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The Exchange Rate Pass-Through to CPI and its components in Oil-Exporting CIS Countries

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The Exchange Rate Pass-Through to CPI and its components in Oil-Exporting CIS Countries[1]

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Abstract

In this study, we explore the pass-through of exchange rate fluctuations to domestic CPI and its components for Azerbaijan, Kazakhstan and Russia. Using the data of 2003:Q1-2016:Q2, we estimate a VAR model and find significant but incomplete pass-through in all sample countries. The accumulated pass-through to aggregate CPI within one year is 28 percent for both Azerbaijan and Kazakhstan; however the equivalent figure for Russia is 32 percent. According to our empirical findings the largest pass-through (ERPT) is observed in the non-food CPI in Azerbaijan and Kazakhstan, whereas in Russia the food prices demonstrate the greatest ERPT. Since the ERPT is an essential ingredient of price developments in sample countries, it should be assessed precisely and taken into account in monetary policy decisions and inflation forecasting.

JEL classification: F31, E31, E52, C51, C52

Keywords: Exchange rate pass-through, VAR model, disaggregated CPI, oil exporting countries

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1. Introduction

In most open and developing economies, the exchange rate exerts a significant influence on inflation dynamics. Oil exporting CIS countries, particularly Azerbaijan, Kazakhstan and Russia are not exception in this regard. Due to the recent decline in oil prices starting from late 2014, the exchange rate of local currencies turned out to be extremely volatile. The Central Bank of Azerbaijan has devalued the Azerbaijani Manat (AZN) against USD by 34 percent in February 2015 and then in December 2015 it switched to a managed float regime. Following the adoption of a new ER regime, manat has further depreciated by 47 percent. Earlier Kazakhstan and Russia facing with severe currency depreciations of about 50 percent were also forced to adopt a floating exchange rate regime. Since floating regimes enable the exchange rate to act as a short term macroeconomic adjustment mechanism, the role of the ERPT becomes crucial in determining the potential contribution of higher exchange rate volatility on the economy (Obstfeld and Rogoff, 1995; Rincon and Rodriguez, 2016). On the other hand, the precise determination of the ERPT is a key asset for central banks in monetary policy formulation process. Specifically, the estimation of ERPT to CPI components, i.e. food, non-food and service prices are of great importance for producing better inflation forecasting output and for adoption of adequate and timely monetary decisions.

Two main channels are differentiated in the exchange rate pass-through to domestic inflation: *direct and indirect channels.* A direct channel operates through the *cost* and *consumption sub-channels*. To put it in another way, via the *cost channel*, the exchange rate shocks are first transmitted to the price of imported *intermediate* goods then to the producer prices and ultimately, to the final price of domestic products. Through the *consumption channel*, the price of imported *final* goods and services changes after the exchange rate shocks hit the economy, in turn, directly influencing the overall price level in the country. Depending on the direction of exchange rate movements, depreciation leads to more expensive imported final products or vice versa. Consequently, through the direct channel, the ultimate change in overall CPI basket will depend on the import substitutability, price rigidities and the degree of competition in the market. In the case of an indirect channel, depreciation of local currency initially results in higher exports, which boosts output and hence, domestic inflation goes up. In the long run, when the internal and external demand for local products goes up due to cheap exports, then real wages are adjusted upwardly and subsequently, the cost of production and hence, the price level increases and output shrinks (Kahn, 1987; Rincon and Rodriguez, 2016). Additionally, Lafleche (1996, 1997) states that after depreciation, expensive imports increase the internal demand and external demand for domestic products through the expenditure switching effect. As a result, the supply of domestic products becomes insufficient to satisfy all demand and thus, it creates an upward pressure on the price of local products. At the same time, due to the weakened currency, exported goods become more competitive in international markets and demand for labor in export-oriented sectors goes up. According to Lafleche, it may lead to possible wage rises and a surge in consumer prices.

Due to the lack of the relevant literature and importance of the exchange rate shocks for CIS countries, in this paper we will study the ERPT mechanism in Azerbaijan, Kazakhstan and Russia. We will examine the degree of the ERPT to CPI and its components for the period of 2003:Q1-2016:Q2 for three oil-exporting CIS countries. The empirical model is the VAR in first differences estimated following Cholesky decomposition method. The motivation behind our sample choice is the similarity of socio-economic structure, institutional arrangements and terms of trade shocks hitting the economies.

The paper contributes to the literature mainly in two ways. Firstly, the ERPT to CPI components has not been studied so far for Azerbaijan and Kazakhstan individually. To our knowledge, this is the first study which presents the pass-through coefficients on major CPI components namely food, non-food and service CPI in those countries. Secondly, this paper employs the most recent- post floating regime period which is of great importance due to increased exchange rate volatility and hence, for accurate estimation of the ERPT.

The major finding of the paper is that the degree of the ERPT in all sample countries is incomplete. According to our estimates, the accumulated pass-through on aggregate CPI of NEER fluctuations rises from 19 percent in the first quarter to a maximum of 28 percent in the first year in Azerbaijan. The accumulated pass-through coefficient on food CPI and non-food CPI equals to 26 percent and 41 percent respectively, in the first year. For service CPI, the pass-through is estimated to be 9 percent during a year. Moreover, we find that for Kazakhstan the accumulated ERPT on aggregate CPI goes from 13 percent in the first quarter to 28 percent within a year. The accumulated ERPT on food, non-food and service CPI are 22, 61 and 8 percent respectively in the first year. The equivalent figure on aggregate CPI for Russia runs from 15 percent in the first quarter to a maximum of 32 percent during the first year. The ERPT on food, non-food and service CPI equals to 39, 25 and 27 percent, respectively within the first year. Our results are similar to previous findings by Dobrynskaya (2007) and Comunale and Simola (2016) in the sense that both authors reveal over 30 percent pass through to domestic CPI in Russia.

The rest of the paper proceeds in the following way. In the second section, we provide some important facts on the peculiarities of each economy. The third section lays out theoretical framework for the ERPT and surveys the literature. In section 4, we describe the relevant data and develop the empirical methodology. The fifth section presents the empirical results and the last section concludes.

2. Background information on sample countries.

After the transition to market economy, sample countries experienced high and volatile inflation, disruption in many industries and political instability. It took more than a decade to renew and establish new infrastructure in all areas of the economy. The inflation rate was particularly high before 2001 due to the crisis in Russia and its spillover effects in neighbor countries. State guaranteed activity in the financial sector and to some extent enhanced credibility of the central banks helped to overcome inflationary pressures and achieve lower and stable inflation rates. As it can be seen from the Table 1, between the years of 1995-2000, during the transition period, all sample countries experienced high and volatile inflation rates which was then replaced by low and affordable rates during 2000-2005. Since sample countries are mainly oil exporters, global oil prices were among the major amplifiers of inflation rates in the economy. From 2005 to 2010, oil prices went up by almost 50 percent, which in turn, accelerated inflation level in oil exporters, particularly through the fiscal channel and resulted in double digit inflation rates (Karimli *et al.*, 2016). More precisely, oil windfalls led to excessive budget spending and as a result triggered inflationary pressures in the economy (Huseynov and Ahmadov, 2013, 2014). In the last five years, all three countries have been able to achieve single digit inflation rates due to exchange rate stability, low inflation expectations and improvement in the management of oil revenues. The average inflation rate only in Russia seems a little bit higher in comparison with the remaining two countries. However, after the global financial crisis, Russia has been able to achieve a single digit inflation rate in the economy. The special role of sovereign wealth funds should be stressed for fighting high inflation rates in the context of volatile commodity prices. Undoubtedly, the establishment of those funds helped to prevent the lump sum cash flow of oil windfalls to the economy and thus, depressed general inflation level. For instance, in Azerbaijan case, only the half of oil revenue was allowed to be transferred to the state budget each year. In Kazakhstan, the limit was 8 billion USD in the form of guaranteed transfers to the government on an annual basis. In Russia only the budget deficit of 3-4 percent of GDP was allowed to be financed with the transfers from the Fund.

When it comes to the implementation of monetary policy, the CBs carried out anti-inflation activities mainly through the management of money supply and exchange rate stability. To prevent excess volatility of national currency, the CBs intervened regularly the FX markets. The exchange rate stability helped to build the confidence in the financial system, mitigate the adverse external shocks related to volatility in commodity prices and also contributed positively to capital inflows. Over the last two decades, the fixed exchange regime also limited the pass-through of exchange rate fluctuations to domestic inflation. Thus, low exchange rate volatility made it hard to assess empirically the ERPT. However, in recent years, those countries have attempted to increase the flexibility of exchange rates and adopt more contemporaneous regimes. Below in the Figure 1, one can observe the relationship between nominal effective exchange rate and inflation rate for the sample countries.

Table 1. **Average annual inflation rate dynamics, %**

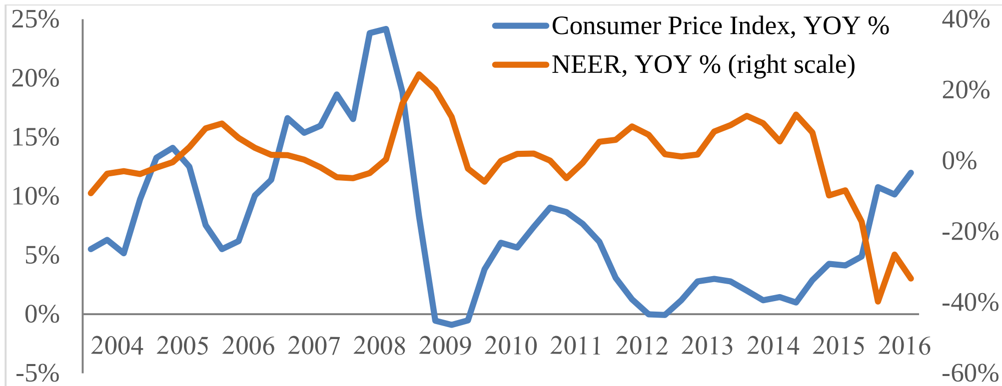
Countries	1995-2000	2000-2005	2005-2010	2010-2015
Azerbaijan	71.3	4.6	10.6	3.3
Kazakhstan	43.6	7.0	10.2	6.5
Russia	65.7	14.9	10.3	8.7

Source: World Economic Outlook, October 2016

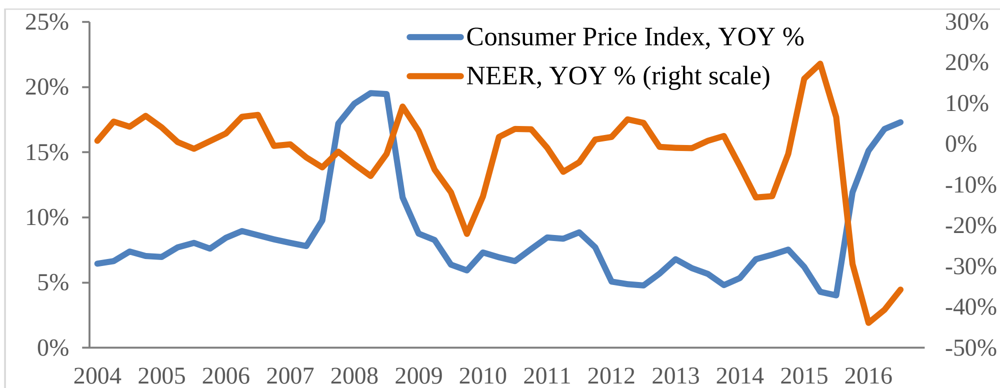
Naturally, the NEER depreciations (or appreciations) should be followed by increase (or decrease) in the domestic inflation level in oil exporters. However, such clear pattern of correlation between those two variables cannot be observed below in the graphs. A simple correlation coefficient between NEER and domestic CPI for Azerbaijan is low (27%).

Figure 1. Co-movement of nominal effective exchange rate[5] and Consumer Price Index (2004Q1-2016Q4)

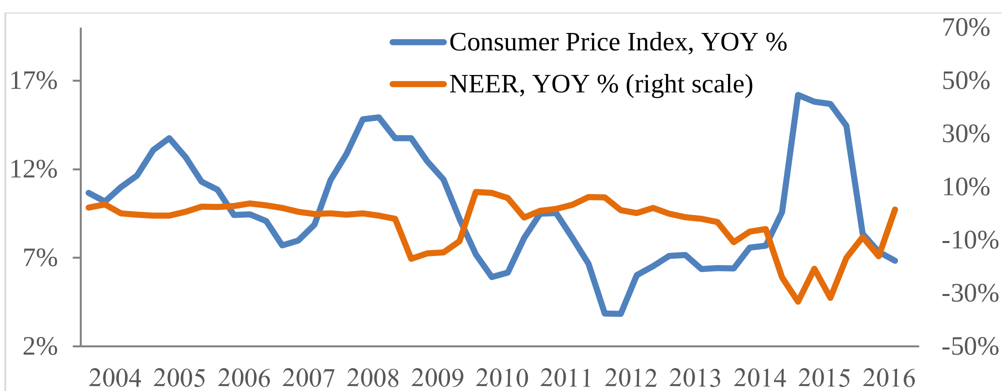
A. Azerbaijan



B. Kazakhstan



C. Russia



Source: International Finance Statistics, Bruegel Database

[5] A rise in NEER change indicates appreciation of the local currency against the trading partners' currencies.

However, the equivalent coefficient for Kazakhstan and Russia is around 50 percent. As we mentioned above, tightly managed exchange rate system, specifically in Azerbaijan, limited the ERPT to domestic inflation. Sharp appreciation observed during 2009 in Azerbaijan and Kazakhstan might be linked to disinflation activities in order to prevent high inflation rates registered in both countries during 2008.

The recent oil price shocks hitting the economies induced greater flexibility in the exchange rate policy which heightened the pass-through effects and consequently, elevated domestic inflation rates. That is to say, after transition to a managed floating regime, NEER of Azerbaijan manat has experienced almost 40 percent depreciation and thus, 11 percent increase in CPI on yearly basis. Kazakhstan moved to a floating regime in August 2015, afterwards the nominal effective exchange rate of tenge lost 29 percent of its value vis-à-vis its main trading partners' currencies and inflation soared up by 12 percent year on year basis. In November 2014 after the adoption of a floating exchange rate regime, Russian ruble depreciated by 33 percent which in turn, increased CPI by 6.2 percent on an annual basis. In the methodology part, we will try to assess empirically the relationship between these two variables using VAR model in first differences.

3. Theoretical Framework

The existence of the perfect ERPT to CPI stems from the Law of One Price and Purchasing Power Parity principle assuming that the equilibrium price of a particular good in two markets cannot be different if expressed in the same currency. It also assumes that there are no transportation costs and no differential taxes applied in the economy. Empirically however, these theories cannot be confirmed. When it comes to the determinants of exchange rate pass-through, most of the studies rely on both microeconomic and macroeconomic factors. If in 1980s the incomplete ERPT was mostly explained by microeconomic principles such as mark-up pricing and market competition, in 1990s macroeconomic foundations were stood at the heart of much of the research to define the rise and development of the exchange rate transmission mechanism. Referring to microeconomic foundations, in most cases the ERPT is incomplete due to competition among firms and tendency to adjust their mark ups (Dornbusch 1987). In other words, to a certain extent the exchange rate shocks are absorbed by lowering firms' profits and mark-ups (Campa and Goldberg, 2002). Also transportation costs, tariffs and other trade barriers limit the degree of complete pass-through (Obstfeld and Rogoff, 2000). The degree of import substitutability and the market power affect the decision of firms to adjust their mark-ups as well. Furthermore, nominal price rigidities delay the adverse effects of exchange rate shocks at least in the short run. As a consequence, the relationship between exchange rate and prices appears to be weak. Today in a globalized world, much of the production process takes place in different countries, so that the final price embodies in itself various currencies resulting in lower pass-through (Mishkin, 2008).

In a macroeconomics perspective, inflation dynamics and volatility traditionally are assumed to contribute to higher ERPT. However, in recent decade low and less persistent level of inflation and stable monetary policy environment weakened the relationship between exchange rate volatility and inflation. Especially under inflation targeting regimes, anchored inflation expectations helped to mitigate possible inflationary pressures of exchange rate shocks (Taylor, 2000). In addition, import composition, openness and the size of a country are also among the main macroeconomic determinants that accelerate the ERPT (McCarthy, 2000; Campa and Goldberg, 2005).

3.1 Literature Review

While disentangling the effects of exchange rate shocks to prices, the attention is mostly devoted to import prices at an aggregate and sectoral level rather than only on CPI itself. It is the import price which is assumed transmitting exchange rate shocks through imported goods. The major model specification used for ERPT analysis is based on the impulse response functions obtained from vector autoregressive and error correction models. In some cases, structural models (especially DSGE models) are employed in order to account for a wide range of possible specific shocks in line with exchange rate shocks to inflation (Mishkin, 2008).

Despite the fact that there is a huge evidence on the declining role of the ERPT for developed economies, the channel still plays an important role for most emerging and developing economies (Taylor 2000, Frankel, 2012). In most cases, the authors link the lower ERPT in advanced economies to the adoption of IT regimes that enables to keep inflation rates in a desirable level. It is noteworthy to mention that the cross country variation among emerging countries is also higher. Using SVAR methodology, Ito and Sato (2006) show that the ERPT is higher in Latin American countries and in Turkey than in East Asian countries. Overall, the ERPT was found to be lower on consumer prices than on import prices in all sample countries. During the crisis periods, the degree of the ERPT was quite high specifically in East Asian countries (Ito and Sato, 2006). Even developed countries exhibit differing responses to exchange rate shocks. It was found that the ERPT is slightly higher in the euro area than in the US for both consumer and import prices (Ca'Zorzi and *et al.*, 2007).

A survey of literature on CIS countries shows that despite some heterogeneity among member countries, the ERPT is higher in comparison with other emerging countries (Table 2). The ERPT in these countries was assessed by applying panel technique to CIS or emerging markets. By estimating short and long run relationship for the period of 1999-2010, Beckmann and Fidrmuc (2013) find that the average ERPT is 30-50 percent after one year and almost 60 percent in the long run. Due to fixed exchange rate systems operating in CIS countries and low exchange rate volatility, only few researchers attempted to study the sample countries individually. Most of those papers have been devoted particularly to the study of the Russian case. According to country specific estimates, in Russia the ERPT to consumer prices ranges between 30-40 percent in the short run and reaches 50-70 percent within a year (Stavrev, 2003; Oomes and Ohnsorge, 2005; Dobrynskaya and Levando, 2005). To our knowledge, there is no paper on ERPT to aggregate CPI and its components devoted specifically to Azerbaijan or Kazakhstan using the recent time period. By employing dynamic OLS for cointegrated regression, the pass-through to import prices is estimated to be in the range of 29-31 percent during the first 12 months in Kazakhstan (Moldasheva, 2013).

Further, Ponomarev, Trunin and Uluykaev (2014) estimate the response of CPI and its components to exchange rate shocks in the case of Russia. They conclude that the cumulative response of CPI and non-food CPI to exchange rate shocks is 47 and 74 percent respectively during the first 12 months.

It should also be mentioned that several papers highlight the evidence of asymmetry and nonlinearity in the transmission of exchange rate shocks to inflation. Asymmetry is usually linked to the fact that when a currency depreciates, firms are inclined to increase their mark-ups more than when they cut them in response to appreciation. Nonlinearities occur due to higher sensitivity of firms to larger depreciations or appreciations (Caselli and Roitman, 2016). The recent IMF estimations suggest that the ERPT in emerging economies is 22 percent after 12 months (IMF, 2015).

However, when the depreciation rate exceeds 20 percent, then the ERPT becomes 45 percent after 6 months. At the same time, it was found out that the ERPT is five times higher during depreciations. Ponomarev and others (2014) also highlight in their paper the existence of the ERPT asymmetry for all components of CPI.

By employing a nonlinear logistic smooth transition VAR model, Rincon and Rodriguez (2016) find that the pass-through is highly dependent on the state of the economy, is nonlinear and responds asymmetrically to exchange rate shocks depending on their sign (depreciation or appreciation) and size (large/small depreciations).

However, in this study due to insufficient time span, we will not explore asymmetry and nonlinearity features of ERPT.

Table 2. Empirical pass-through studies on CIS countries. A Summary

Authors	Sample	Model	Exchange rate	Estimated pass-through
Watchtel and Korhonen (2005) Russia	1999M1-2004M12	VAR	USD	42% ERPT in 12 and 24 months
Oomes and Ohnsorge (2005), Russia	1996M1-2004M12	Long run cointegration	NEER	47-49% ERPT in the long run
Dobrynskaya (2005), Russia	1998M1-2005M5	VAR	NEER	35% ERPT in 12 months
Beckmann and Fidrmuc (2013), CIS	1999M1-2010M12	Panel VAR	USD	26% ERPT in 12 months 57% ERPT in the long run
Ponomarev and others (2014), Russia	2000M1-2012M12	VEC	NEER	28% ERPT in 6 months 47% ERPT in 12 months
Faryna (2016), Russia	2000M1-2015M11	Panel VAR	USD	14-18% ERPT in 12 months
Comunale and Simola (2016), CIS	1999Q1-2014Q4	Factor panel	NEER	28-31% ERPT in 6 months 50% ERPT in 12 months

Taylor (2000) also mentions the importance of monetary regime in the degree of ERPT. He finds out that the countries with inflation targeting regime experience lower pass-through due to credibility of the CBs and low inflation environment. Recently transition to the floating regime in sample countries makes Markov regime switching model more appropriate for estimation. Taking into account the switch between time periods, such models enable to capture the relevant dynamic patterns. However, the floating regime period covers only the recent short time span which makes it hard to carry out such empirical assessment method.

4. Data and Methodology

In this paper we try to assess the degree of the exchange rate pass-through to domestic CPI and its main components. The full sample contains quarterly data for 2003:Q1-2016:Q2 on three oil-exporting CIS countries namely Azerbaijan, Kazakhstan and Russia. As a starting point, we employ a four variable VAR model similar to those developed by Mccarthy (2000), Hahn (2003) and Ca' Zorzi (2007). Those variables include oil revenue, trading partners' CPI (tp_cpi), nominal effective exchange rate (neer) and domestic CPI (cpi). It would be of great importance to include import price index as well, however sample countries do not provide information on that indicator. *Oil revenue* is calculated as the product of real price of oil and oil production for a given country. Oil prices are deflated using US CPI. The source for this indicator is the US Energy Information Administration Database (EIA). *Nominal effective exchange rate* is a weighted average of the bilateral nominal exchange rates vis-à-vis the trade partners' currency and is obtained from Bruegel database. *Trade Partners' CPI* is derived from REER formula by dividing the product of NEER and domestic CPI to REER. *Domestic CPI* and its components are the cumulative consumer price index for which the base period is 2003:Q1 for all sample countries. The source for CPI and its components (food, non-food and service CPI) are the official Statistics Offices of sample countries. All variables are seasonally adjusted through Census-X-12 procedure and transformed into logarithmic form. A detailed description of all series for each country is presented in Appendix A1. According to unit root test results[6], the variables are non-stationary, so we run VAR model in first differences.

[6] See Appendix A2, *Table 2* for detailed information on unit roots.

The existing literature employs different approaches to estimate the ERPT (Calpa and Goldberg, 2005; Chabot and Khan, 2015; Choudri, 2005; Ca' Zorzi et al., 2007; Stulz, 2007). The choice of methodology for our paper is constrained with some issues related to sample countries and time span. Since the number of countries is three, we suppose that panel methods will not be efficient due to the few cross sections. On the other hand, short sample period does not allow us to use non-linear or Markov Switching models. Due to these constraints, we will conduct our estimations by employing simple VAR methodology (Mccarthy, 2000; Hahn, 2003 and Ca' Zorzi, 2007). VAR model allows us to eliminate possible endogeneity problems of explanatory variables. In a VAR specification we propose the following Cholesky ordering scheme: **X= (Δoil revenue, Δtp_cpi, Δneer, Δcpi) ′.**

$$\Delta R_t^{oil} = E_{t-1}(\Delta R_t^{oil}) + a_{11}\varepsilon_t^{oil} \quad (1)$$

$$\Delta \pi_t^{tp} = E_{t-1}(\Delta \pi_t^{tp}) + a_{21}\varepsilon_t^{oil} + a_{22}\varepsilon_t^{tp} \quad (2)$$

$$\Delta e_t = E_{t-1}(\Delta e_t) + a_{31}\varepsilon_t^{oil} + a_{32}\varepsilon_t^{tp} + a_{33}\varepsilon_t^{e} \quad (3)$$

$$\Delta \pi_t^{cpi} = E_{t-1}\left(\Delta \pi_t^{cpi}\right) + a_{41}\varepsilon_t^{oil} + a_{42}\varepsilon_t^{tp} + a_{43}\varepsilon_t^{e} + a_{44}\varepsilon_t^{cpi} \quad (4)$$

$$\Delta \pi_t^{food} = E_{t-1}\left(\Delta \pi_t^{food}\right) + a_{41}\varepsilon_t^{oil} + a_{42}\varepsilon_t^{tp} + a_{43}\varepsilon_t^{e} + a_{44}\varepsilon_t^{food} \quad (5)$$

$$\Delta \pi_t^{non-food} = E_{t-1}\left(\Delta \pi_t^{non-food}\right) + a_{41}\varepsilon_t^{oil} + a_{42}\varepsilon_t^{tp} + a_{43}\varepsilon_t^{e} + a_{44}\varepsilon_t^{non-food} \quad (6)$$

$$\Delta \pi_t^{service} = E_{t-1}\left(\Delta \pi_t^{service}\right) + a_{41}\varepsilon_t^{oil} + a_{42}\varepsilon_t^{tp} + a_{43}\varepsilon_t^{e} + a_{44}\varepsilon_t^{service} \quad (7)$$

where R_t^{oil} is real oil revenue, π_t^{tp} denotes consumer price level of trade partners. e_t shows nominal effective exchange rate. Finally, π_t^{cpi},π_t^{food}, $\pi_t^{non-food}$, $\pi_t^{service}$ represents aggregate headline CPI, food CPI, non-food CPI and service CPI. ε_t^{oil},ε_t^{tp}, ε_t^{e},ε_t^{π}, ε_t^{food}, $\varepsilon_t^{non-food}$ and $\varepsilon_t^{service}$ are shocks of oil revenue, trade partners' CPI, exchange rate, aggregate CPI, food CPI, non-food CPI and service CPI, respectively. E_{t-1} is the expectation of a variable conditional on the information set at the end of period t-1.

In our identification scheme we assume that *Oil revenue* is the most exogenous variable. As we already mentioned above, *Oil revenue* consists of two components: oil prices and oil production. Since oil prices are exogenously determined in international markets and volume of oil production is determined based on long-term contracts between oil producers and importers, we assume that oil production is also exogenous variable. Therefore, we can treat oil revenue as an exogenous variable. It implies that in our identification scheme structural shocks on the rest of the variables do not have any effect on this variable.

We include *trade partners' CPI* to capture the effects of foreign prices shocks. According to Purchasing Power Parity Hypothesis, price differences among trade partners determine exchange rate in the long run. By including this variable, we can net out the influence of trade partners' CPI on the exchange rate.

NEER is included in order to identify exchange rate shocks. By including both *oil revenue* and *trade partners' CPI*, we separate their effects on exchange rate. Thus, exchange rate shock can be interpreted as a shock that is isolated from the influence of those variables.

In our identification scheme the last variable is CPI (and its components). It is obviously included to measure the degree of exchange rate pass-through to inflation. Hence, we expect CPI and its components to react positively to NEER depreciations and vice versa.

In fact, one may try to identify the exchange rate shocks by employing only two variables (domestic CPI and exchange rate) in the above scheme. However, this identification scheme violates the *ceteris paribus* assumption of the impulse response analysis. As long as we do not include *Oil revenue* or *trade partners' CPI* in the model, there will be only two shocks in the system: exchange rate and CPI shocks. Such identified shocks will also reflect previous omitted (oil revenue and trade partners' CPI) shocks. This is due to the fact that, for instance, potential effects of oil revenue on CPI (and its components) do not only work through NEER channel, but also through direct channel (fiscal channel) (Karimli *et al.*, 2016). If the observed NEER shock is because of the oil revenue shock, we would expect that CPI shock will also move as it is contaminated with the oil revenue shock. Therefore, any counterfactual analysis with the NEER shock will not produce *ceteris paribus* result. Thus, in our proposed scheme we include those two variables (oil revenue and trade partners' CPI) to avoid the violation of *ceteris paribus* assumption.

5. Results and discussion

In this section we report the empirical results for each sample country. The desired lag order of the model is two. The stability tests suggest that all models are stable. The estimates of the cumulative pass-through coefficients are derived from orthogonalized impulse response functions. We obtain pass-through coefficients by dividing cumulative change in price index by the cumulative change in nominal effective exchange rate:

$$PT_{t,t+j} = P_{t,t+j}/E_{t,t+1}$$

where, $P_{t,t+j}$ is cumulative change in the price level while E_{t+1} is nominal effective exchange rate between corresponding periods.

In order to examine the importance of exchange rate shocks, we also run variance decompositions for each country with the Cholesky ordering and determine the contribution of each shock to CPI fluctuations.

a. Azerbaijan

Figures 5a-5d in Appendix A3 depict impulse response functions of aggregate, food, non-food and service CPI of Azerbaijan within twelve quarters. Solid lines are accumulated impulse responses, while dotted lines represent one standard error confidence bands. The accumulated response of aggregate CPI and non-food CPI is significant for 12 quarters, while response of food and service CPI stays significant only for three and two quarters, respectively.

Table 3 contains the pass-through coefficients to aggregate CPI and its components. The results show that exchange rate pass-through is incomplete in Azerbaijan. 28 percent change of NEER is passed to aggregate CPI by the 4th quarter. After a shock to NEER, the ERPT to food CPI reaches maximum of 28 percent in the second quarter and 26 percent in the first year, while non-food CPI changes by 41 percent within a year. However, in the long run cumulative pass-through to non-food CPI reaches 49 percent. The services component is the least affected variable by the exchange rate shocks. The strongest response is observed in the second quarter, where the pass through is 15 percent.

These results are intuitive. Since a large part of food products is produced locally and sold in local currency, the consumers prefer to buy local food products due to a rise in imported food prices (IMF, 2016). In other words, expenditure switching causes the degree of the ERPT to decline. However, in non-food sector consumers do not have many options to choose from. According to Official Customs Statistics, food and tobacco products account for 14 percent of imports in 2015, while non-food products are about 70 percent of total imports. In other words, non-food importers have significant market power and exchange rate shocks are transmitted into domestic prices to a great extent. Low pass-through in service CPI could be attributed to regulated price effects. Around 12 percent of services in the CPI basket are administratively regulated by the government. In fact, after the recent devaluations in 2015, authorities did not allow administrative prices to increase in order to keep service inflation in check (IMF, 2016). Overall, the results suggest that the ERPT is heterogeneous across CPI components in Azerbaijan. As we mentioned earlier, there is no enough literature that has studied the pass through of exchange rate shocks to CPI components for Azerbaijan case.

Table 3: Degree of exchange rate pass-through in Azerbaijan

Quarters	Aggregate CPI	Food CPI	Non-food CPI	Service CPI
1	0.19*	0.23*	0.22*	0.12*
2	0.23*	**0.28***	0.28*	**0.15***
3	0.26*	0.27*	0.35*	0.10
4	**0.28***	0.26*	0.41*	0.09
5	0.27*	0.21	0.44*	0.07
6	0.27*	0.19	0.47*	0.06
7	0.27*	0.17	0.48*	0.05
8	0.27*	0.17	**0.49***	0.05
9	0.27*	0.17	0.49*	0.04
10	0.27*	0.17	0.49*	0.04
11	0.27*	0.17	0.49*	0.04
12	0.27*	0.17	0.49*	0.04

*****shows significance at 10%

Tables 6a-6d in Appendix A4 report the variance decomposition of CPI and its components obtained from the VAR model. According to the tables, about a third of variation in aggregate and food CPI in the first quarter is explained by NEER shocks. However, in the following periods, NEER shocks explain only 24 and 20 percent of CPI volatility, respectively. In case of non-food CPI, exchange rate shock has the highest contribution in explaining the variation. Initially, the exchange rate shocks account for 57 percent of the variance and in the following periods it stabilizes at around 50 percent. In contrast, NEER shocks explain only 5-6 percent of variation in the service CPI in the first quarter. The variations in service CPI are explained mostly by its own innovations.

b. Kazakhstan

For Kazakhstan the impulse response functions are reported in Figures 5e-5h, Appendix A3. Responses of aggregate, food, non-food CPI to Cholesky one standard deviation innovation in NEER appear to be significant for 12 quarters while response of service CPI is significant only in the second and third quarters. Aggregate CPI reacts quickly to innovations in exchange rate and the pass-through reaches its maximum level in the third quarter. In order words, 100 percent change of tenge results in 31 percent change in aggregate CPI and 22 percent change in food CPI in the third quarter. Responses of food, non-food CPI and services CPI are also strongest in the third quarter, 22, 61 and 8 percent, respectively. Within a year the ERPT coefficient reaches to 28 percent for aggregate CPI, 20 percent for food CPI, 52 percent for non-food CPI and 7 percent for services CPI.

Table 4: Degree of exchange rate pass-through in Kazakhstan

Quarters	Aggregate CPI	Food CPI	Non-food CPI	Service CPI
1	0.13*	0.09*	0.31*	0.04
2	0.25*	0.20*	0.50*	0.06*
3	**0.31***	**0.22***	**0.61***	**0.08***
4	0.28*	0.20*	0.52*	0.07
5	0.23*	0.17*	0.42*	0.05*
6	0.20*	0.16*	0.33*	0.04*
7	0.21*	0.18*	0.31*	0.04*
8	0.23*	0.20*	0.34*	0.05
9	0.25*	0.21*	0.39*	0.06
10	0.26*	0.21*	0.42*	0.07
11	0.26*	0.20*	0.44*	0.07
12	0.25*	0.19*	0.44*	0.06

*****shows significance at 10%

Overall, the degree of the exchange rate pass-through exhibits similarities with Azerbaijan case. Kazakhstan is also considered a small open economy being vulnerable to terms of trade shocks, particularly to oil price fluctuations. After oil price shocks hit the economy, the exchange rate of tenge exerts sensitivity by excessive fluctuations. Considering the fact that Kazakhstan has recently moved to a floating regime, such volatility in the exchange rate has been increased considerably. Since most of the intermediate and final industrial products are imported abroad, it is not surprising to observe higher pass through in Kazakhstan as well. In addition, Kazakhstan possesses relatively higher non-food import ratio (around 50%), which results in the highest pass through to non-food CPI among other CPI components.

Variance decomposition results for Kazakhstan are presented in Tables 7a-7c Appendix 4A. NEER shocks explain 17 percent of variations in aggregate CPI in the first quarter; while in the following quarters, the contribution of NEER fluctuates around 30 percent. Although NEER shocks have substantial importance in variance decomposition of aggregate CPI, in food CPI it is only 5 percent initially and then 10 percent the rest of the time. Since NEER has the highest pass-through to non-food prices, it also has substantial contribution (more than 60 percent in all periods) to non-food CPI variations across time. As expected, variance decomposition of Kazakh service CPI shows that NEER has very small contribution on it.

c. Russia

In Figures 5j-5m, Appendix A3, we report cumulative impulse responses of CPI and its components in Russia. The response of aggregate CPI, food, non-food and service CPI to one s.d. innovation in NEER is significant for the whole period. In contrast to previous findings for Azerbaijan and Kazakhstan, the impulse response of service CPI to NEER shocks appears to be significant in Russia.

The pass-through coefficients to aggregate, food and non-food CPIs are similar to Azerbaijan and Kazakhstan case. The pass-through is about 32 percent for aggregate CPI, 39 percent for food CPI and 25 percent for non-food CPI in the first twelve months. For service CPI, the ERPT reaches 27 percent during a year. The degree of pass-through to aggregate CPI, non-food CPI and service CPI reaches the maximum level (40%, 35% and 35%, respectively) only after two years. However, the maximum pass-through of 43 percent for food CPI is reached after a year. Thus, the ERPT to food CPI is relatively fast and higher in comparison with other components of CPI for Russian case.

Table 5: Degree of exchange rate pass-through in Russia

Quarters	Aggregate CPI	Food CPI	Non-food CPI	Service CPI
1	0.15*	0.19*	0.09*	0.13*
2	0.25*	0.34*	0.20*	0.19*
3	0.27*	0.33*	0.21*	0.23*
4	0.32*	0.39*	0.25*	0.27*
5	0.36*	0.42*	0.28*	0.29*
6	0.37*	0.42*	0.30*	0.31*
7	0.38*	**0.43***	0.31*	0.32*
8	0.39*	0.43*	0.33*	0.33*
9	0.39*	0.43*	0.33*	0.34*
10	**0.40***	0.43*	0.34*	0.34*
11	0.40*	0.43*	**0.35***	**0.35***
12	0.40*	0.43*	0.35*	0.35*

*****shows significance at 10%

The greater ERPT in Russia can also be explained by higher dependency on imports. More precisely, over 35% of the Russian CPI basket depends on imported goods and services. It is also noteworthy to mention that Russia has a more developed non-food industry relative to other sample countries. This implies that consumers have more expenditure switching opportunities and therefore, the lower ERPT to non-food CPI compared to other countries. According to official statistics, Russian food products accounts for 21 percent of imports. Such relatively higher dependency on food imports causes highest ERPT to food CPI among sample countries. In the meantime, our results for Russia are in line with some previous findings presented by Dobrynskaya and Levando (2005), Kataranova (2010) and Comunale and Simola (2016). Dobrynskaya and Levando also find higher pass-through to food prices (56%) and lower pass-through to non-food consumer prices (29%) within 6 months. In terms of aggregate CPI, our results concur with the findings of Kataranova (2010). She shows that the ERPT to aggregate CPI is around 19-21 percent in the short-term and 32-34 percent in the medium-term which is consistent with our results for Russia.

We report variance decomposition of aggregate CPI and its components in Table 8a-8d, Appendix A4. According to Table 8a, NEER shocks explain 55 percent of variations in aggregate CPI, while it is about 40 percent in case of food CPI. More than 50 percent of variations in this component is explained by its own persistence. The contribution of exchange rate shocks to non-food CPI variation is also high. Unlike in Azerbaijan and Kazakhstan, NEER shock has relatively high contribution in explaining Russian service CPI. It fluctuates between 26-28 percent.

5. Conclusion

In our study we examine the ERPT to CPI and its components for oil exporting CIS countries namely Azerbaijan, Kazakhstan and Russia. For this purpose, we employ a VAR model in first differences and identification in the model is achieved through Cholesky decomposition. Using the quarterly data for the period 2003:Q1-2016:Q2, we find the significant pass-through of exchange rate shocks to domestic inflation. We also carry out the performance evaluation of the given model by running stability tests.

For all sample countries, the ERPT appears to be fast and significant. The response of aggregate CPI to exchange rate shocks in Azerbaijan and Kazakhstan reaches to 28 percent and in Russia it reaches to 32 percent within a year. The ERPT to food CPI appears to be lower than the aggregate CPI in all sample countries, except Russia (26% for Azerbaijan, 20% for Kazakhstan and 39% for Russia). For non-food CPI, there is some heterogeneity among the sample countries. More precisely, Russian non-food CPI exhibits the lowest pass-through coefficient (25%), while for Kazakhstan the pass-through effect is the largest one (52%) during the first year. In contrast, the pass through to the service CPI is the highest in Russia (27%) and the lowest in Kazakhstan (7%) during a year.

Apart from impulse response functions, we also estimate variance decomposition of CPIs for each country. The estimations suggest that in Azerbaijan about a third of variations in aggregate and food CPI, and more than half of variation in non-food CPI are explained by exchange rate shocks. However, the contribution of exchange rate shocks to variation in aggregate, food and non-food CPI is 30, 10 and 61 percent, respectively in Kazakhstan. In both countries exchange rate shocks explain only small portion (6 and 8 percent, respectively) of variations in service CPI. In case of Russia, NEER shocks also explain substantial part of variations in aggregate, food, non-food, service CPIs: 55, 39, 44 and 27 percent, respectively. All in all, our findings show that the ERPT is still higher but incomplete in oil exporting CIS countries.

The major policy implications of the paper are the following. Taking into account the greater ERPT, the policy makers should carefully consider its lag and size effects on monetary policy decisions since it will take time for NEER shocks to have the maximum effect on domestic CPI. Also move toward inflation targeting regime increases the relevance of pass through in improving forecasting capabilities of the structural models used at the CBs.

Bibliography

1. Beckmann, E., and J. Fidrmuc (2013). “Exchange rate pass-through in CIS countries”. *Comparative Economic Studies*, 55, 705–720.

2. Ca’ Zorzi M., Hahn E. and Sanchez M. (2007). “Exchange Rate Pass-Through in Emerging Markets”, *European Central Bank*, Working Paper Series 0739

3. Campa, J. M., and Goldberg, L.S. (2002). “Exchange Rate Pass-Through into Import Prices: A Macro or Micro Phenomenon?” *NBER Working Paper* No.8934.

4. Campa, J. M., and Goldberg, L.S. (2005). “Exchange Rate Pass-Through into Import Prices”. *Review of Economics and Statistics*, 87(4), 679-690.

5. Caselli, F. and Roitman, A. (2016). “Non-Linear Exchange Rate Pass-Through in Emerging Markets”. *IMF Working Paper* 16/1

6. Comunale, M. and Simola, H. (2016). “The pass through to consumer prices in CIS countries: The role of exchange rates, commodities and other common factors”. *BOFIT Discussion Paper* No. 16/2016 .

7. Dobrynskaya V., V. and Levando D. (2005). “A study of exchange rate pass-through effect in Russia”. Moscow State University, *Higher School of Economics*, Working Paper WP9/2005/02.

8. Dobrynskaya V., V. and Levando D., V (2005). “Exchange rate pass-through effect and monetary policy in Russia”. *Exchange Rate Econometrics* AEA

9. Espada J.F.C (2013), “Estimating the Exchange Rate Pass-through to Prices in Mexico”, *Monetaria*, Vol. I, Issue 2, pp. 287-316

10. Frankel, J., D. Parsley and S. Wei. (2012). “Slow Pass-through around the World: A New Import for Developing Countries?” *Open Economies Review*, 23, 213–251.

11. Hajek J. and Horvath R. (2015). “Exchange Rate Pass-Through in an Emerging Market: the Case of the Czech Republic”, IES FSV, Charles University, *IES Working Paper* 8/2015.

12. Huseynov, S. and Ahmadov, V. (2013). “Oil windfalls, fiscal Policy and Money Market Disequilibrium”, *William Davidson,* WP 1051.

13. Huseynov, S. and Ahmadov. V. (2014). “Business cycles in oil exporting countries: A Declining role for Oil?” *Geneva Graduate Institute,* WP 03/2014.

14. Ito, T. and Kiyotaka, S. (2006). “Exchange rate changes and inflation in post-crisis Asian economies: VAR analysis of the exchange Rate Pass Through” *RIETI Discussion Paper Series* 06-E-018.

15. Kahn, G. A. (1987). “Dollar depreciation and inflation” *Federal Reserve Bank of Kansas City Economic Review* 72 (9), 32-49.

16. Karimli, T., Jafarova, N., Aliyeva, H., and Huseynov, S. (2016). “Oil Price Pass-Through into Inflation: The Evidence from Oil Exporting Countries”. *The Graduate Institute of International Studies*. IHEID WP 01-2016.

17. Kataranova, M. (2010). “The Relationship between the Exchange Rate and Inflation in Russia”. *Problems of Economic Transition,* Vol. 53, No. 3, pp. 45-68

18. Korhonen, I. and Wachtel P. (2005). "A note on exchange rate pass-through in CIS countries", Bank of Finland, Institute for Economies in Transition, *BOFIT Discussion Papers* 2/2005.

19. Laflèche T. (1996/1997). "The Impact of Exchange Rate Movements on Consumer Prices", *Bank of Canada Review* (Winter), pp. 21-32

20. Masha I. and Park C. (2012). “Exchange Rate Pass Through to Prices in Maldives”, *IMF, Working Paper Series* 12/126

21. Mishkin, F., S. (2008). "Exchange Rate Pass-Through and Monetary Policy". *National Bureau of Economic Research* Working Papers 13889.

22. Moldasheva, G. (2013). “Exchange rate pass-through into import prices: Evidence from Central Asia”. *International Journal of Economics and Finance Studies*, Vol 5, No1, ISSN: 1309-8055 (online)

23. Obstfeld, M., and K. Rogoff (2000). "The Six Major Puzzles in International Macroeconomics". Is there a Common Cause? *NBER Macroeconomics Annual*.

24. Obstfeld, M., and Rogoff, K. (1995). "Exchange rate dynamics redux. *Journal of Political Economy*, 103(3), 624-660.

25. Oomes N. and Ohnsorge F. (2005). "Money demand and inflation in dollarized economies: The case of Russia". *Journal of Comparative Economics*. Vol.33, No 3. P.462-483.

26. Ponomarev Y., Trunin P. and Uluykaev A. (2014). "Exchange Rate Pass-through in Russia", *Gaidar Institute for Economic Policy*, Working Papers 0099, revised 2014

27. Republic of Azerbaijan: 2016 Article IV Consultation Press, *IMF Country Report* No. 16/296.

28. Rincon, C., H and Rodriguez, N., N (2016). "Nonlinear Pass-Through of Exchange Rate Shocks on Inflation: A Bayesian Smooth Transition VAR Approach". *The Graduate Institute of International Studies*. HEIDWP13-2016.

29. Savoie-Chabot L. and Khan M. (2015). "Exchange Rate Pass-Through to Consumer Prices: Theory and Recent Evidence", *Bank of Canada*, Discussion Paper/Document d'analyse 2015-9

30. Soffer, Y. (2006). "ERPT to the Consumer Price Index: a Micro Approach", *Bank of Israel*. Discussion Paper no.2

31. Stavrev E. (2003). "The pass through from the nominal exchange rate to inflation" Russian Federation: Selected Issues. *IMF Country Report*. No 03/146.

32. Stulz J. (2007). Exchange Rate Pass-through in Switzerland: Evidence from Vector Autoregressions", *Swiss National Bank Economic Studies* 4-2007

33. Taylor J., B. (2000). "Low Inflation, Pass-Through and the Pricing Power of Firms", *European Economic Review*, vol. 44 (June), pp. 1389-408.

APPENDIX A1

Data and sources

Oil revenue: *Oil revenue* is calculated as the product of real price of oil and oil production for a given country. Oil prices are deflated using US CPI. The source for this indicator is the US Energy Information Administration Database (EIA). Data on oil production is taken from the EIA database. Both series are seasonally adjusted by means of the X-12 Census procedure.

Trade partners' CPI: Data on trading partners' CPI (2003 Q1 = 100) is calculated by using NEER and REER series which is published by Bruegel database. Taking the first quarter of 2003 as base period and normalizing all series to 100 we divide NEER to REER series and multiply it to the domestic CPI to get the trade partners' CPI. This series is also seasonally adjusted.

NEER: Nominal effective exchange rate (2003 Q1 = 100) is taken as trade weighted index of bilateral exchange rates of major trading partners. The source for this series is Bruegel database. This series is seasonally adjusted through X-12 seasonal adjustment procedure.

Domestic CPI: Consumer Prices Index (2003 Q1 = 100) is obtained from official Statistics Offices of sample countries. X-12 Census methodology is applied to obtain seasonally adjusted series.

Components of CPI: Food, non-food, service components of CPI (2003 Q1 = 100) are obtained from official Statistics Offices of sample countries. X-12 Census methodology is applied to obtain seasonally adjusted series.

Figure 2: Variables in logarithmic form

Azerbaijan

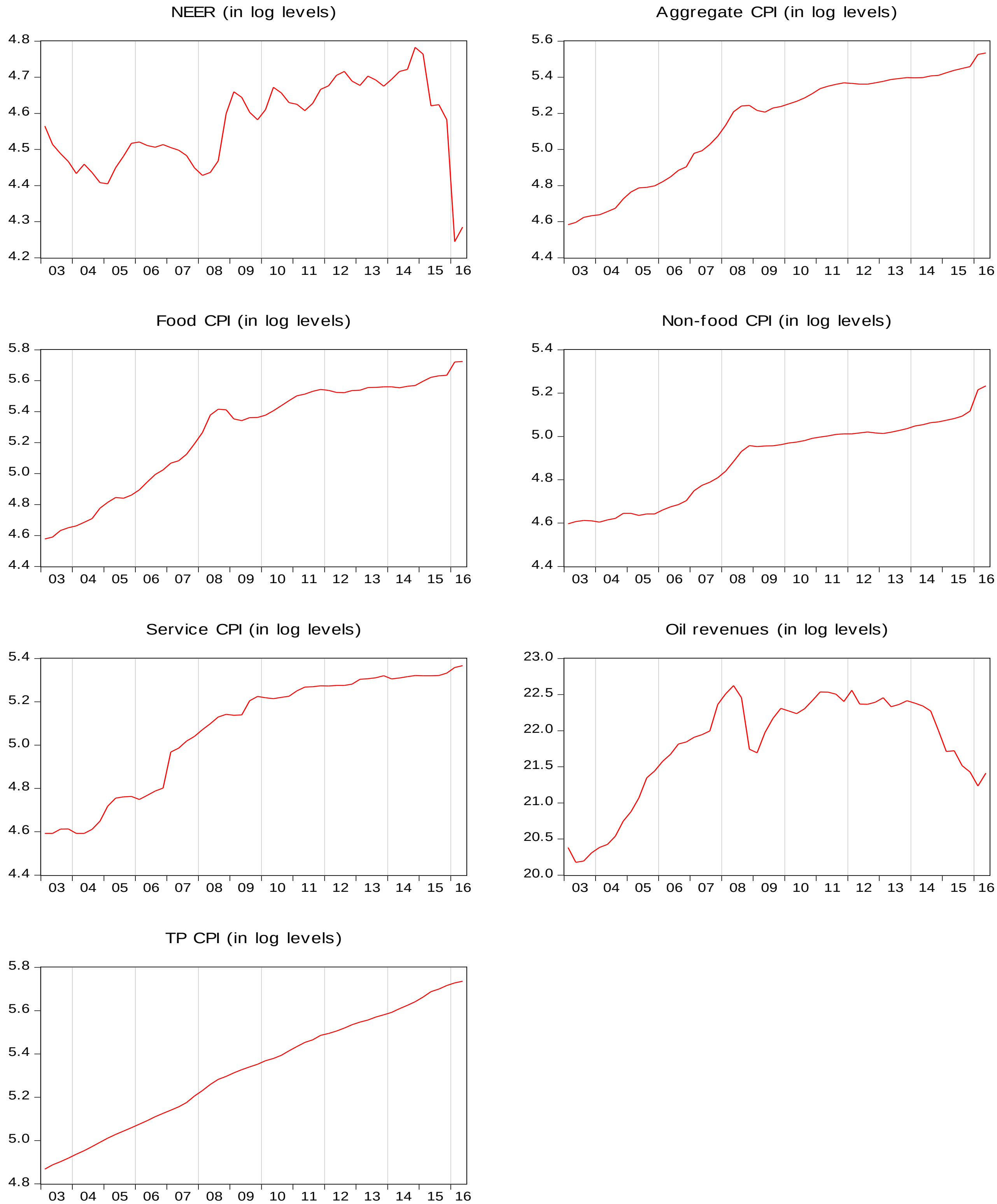


Figure 3: Variables in logarithmic form

Kazakhstan

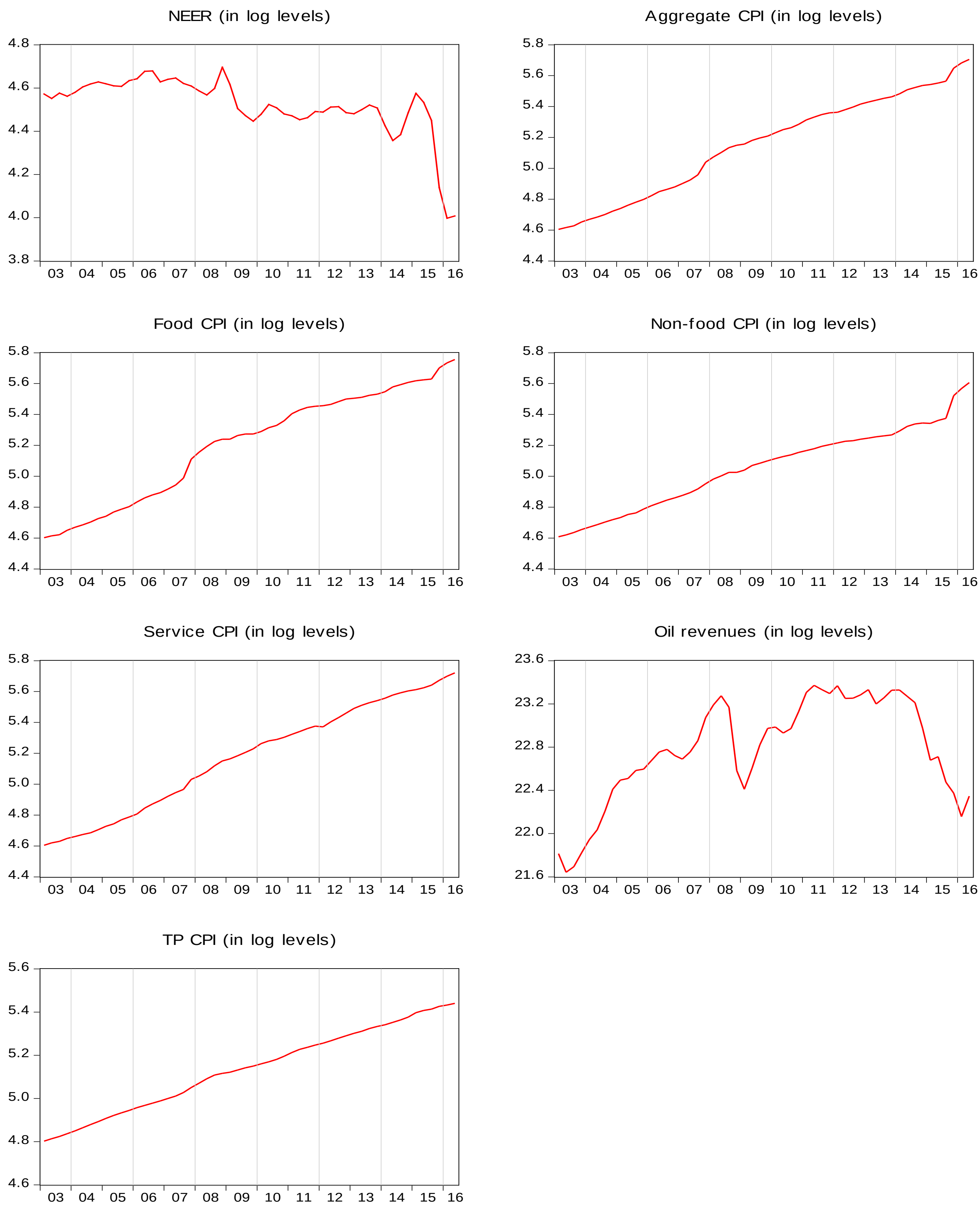
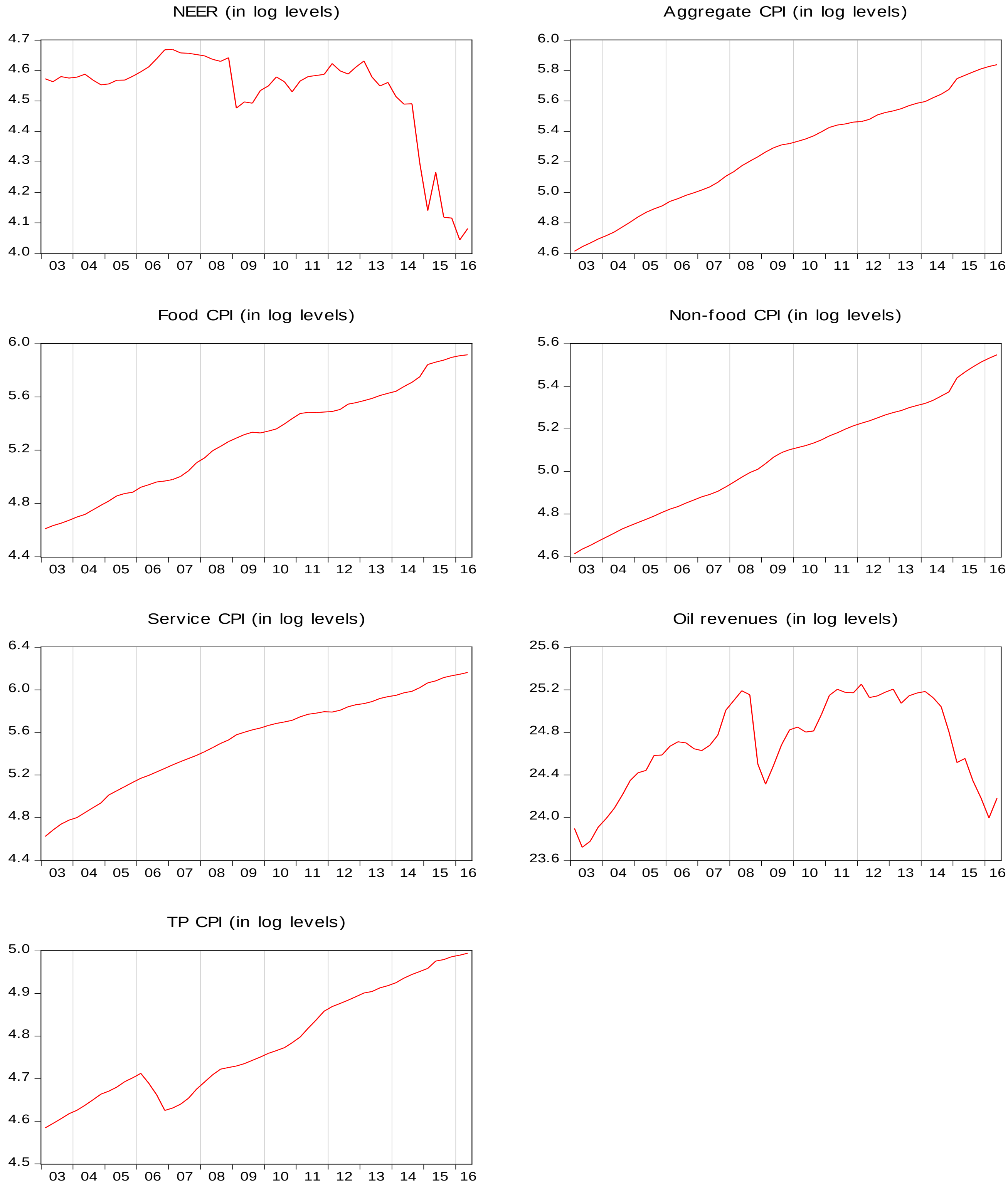


Figure 4: Variables in logarithmic form

Russia



Appendix A2

Table 2a: Unit root tests

Azerbaijan

Variable	Level			First differences		
	Intercept	Intercept and trend	Status	Intercept	Intercept and trend	Status
Aggregate CPI	-1.770	-1.378	Non-stationary	-4.390***	-4.643***	Stationary
Food CPI	-1.907	-1.636	Non-stationary	-4.263***	-4.533***	Stationary
Non-food CPI	-0.007	-1.820	Non-stationary	-4.495***	-4.493***	Stationary
Service CPI	-1.714	-0.597	Non-stationary	-5.912***	-6.182***	Stationary
NEER	-1.398	-0.566	Non-stationary	-3.862***	-3.962**	Stationary
Oil revenue	-2.596	-0.378	Non-stationary	-4.899***	-5.598***	Stationary
TP CPI	-1.481	-1.136	Non-stationary	-3.909***	-4.178***	Stationary

Table 2b: Unit root tests

Kazakhstan

Variable	Level			First differences		
	Intercept	Intercept and trend	Status	Intercept	Intercept and trend	Status
Aggregate CPI	-0.097	-1.825	Non-stationary	-5.284***	-5.231***	Stationary
Food CPI	-0.844	-1.657	Non-stationary	-4.831***	-4.830***	Stationary
Non-food CPI	1.184	-3.454	Non-stationary	-5.458***	-5.544***	Stationary
Service CPI	-0.537	-0.889	Non-stationary	-5.695***	-5.674***	Stationary
NEER	1.119	-4.453	Non-stationary	-5.709***	-6.277**	Stationary
Oil revenue	-2.968**	-2.186	Non-stationary	-4.596***	-5.078***	Stationary
TP CPI	-1.943	-2.089	Non-stationary	-4.802***	-5.278***	Stationary

Table 2c: Unit root tests

Russia

Variable	Level			First differences		
	Intercept	Intercept and trend	Status	Intercept	Intercept and trend	Status
Aggregate CPI	-1.130	-1.945	Non-stationary	-4.414***	-4.507***	Stationary
Food CPI	-0.662	-2.452	Non-stationary	-4.654***	-4.625***	Stationary
Non-food CPI	0.513	-2.135	Non-stationary	-4.600***	-4.621***	Stationary
Service CPI	-0.559	-2.136	Non-stationary	-3.998***	-5.209***	Stationary
NEER	0.447	-0.738	Non-stationary	-7.950***	-8.577***	Stationary
Oil revenue	-2.822*	-2.074	Non-stationary	-4.838***	-5.281***	Stationary
TP CPI	0.228	-2.812	Non-stationary	-4.428***	-4.448***	Stationary

Appendix A3

Figure 5a: Accumulated response of *aggregate CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Azerbaijan

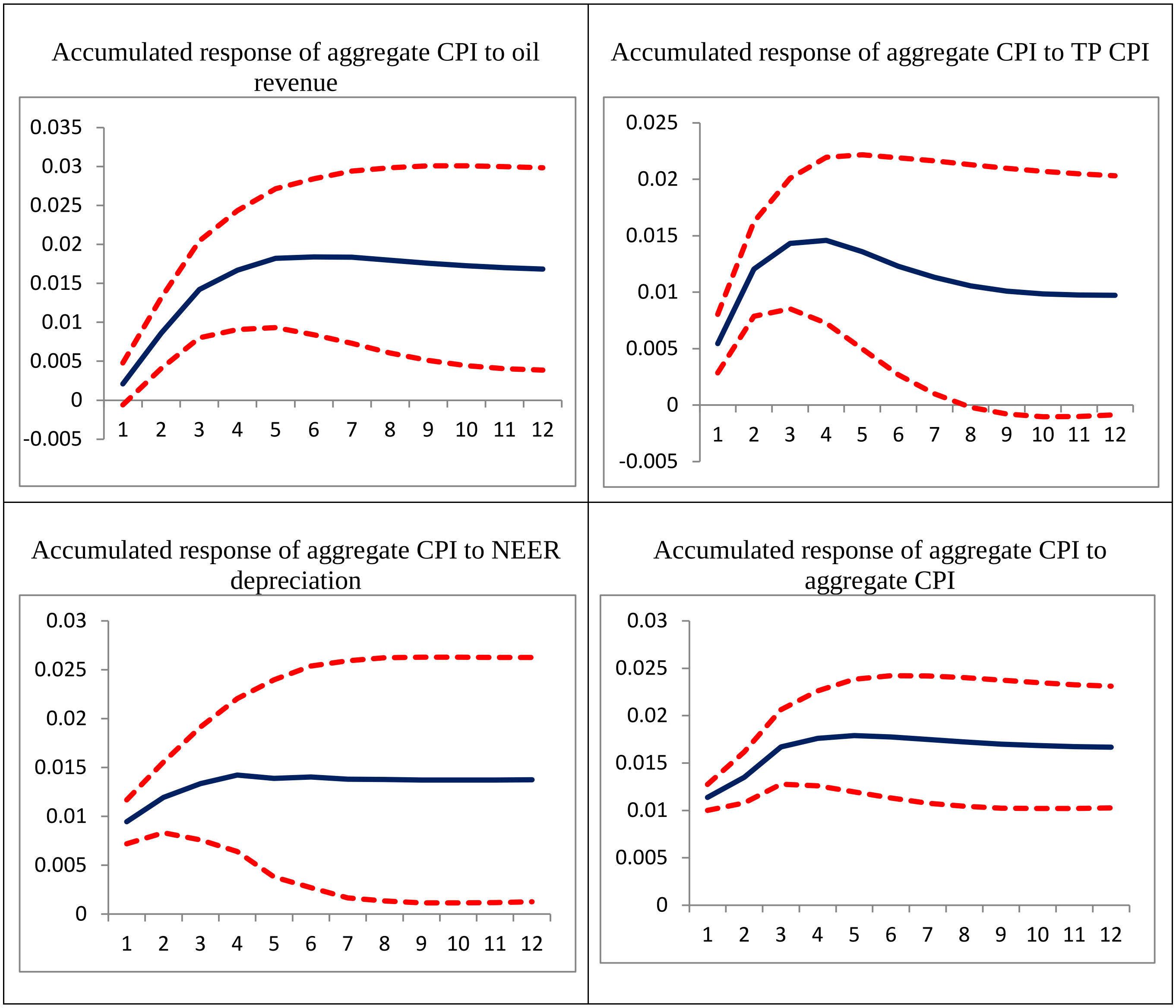


Figure 5b: Accumulated response of *Food CPI* to Cholesky one standard deviation innovations $\pm$ 1 S.E.

Azerbaijan

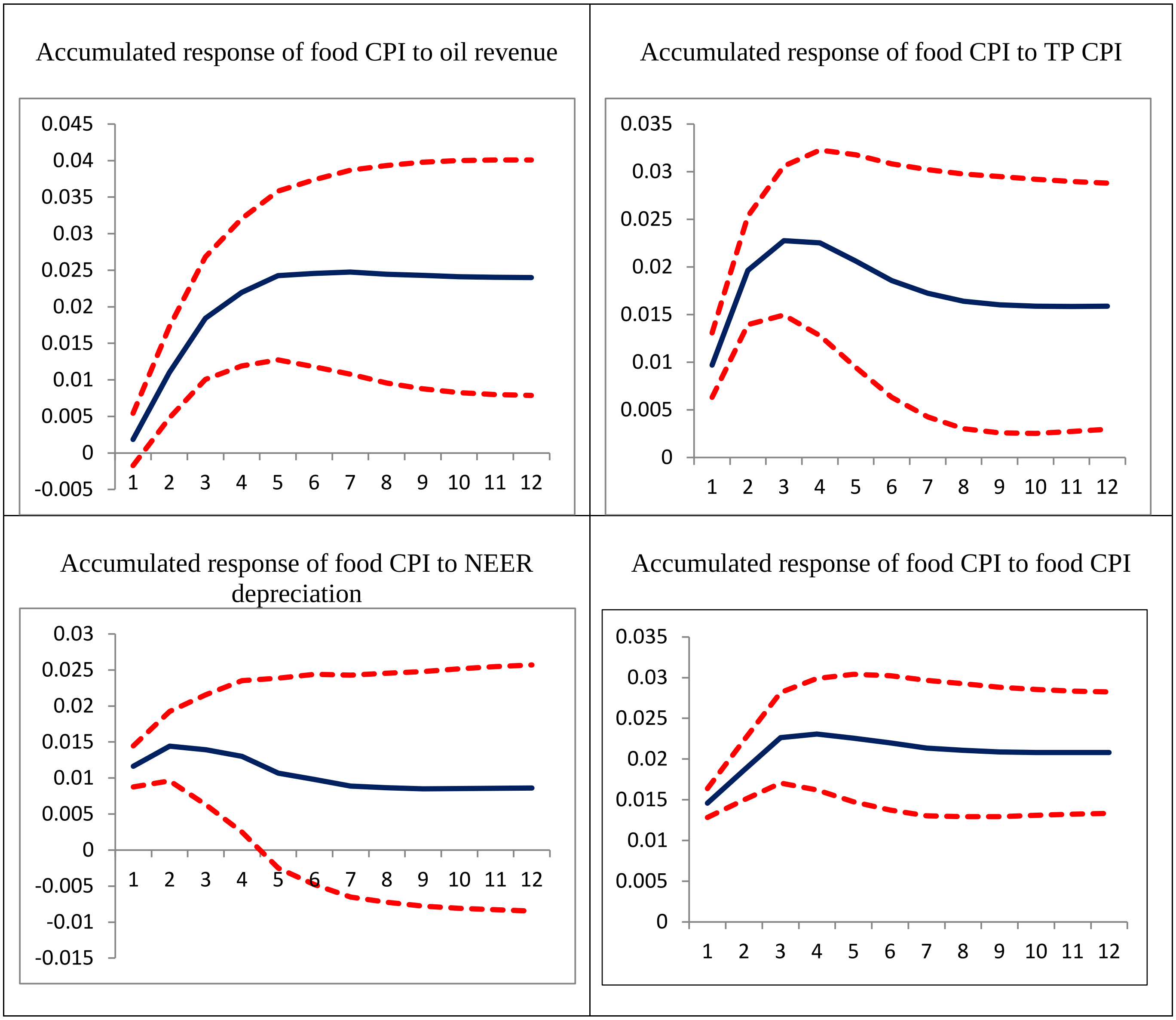


Figure 5c: Accumulated response of *Non-Food CPI* to Cholesky one standard deviation innovations $\pm$ 1 S.E.

Azerbaijan

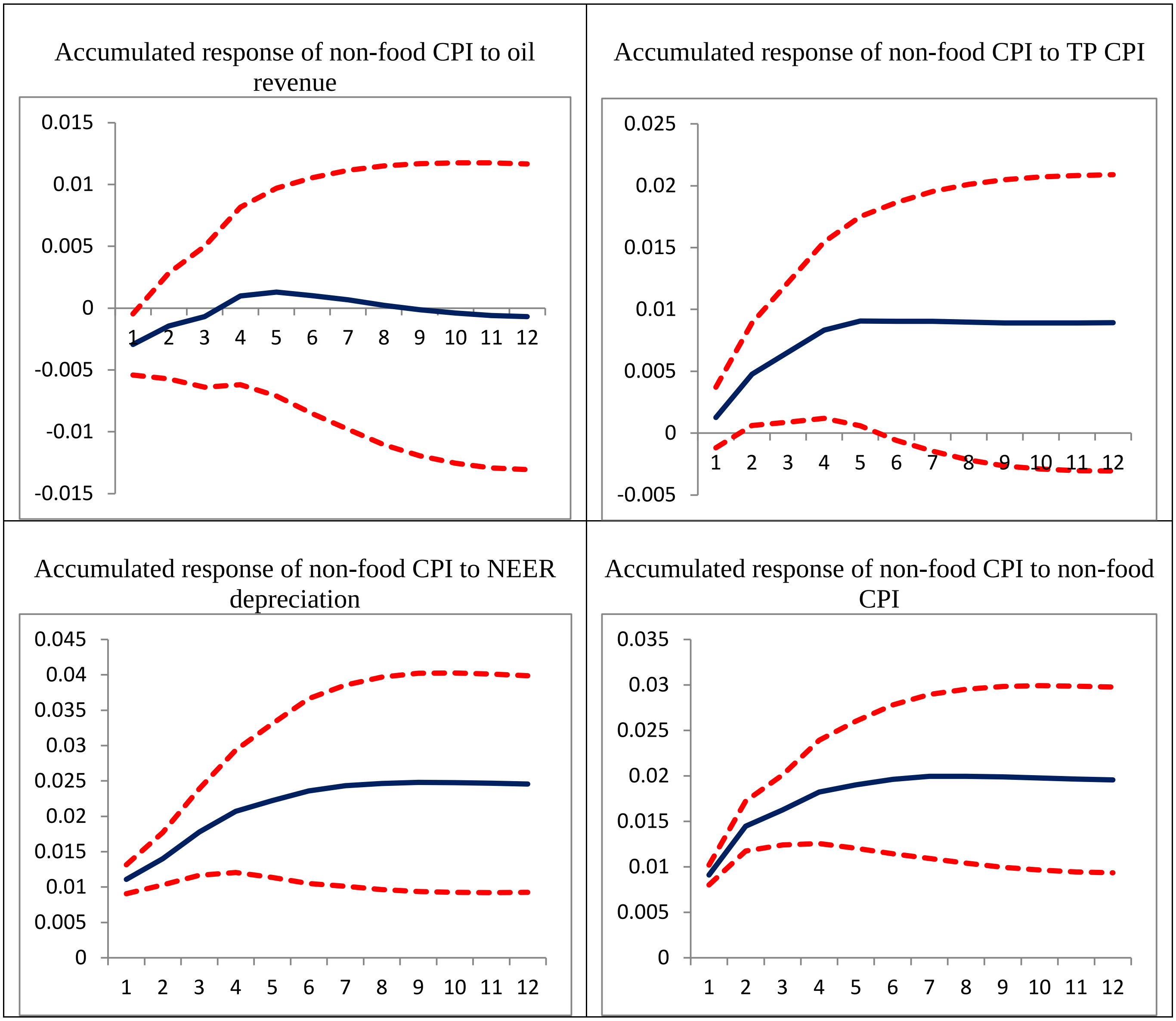


Figure 5d: Accumulated response of *Service CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Azerbaijan

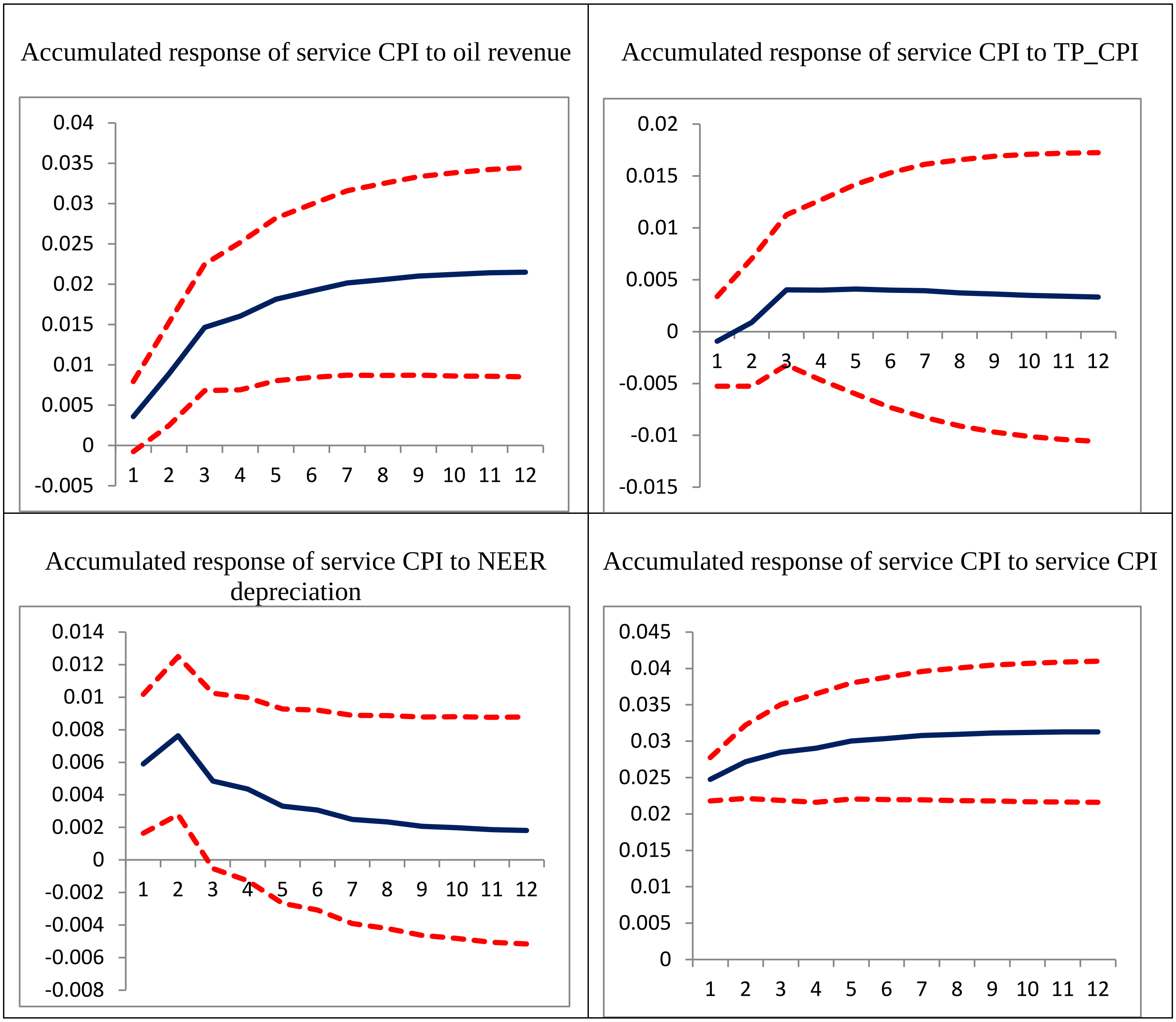


Figure 5e: Accumulated response of *aggregate CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Kazakhstan

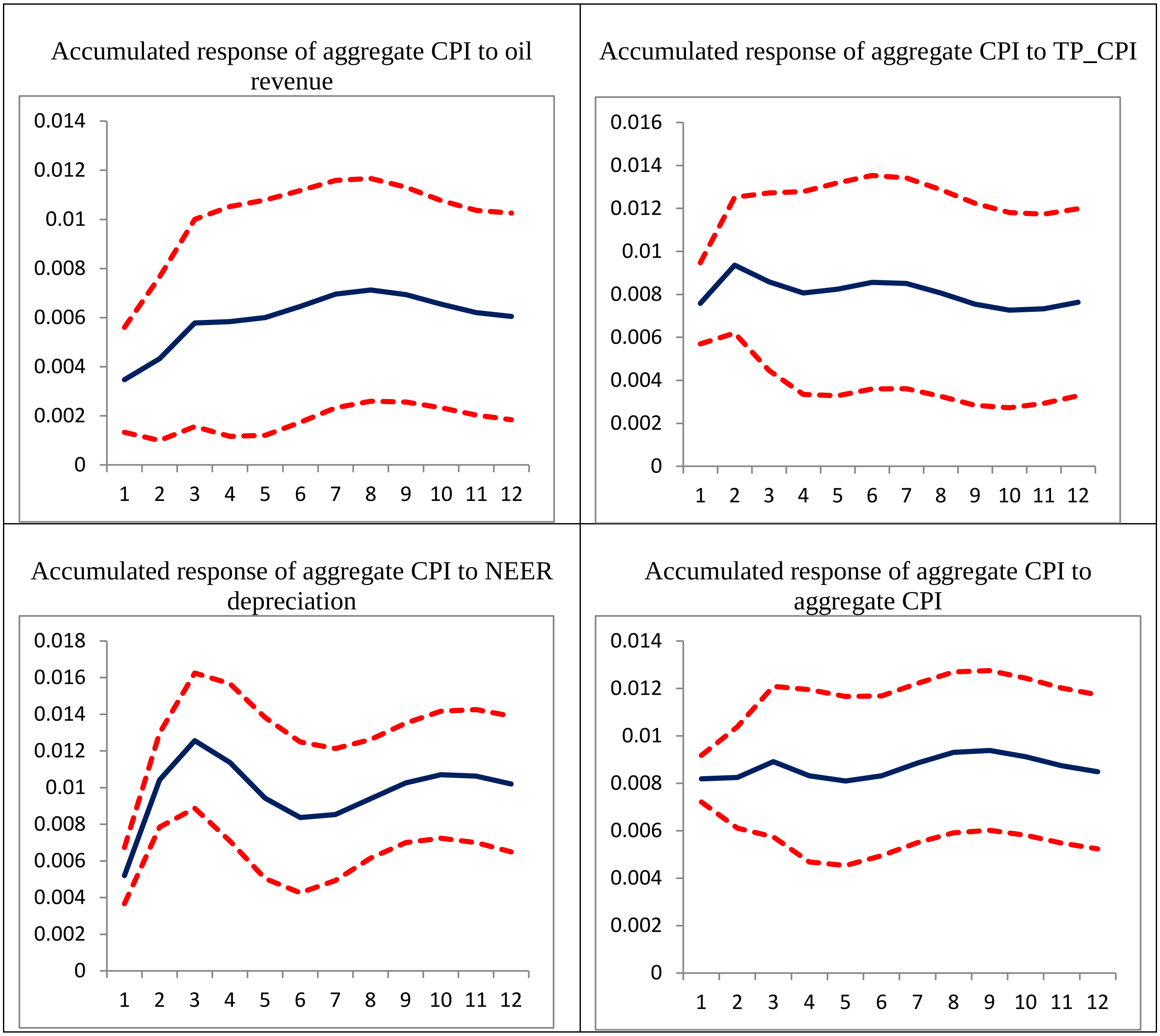


Figure 5f: Accumulated response of *Food CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Kazakhstan

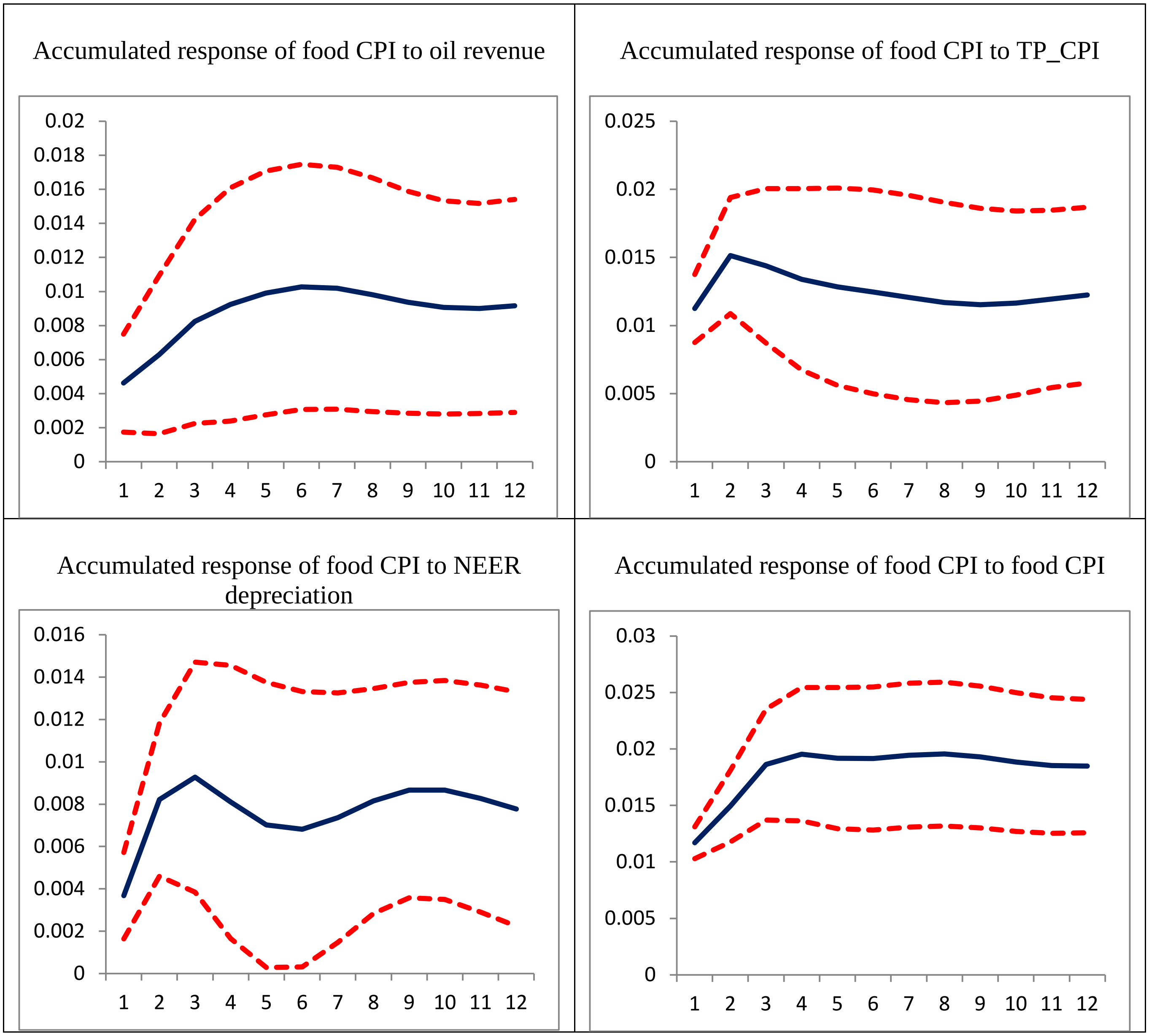


Figure 5g: Accumulated response of *Non-Food CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Kazakhstan

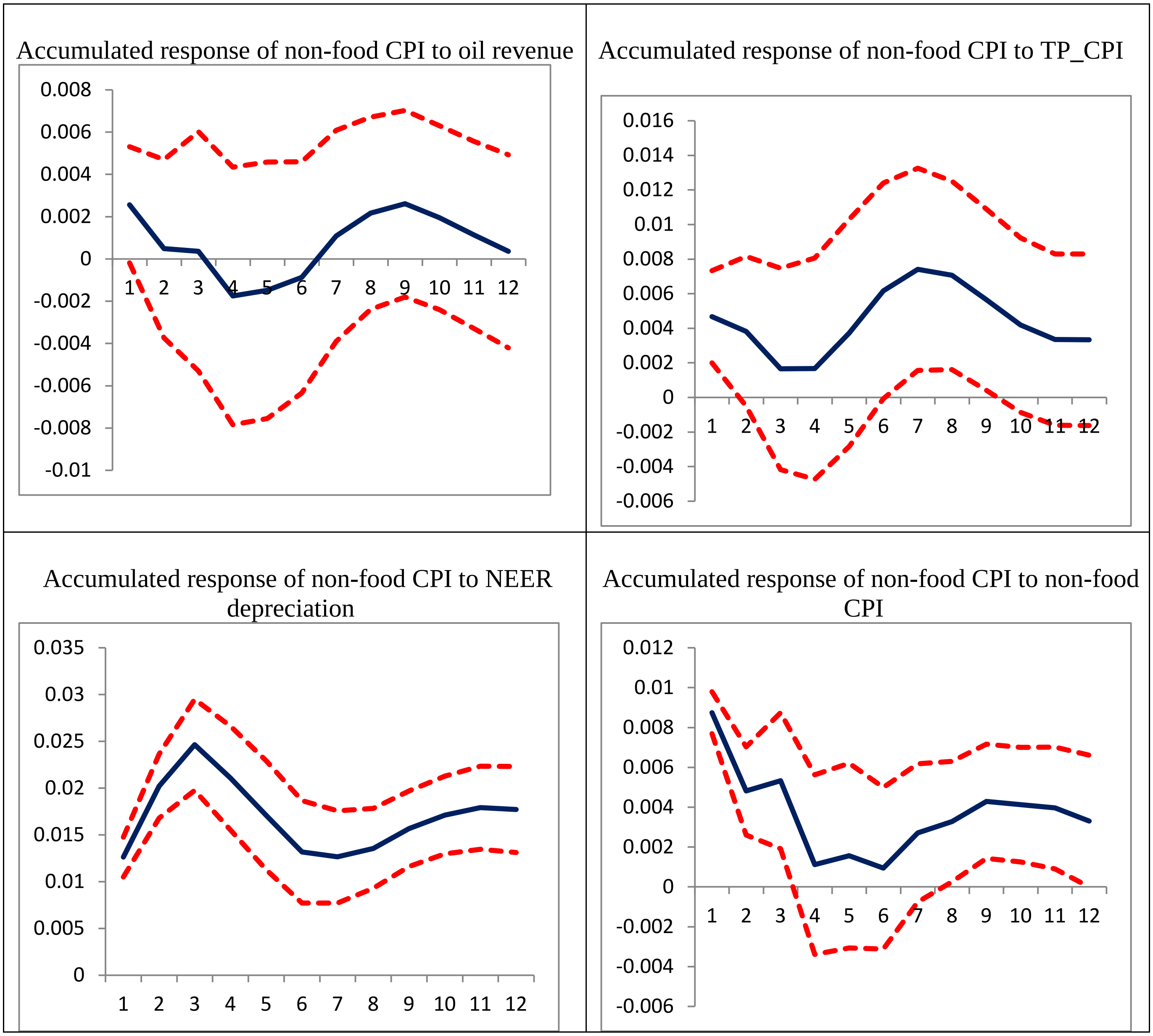


Figure 5h: Accumulated response of *Service CPI* to Cholesky one standard deviation innovations ± 1 S.E.

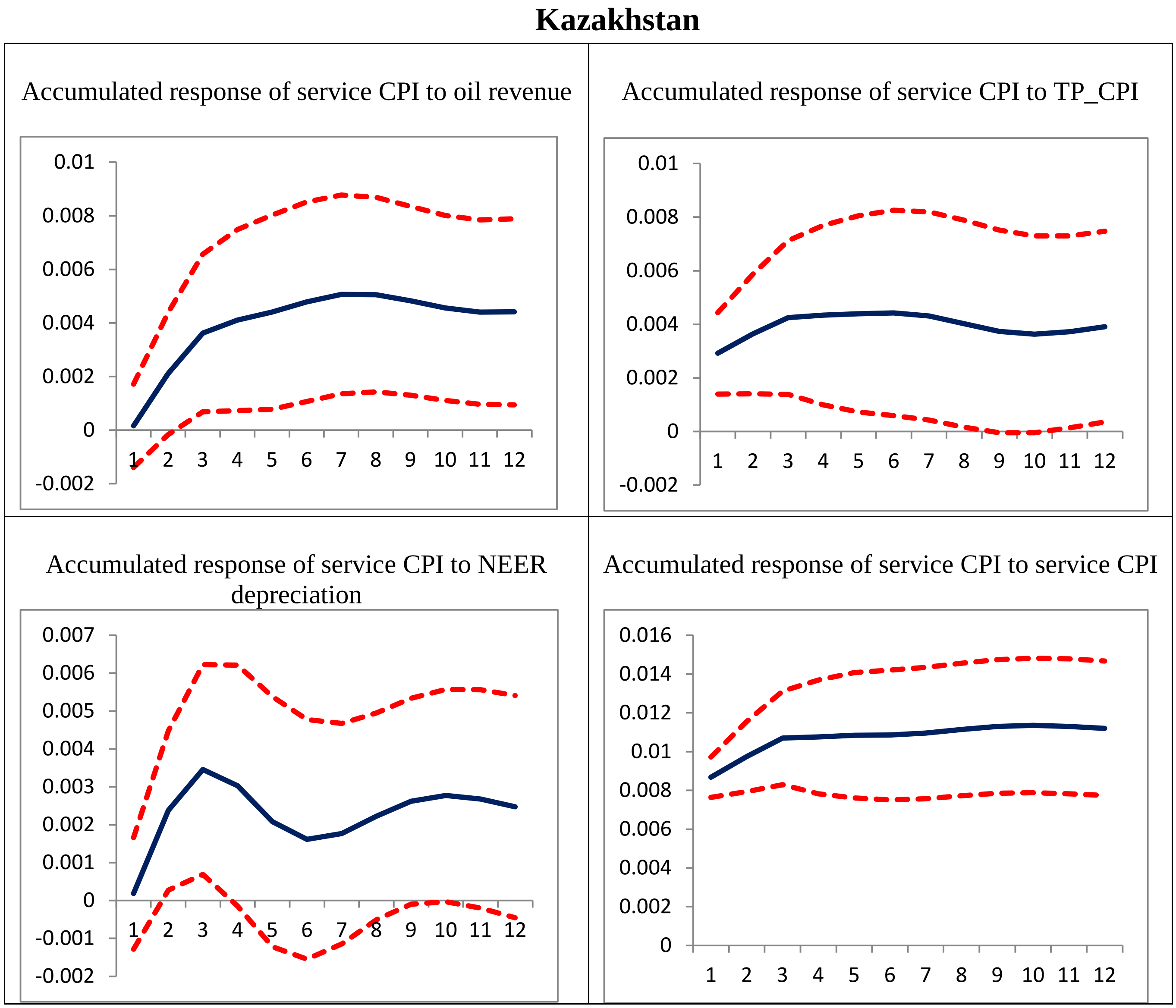


Figure 5j: Accumulated response of *aggregate CPI* to Cholesky one standard deviation innovations $\pm$ 1 S.E.

Russia

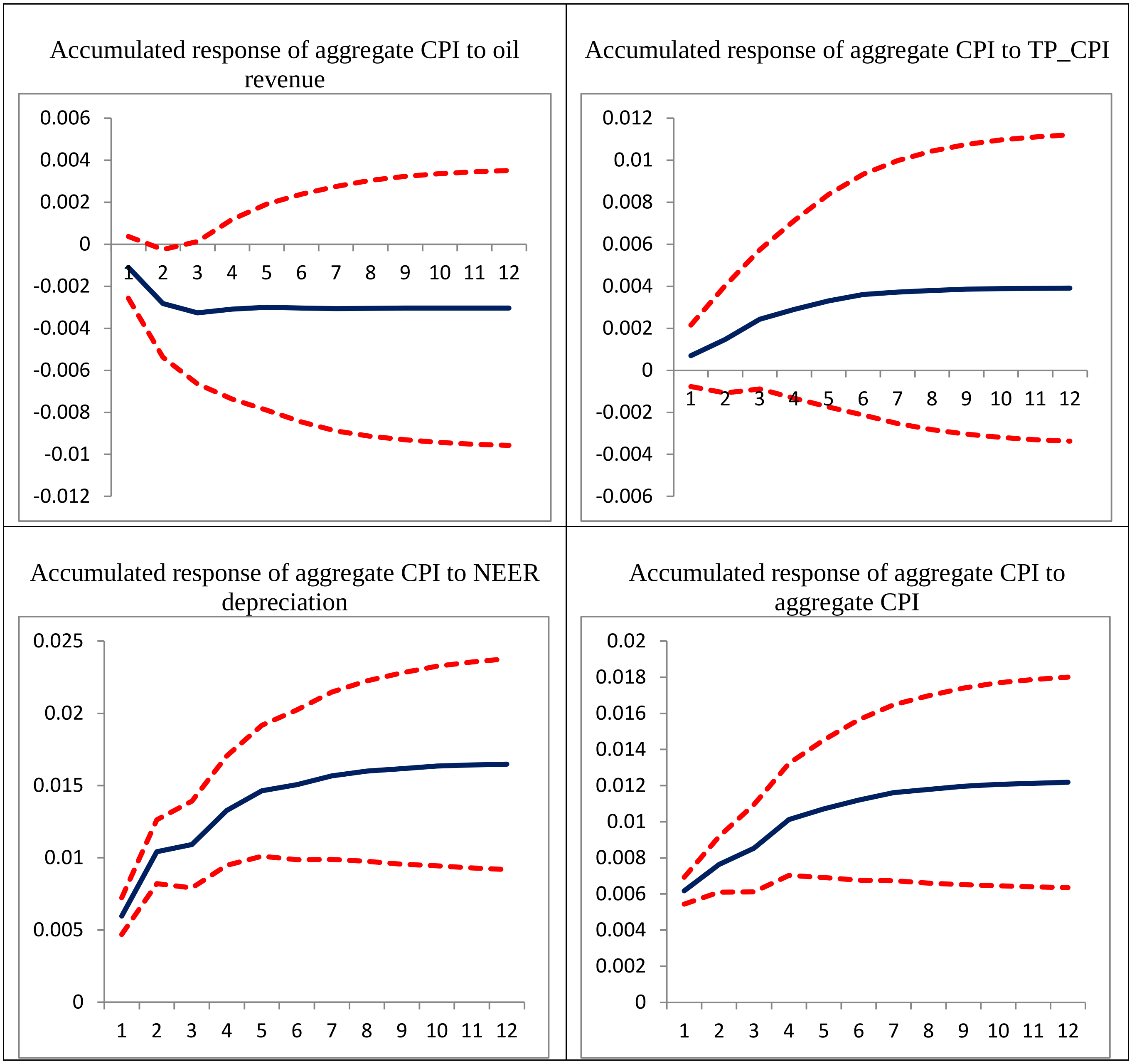


Figure 5k: Accumulated response of *Food CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Russia

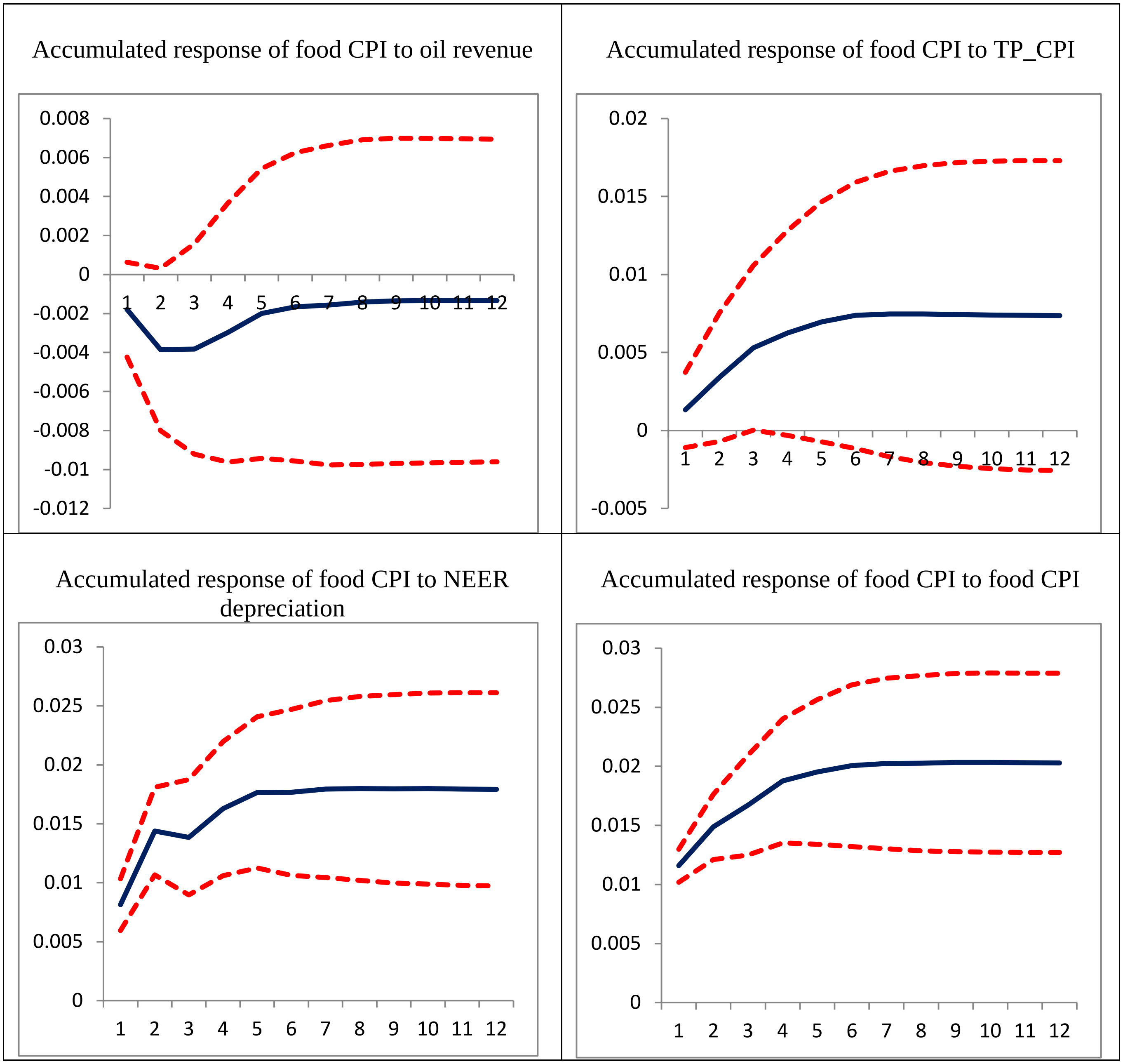


Figure 5l: Accumulated response of *Non-Food CPI* to Cholesky one standard deviation innovations $\pm$ 1 S.E.

Russia

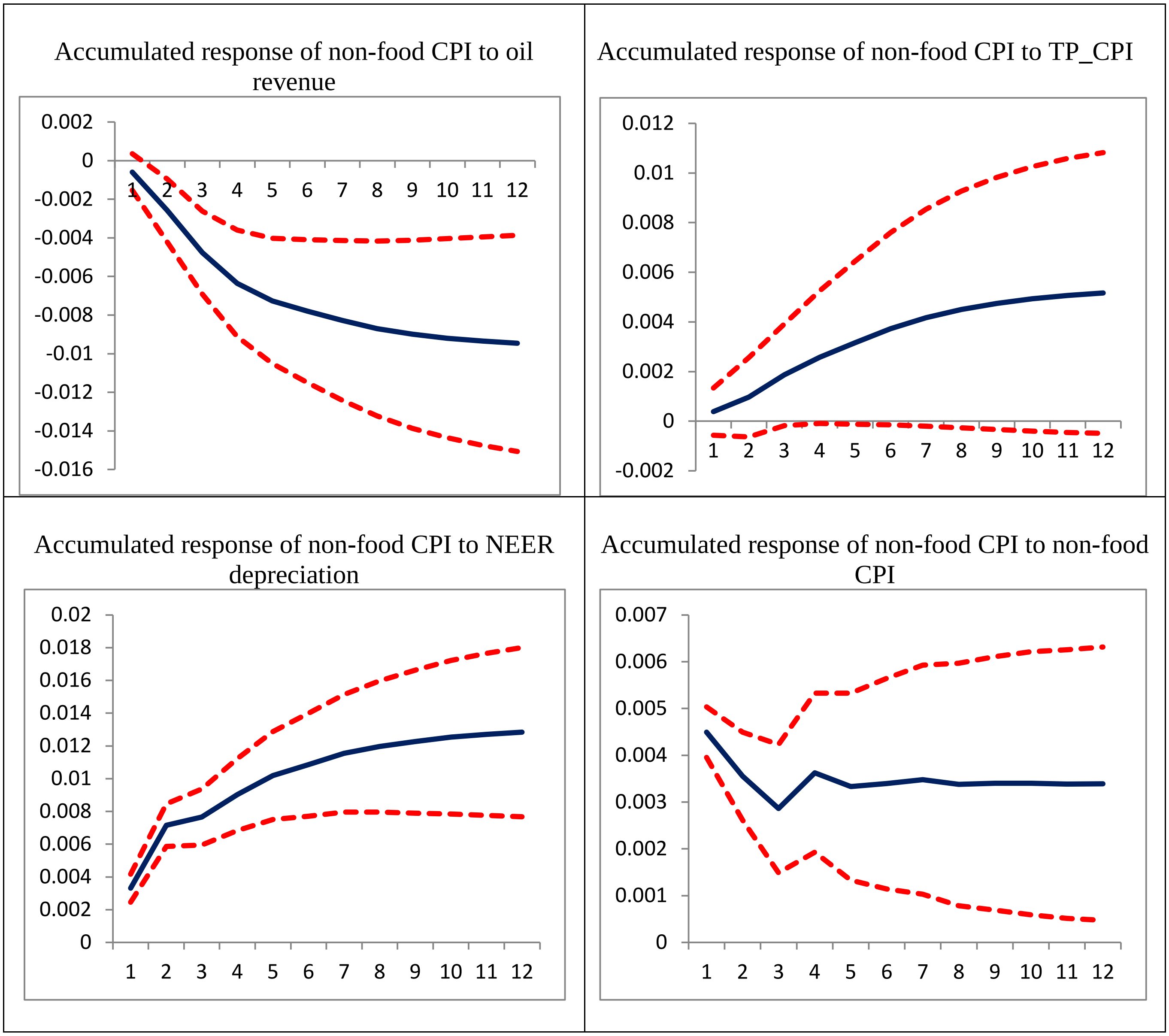
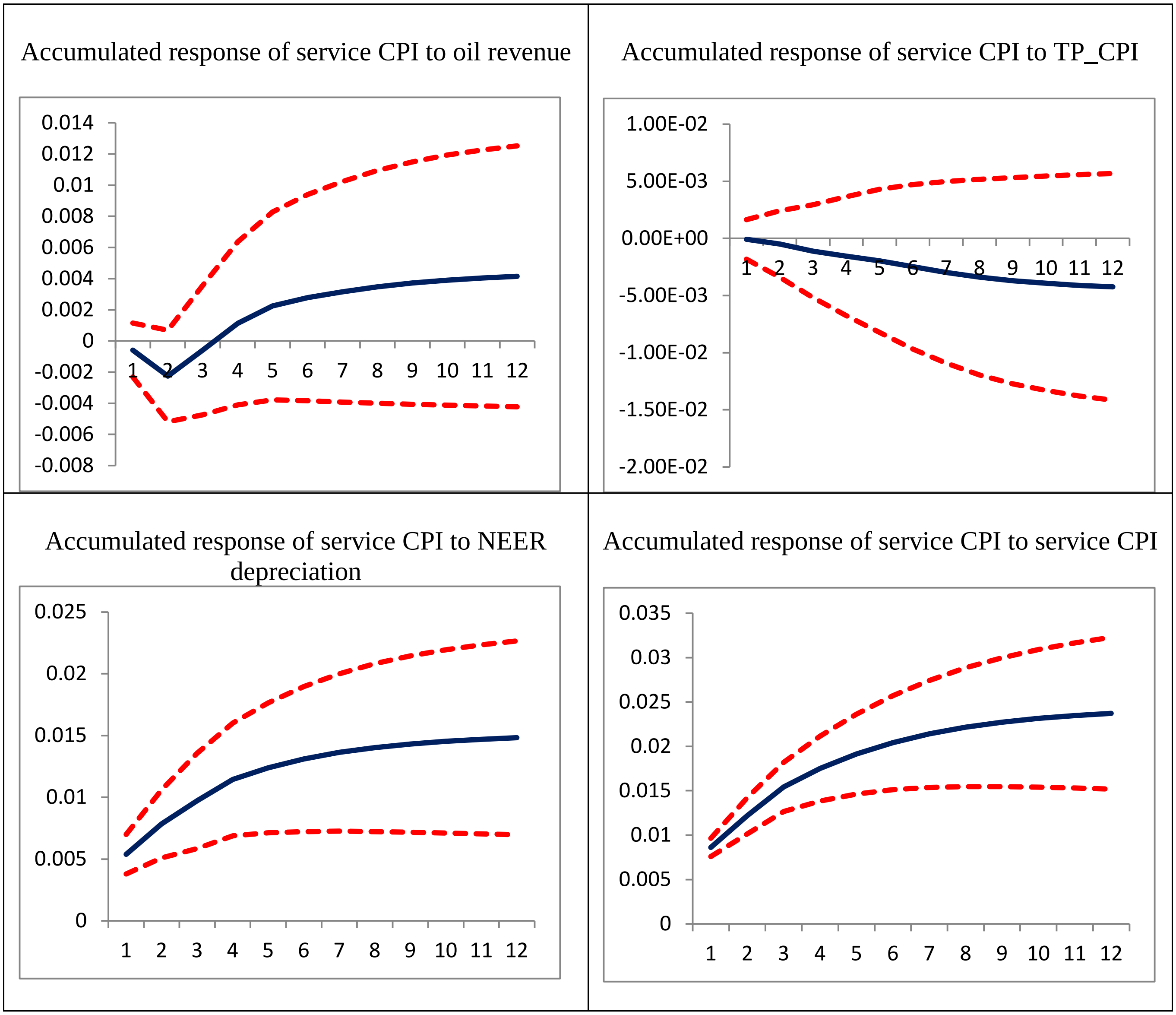


Figure 5m: Accumulated response of *Service CPI* to Cholesky one standard deviation innovations ± 1 S.E.

Russia



Appendix A4

Azerbaijan

Table 6a: Variance decomposition of aggregate CPI

Period	Oil revenue	TP_CPI	NEER	CPI
1	1.73	11.75	35.33	51.19
2	13.44	21.01	27.30	38.25
3	19.67	19.70	24.46	36.17
4	20.82	19.34	24.17	35.67
5	21.21	19.43	23.99	35.37
6	21.13	19.74	23.89	35.24
7	21.07	19.93	23.84	35.16
8	21.07	20.03	23.79	35.11
9	21.08	20.06	23.77	35.09
10	21.10	20.06	23.76	35.08
11	21.11	20.06	23.76	35.07
12	21.11	20.06	23.76	35.07
	Cholesky ordering: oil revenue tp_cpi neer cpi			

Table 6b: Variance decomposition of Food CPI

Period	Oil revenue	TP_CPI	NEER	Food CPI
1	0.78	21.12	30.29	47.81
2	13.37	29.57	21.89	35.17
3	19.40	27.64	19.51	33.45
4	20.73	27.15	19.27	32.85
5	21.02	27.10	19.62	32.26
6	20.88	27.46	19.58	32.08
7	20.80	27.57	19.62	32.01
8	20.79	27.64	19.60	31.97
9	20.79	27.64	19.60	31.97
10	20.79	27.65	19.60	31.96
11	20.79	27.65	19.60	31.96
12	20.79	27.65	19.60	31.96
	Cholesky ordering: oil revenue tp_cpi neer food cpi			

Table 6c: Variance decomposition of Non-Food CPI

Period	Oil revenue	TP_CPI	NEER	Non-food CPI
1	3.99	0.74	56.96	38.31
2	4.06	5.14	49.14	41.66
3	3.96	5.85	50.48	39.71
4	4.64	6.54	50.21	38.61
5	4.62	6.64	50.37	38.37
6	4.61	6.59	50.60	38.20
7	4.64	6.57	50.65	38.14
8	4.69	6.57	50.64	38.10
9	4.73	6.57	50.62	38.08
10	4.75	6.57	50.60	38.08
11	4.75	6.57	50.60	38.08
12	4.75	6.57	50.60	38.08
	Cholesky ordering:oil revenue tp_cpi neer non-food cpi			

Table 6d: Variance decomposition of Service CPI

Period	Oil revenue	TP_CPI	NEER	Service CPI
1	1.94	0.13	5.30	92.63
2	5.82	0.58	5.41	88.19
3	9.80	1.84	6.07	82.29
4	10.03	1.83	6.09	82.05
5	10.51	1.82	6.16	81.51
6	10.64	1.82	6.16	81.38
7	10.74	1.82	6.19	81.25
8	10.76	1.82	6.19	81.23
9	10.78	1.82	6.19	81.21
10	10.78	1.82	6.19	81.21
11	10.79	1.82	6.19	81.20
12	10.79	1.83	6.19	81.19
	Cholesky ordering:oil revenue tp_cpi neer service cpi			

Kazakhstan

Table 7a: Variance decomposition of aggregate CPI

Period	Oil revenue	TP_CPI	NEER	CPI
1	7.35	35.13	16.53	40.99
2	6.56	31.14	27.85	34.45
3	7.35	30.23	29.06	33.36
4	7.28	30.06	29.46	33.20
5	7.16	29.51	30.73	32.60
6	7.21	29.35	31.05	32.39
7	7.30	29.28	30.98	32.44
8	7.28	29.21	31.15	32.36
9	7.26	29.19	31.35	32.20
10	7.31	29.16	31.37	32.16
11	7.36	29.12	31.33	32.19
12	7.36	29.12	31.37	32.15
	Cholesky ordering: oil revenue tp_cpi neer cpi			

Table 7b: Variance decomposition of Food CPI

Period	Oil revenue	TP_CPI	NEER	Food CPI
1	7.16	42.41	4.52	45.91
2	6.95	40.79	9.81	42.45
3	7.63	38.83	9.61	43.93
4	7.81	38.65	9.87	43.67
5	7.89	38.52	10.13	43.46
6	7.92	38.53	10.13	43.42
7	7.91	38.51	10.20	43.38
8	7.93	38.46	10.34	43.27
9	7.97	38.40	10.39	43.24
10	7.99	38.38	10.39	43.24
11	7.98	38.37	10.42	43.23
12	7.98	38.35	10.47	43.20
	Cholesky ordering: oil revenue tp_cpi neer food cpi			

Table 7c: Variance decomposition of Non-Food CPI

Period	Oil revenue	TP_CPI	NEER	Non-food CPI
1	2.49	8.24	60.33	28.94
2	3.18	6.57	63.38	26.87
3	2.97	7.41	64.48	25.14
4	3.82	6.77	62.04	27.37
5	3.65	7.45	62.80	26.10
6	3.56	8.42	63.13	24.89
7	4.34	8.60	61.97	25.09
8	4.57	8.58	61.82	25.03
9	4.54	8.86	61.76	24.84
10	4.58	9.24	61.58	24.60
11	4.71	9.35	61.45	24.49
12	4.82	9.33	61.32	24.53
	Cholesky ordering: oil revenue tp_cpi neer non-food cpi			

Table 7d: Variance decomposition of Service CPI

Period	Oil revenue	TP_CPI	NEER	Service CPI
1	0.03	10.16	0.04	89.77
2	3.99	9.42	6.89	79.70
3	6.09	9.35	7.73	76.83
4	6.29	9.32	7.88	76.51
5	6.32	9.23	8.68	75.77
6	6.44	9.20	8.86	75.50
7	6.51	9.20	8.87	75.42
8	6.49	9.25	9.05	75.21
9	6.52	9.30	9.17	75.01
10	6.58	9.31	9.18	74.93
11	6.60	9.31	9.19	74.90
12	6.60	9.34	9.22	74.84
	Cholesky ordering: oil revenue tp_cpi neer service cpi			

Russia

Table 8a: Variance decomposition of aggregate CPI

Period	Oil revenue	TP_CPI	NEER	CPI
1	1.59	0.64	47.15	50.62
2	4.10	1.08	54.92	39.90
3	4.21	1.94	54.01	39.84
4	3.92	2.00	54.94	39.14
5	3.84	2.10	55.42	38.64
6	3.83	2.17	55.33	38.67
7	3.81	2.17	55.40	38.62
8	3.81	2.17	55.42	38.60
9	3.80	2.17	55.42	38.60
10	3.80	2.17	55.42	38.60
11	3.80	2.17	55.42	38.60
12	3.80	2.17	55.42	38.60
	Cholesky ordering: oil revenue tp_cpi neer cpi			

Table 8b: Variance decomposition of Food CPI

Period	Oil revenue	TP_CPI	NEER	Food CPI
1	1.57	0.85	32.22	65.34
2	2.82	2.32	39.88	54.98
3	2.74	3.59	38.91	54.76
4	2.88	3.75	39.40	53.97
5	3.17	3.87	39.51	53.45
6	3.21	3.93	39.43	53.43
7	3.21	3.93	39.44	53.42
8	3.22	3.93	39.44	53.41
9	3.22	3.93	39.44	53.41
10	3.22	3.93	39.44	53.41
11	3.22	3.93	39.44	53.41
12	3.22	3.93	39.44	53.41
	Cholesky ordering: oil revenue tp_cpi neer food cpi			

Table 8c: Variance decomposition of Non-Food CPI

Period	Oil revenue	TP_CPI	NEER	Non-food CPI
1	1.09	0.47	34.63	63.81
2	8.34	0.94	49.92	40.80
3	15.65	2.24	44.92	37.19
4	18.30	2.84	43.97	34.89
5	18.84	3.25	44.27	33.64
6	18.96	3.68	44.24	33.12
7	19.05	3.91	44.35	32.69
8	19.17	4.04	44.30	32.49
9	19.23	4.12	44.27	32.38
10	19.26	4.16	44.28	32.34
11	19.27	4.20	44.28	32.25
12	19.27	4.19	44.28	32.26
	Cholesky ordering: oil revenue tp_cpi neer non-food cpi			

Table 8d: Variance decomposition of Service CPI

Period	Oil revenue	TP_CPI	NEER	Service CPI
1	0.34	0.01	28.02	71.64
2	2.45	0.13	28.01	69.38
3	4.13	0.40	27.05	68.42
4	5.78	0.49	27.17	66.57
5	6.38	0.59	26.88	66.15
6	6.45	0.74	26.74	66.07
7	6.47	0.89	26.64	66.00
8	6.49	0.99	26.57	65.95
9	6.51	1.04	26.53	65.92
10	6.52	1.07	26.51	65.90
11	6.52	1.09	26.50	65.89
12	6.52	1.10	26.49	65.89
	Cholesky ordering: oil revenue tp_cpi neer service cpi			