



Note: This Figure presents orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation for Czech, Estonia, Hungary and Latvia. The model used is asymmetric specification. The orthogonalised impulse-response function is referred to a six-variable system (with DLROPD missing) in all cases but Hungary, where it is seven-variable. The ordering of the variables is the following: short-term interest rate, real GDP, REER, EU-15 imports, DLROPI, and inflation. The results are presented for the countries where the corresponding oil price shock measure is found statistically significant.

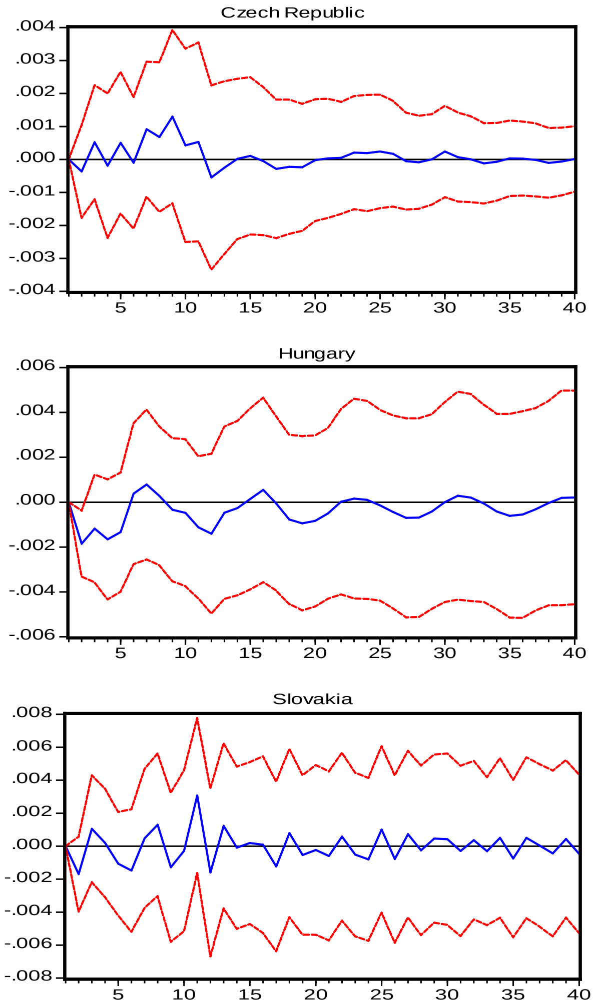
Figure 24
Orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation
Baseline and Alternative ordering: Asymmetric specification
The Czech Republic, Estonia, Hungary and Latvia



Note: This Figure presents orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation for Czech, Estonia, Hungary and Latvia. The model used is asymmetric specification. The orthogonalised impulse-response function is referred to a six-variable system (with DLROPD missing) in all cases but Hungary, where it is seven-variable. The ordering of the variables is the following:

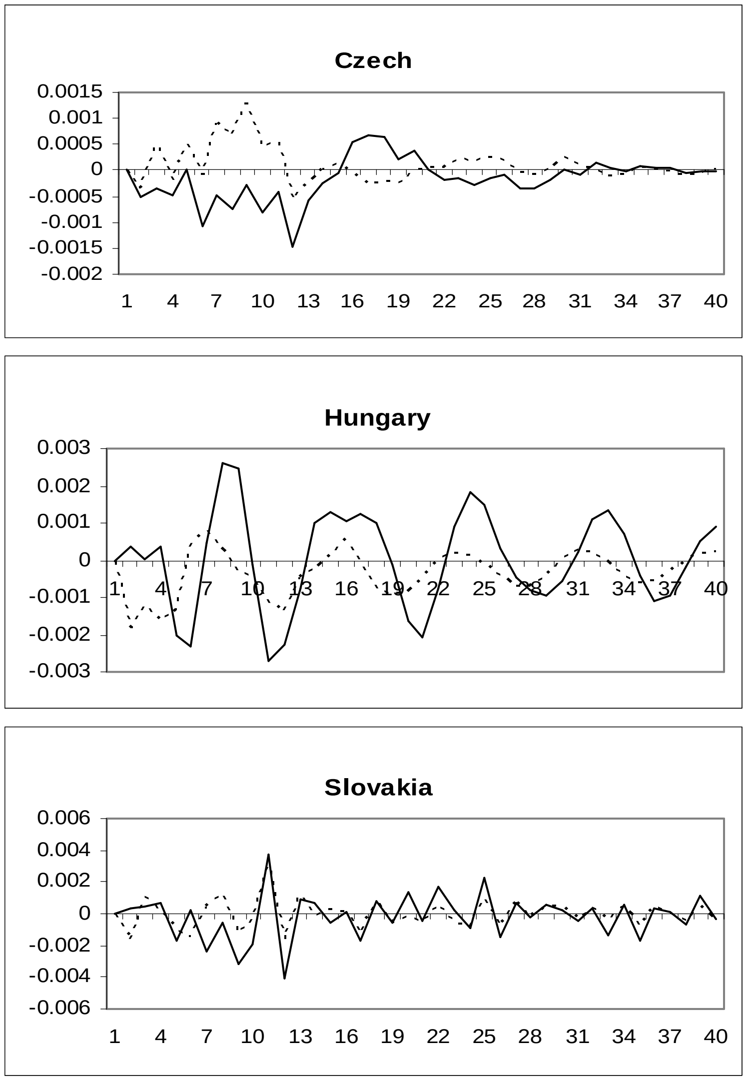
- GDP, oil price, inflation, short-term interest rate, REER, and EU-15 imports (solid line)
- Short-term interest rate, real GDP, REER, EU-15 imports, DLROPI, and inflation (dashed line).

Figure 25
Orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation
Alternative ordering: Scaled specification
The Czech Republic, Hungary and Slovakia



Note: This Figure presents orthogonalised impulse-response function of the GDP growth to a positive one-standard-deviation oil price innovation for Czech, Hungary and Slovakia. The model used is Scaled specification. The orthogonalised impulse-response function is referred to a seven-variable system which includes both positive and negative oil price measures, that is SOPI and SOPD, respectively. The ordering of the variables is the following: short-term interest rate, real GDP, REER, EU-15 imports, (SOPD), SOPI, and inflation. The results are presented for the countries where the corresponding oil price shock measure is found statistically significant.

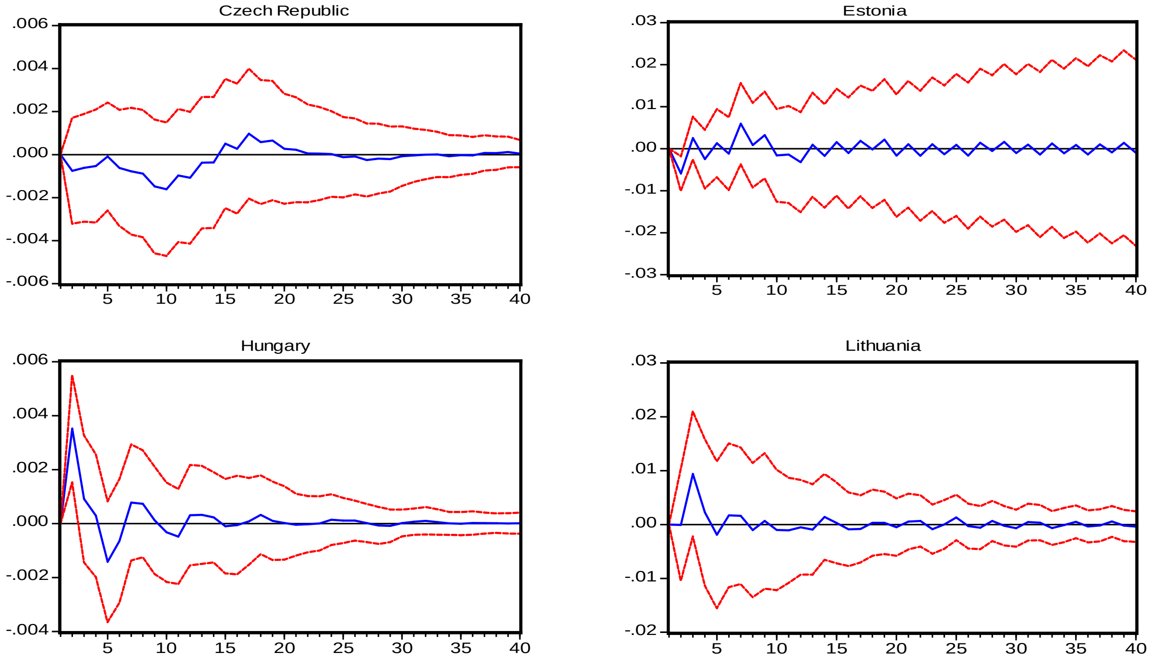
Figure 26
Orthogonalised impulse-response function of GDP growth to a positive one-standard-deviation oil price innovation
Baseline and Alternative orderings: Scaled specification
The Czech Republic, Hungary and Slovakia



Note: This Figure presents orthogonalised impulse-response function of the GDP growth to a positive one-standard-deviation oil price innovation for Czech, Hungary and Slovakia. The model used is Scaled specification. The orthogonalised impulse-response function is referred to a seven-variable system which includes both positive and negative oil price measures, that is SOPI and SOPD, respectively. The ordering of the variables is the following:

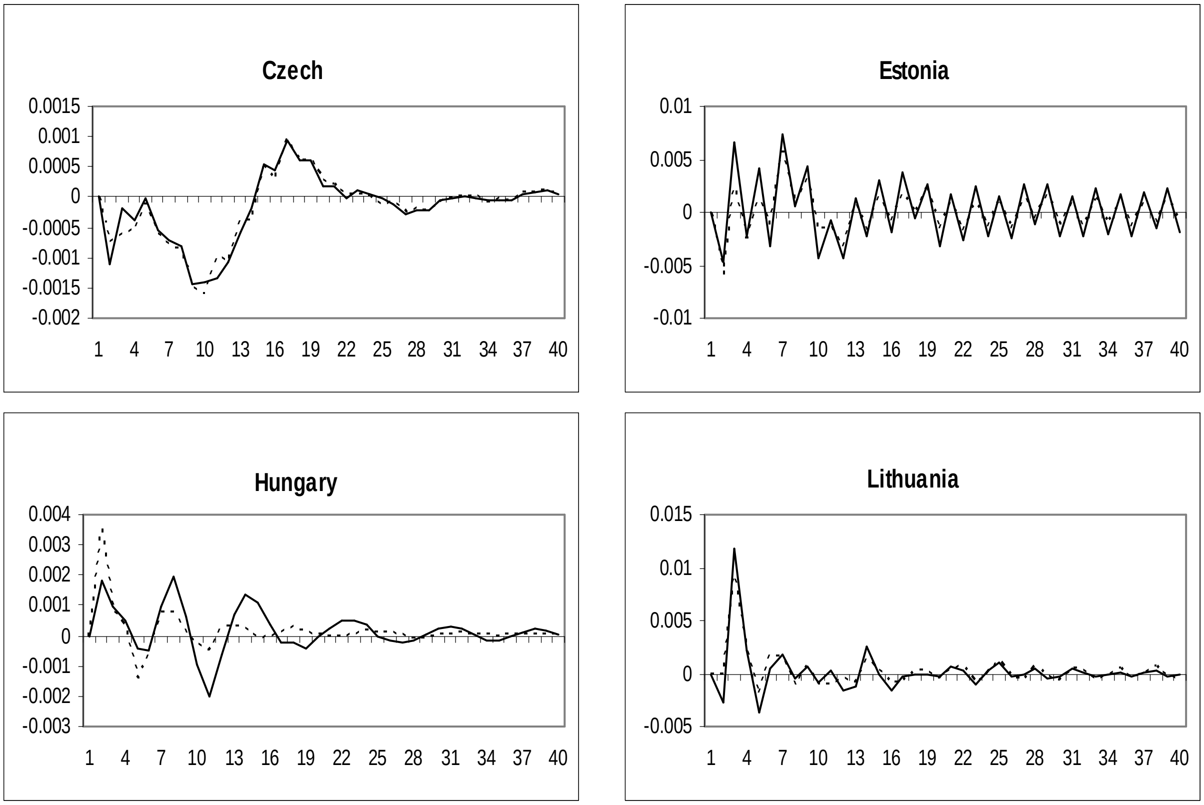
- GDP, oil price, inflation, short-term interest rate, REER, and EU-15 imports (solid line)
- Short-term interest rate, real GDP, REER, EU-15 imports, (SOPD), SOPI, and inflation (dashed line).

Figure 27
Orthogonalised impulse-response function of GDP growth to a one-standard-deviation oil price innovation Alternative ordering: Net specification (Czech, Estonia, Hungary and Lithuania)



Note: This Figure presents orthogonalised impulse-response function of the GDP growth to a one-standard-deviation oil price innovation for Czech, Estonia, Hungary and Lithuania. The model used is Net specification. The orthogonalised impulse-response function is referred to a six-variable system. The ordering of the variables is the following: short-term interest rate, real GDP, REER, EU-15 imports, NOPI, and inflation. The results are presented for the countries where the corresponding oil price shock measure is found statistically significant.

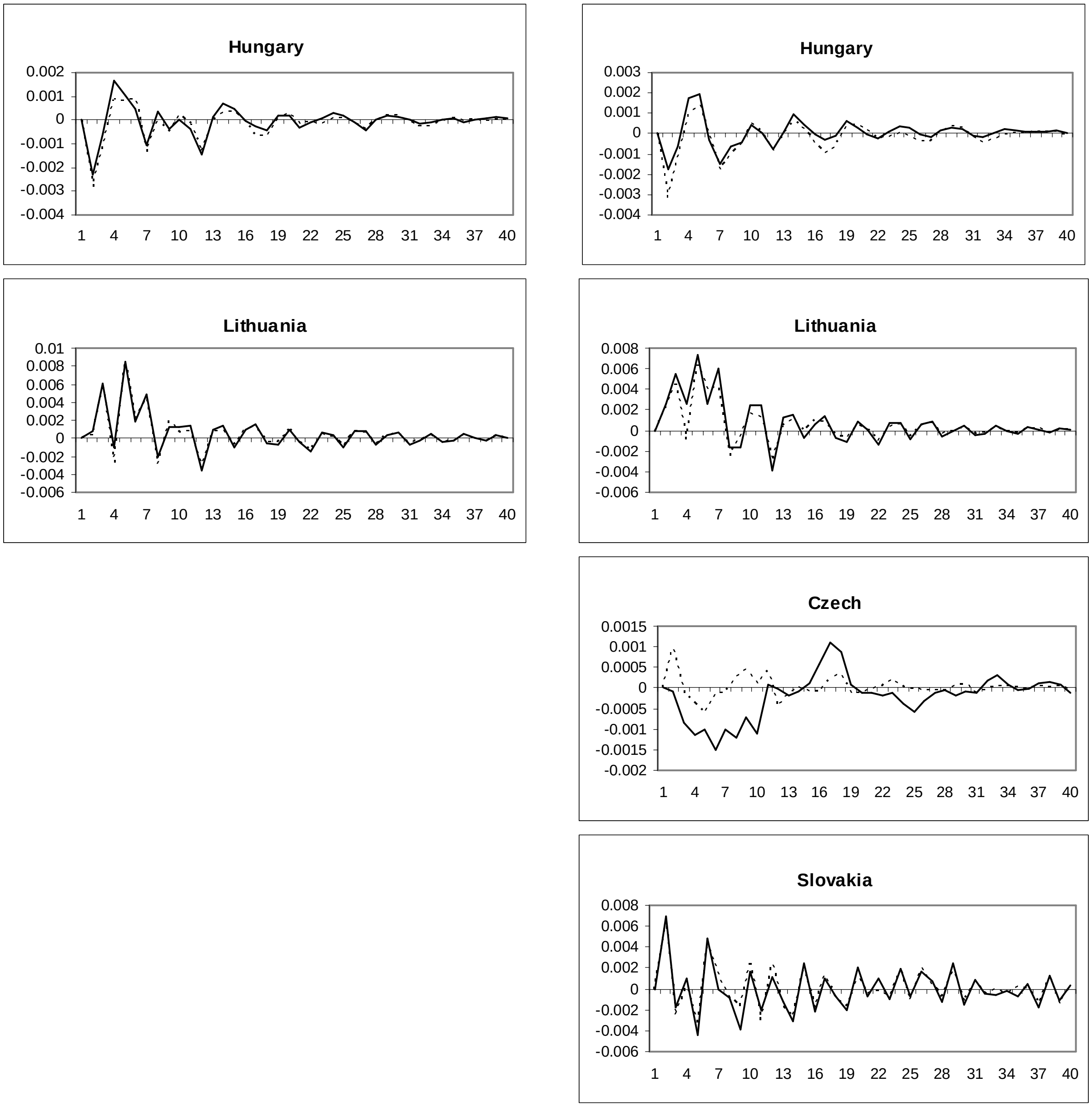
Figure 28
Orthogonalised impulse-response function of GDP growth to a one-standard-deviation oil price innovation Baseline and Alternative orderings: Net specification (Czech, Estonia, Hungary and Lithuania)



Note: This Figure presents orthogonalised impulse-response function of the GDP growth to a one-standard-deviation oil price innovation for Czech, Estonia, Hungary and Lithuania. The model used is Net specification. The orthogonalised impulse-response function is referred to a six-variable system. The ordering of the variables is the following:

- GDP, oil price, inflation, short-term interest rate, REER, and EU-15 imports (solid line)
- Short-term interest rate, real GDP, REER, EU-15 imports, NOPI, and inflation (dashed line).

Figure 29
Orthogonalised impulse-response function of GDP growth to a negative one-standard-deviation oil price innovation
Baseline and Alternative orderings: Selected specifications (Czech, Hungary, Lithuania and Slovakia)



Note: the Figure presents orthogonalised impulse-response function of the GDP growth to a negative one-standard-deviation oil price innovation for the Czech Republic, Hungary, Lithuania and Slovakia since for these countries corresponding measures of oil price decreases are found to be statistically significant. These are the following: asymmetric measure for Hungary and Lithuania, and scaled measure for the Czech Republic, Hungary, Lithuania and Slovakia. The ordering of the variables is the following:

- GDP, oil price, inflation, short-term interest rate, REER, and EU-15 imports (solid line)
- Short-term interest rate, real GDP, REER, EU-15 imports, NOPI, and inflation (dashed line).