EXCHANGE RATE PASS-THROUGH INTO DOMESTIC PRICES IN KAZAKHSTAN

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ABSTRACT

The paper studies the degree of the exchange rate pass-through into domestic prices in Kazakhstan in the period from January 1994 to January 2015. By adopting the vector-autoregression (VAR) approach the study distinguishes the varying degrees of the pass-through into import prices, producer prices, and consumer prices. In the light of the accession of Kazakhstan to the Customs Union and the recent geopolitical situation, the evolution of the exchange rate pass-through is measured by analyzing the change in impulse-response functions (IRFs) before and after economic integration. The main results are as follows: the degree of the pass-through into domestic prices is rather small in Kazakhstan. It tends to be higher for import prices than for producer and consumer prices. The pass-through effect is also observed to be higher after joining the Customs Union than prior to that.

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INTRODUCTION

Understanding the way prices behave is a central issue for inflation targeting. For the purpose of prudent monetary policy, it is all the more important to interpret the adjustment of import prices in a small open economy. Therefore, the degree to which various price indices respond to the changes in the nominal exchange rate is of utmost importance, as the exchange rate is one of the macroeconomic fundamentals, which could significantly affect consumer price inflation. It could have both a direct impact through the increase of the prices on imported goods (the so-called imported inflation) and indirect effect through increased costs of imported input materials in the domestic production. Numerous studies have suggested that the depreciation of national currency in value could exert upward inflationary pressure in the economy. While gradual and steady currency depreciation is a normal economic occurrence that may benefit the exporting sectors of economy (and has been historically encouraged by a number of export-oriented countries, like Japan and China), sudden depreciation shocks, usually as a result of unexpected circumstances, could destabilize national economy by unjustified inflation surge without bringing advantages to the exporting industries.

Exchange rate pass-through is a percentage change in domestic prices (be it import or consumer prices) from one percentage change in exchange rate between domestic currency and foreign currency. It could also be defined as the elasticity of prices with regard to the nominal exchange rate while controlling for other factors that determine prices in the economy. A decrease in value of domestic currency may translate into higher inflation depending on the extent of the pass-through in the economy. The measurement of exchange rate pass-through is important for understanding the degree of dependence of national economy on the goods imported from abroad and it becomes especially significant during and after currency crises, when the scale of inflation following sharp currency depreciation could make a difference in economic rehabilitation from a crisis. If, for instance, domestic prices react to nominal depreciation of the exchange rate in the proportion of one-to-one (i.e. a complete pass-through), then both import prices and general consumer price index (CPI) will increase to the same extent as the national currency will fall in value. But in this case, any advantage from export competitiveness, domestic goods costing less on the international market, will be effectively cancelled out, as the real exchange rate will not change at all. Thus, high inflation will eliminate the benefits of exporting sector, while the principal burden of nonperforming loans and bad debts will lie on financial institutions and businesses, which hold foreign currency liabilities. Hence, the analysis of exchange rate pass-through is crucial for crisis management, especially for the former Soviet countries, which already have experienced currency crises.

Kazakhstan, still being not a liberal capitalist economy, but one that is classified as a "country in transition", should pay attention to the stability of its currency. During Global Financial Crisis 2008 Kazakhstani Central Bank managed to stabilize tenge thanks to favorably high prices on oil and frequent interventions to sell foreign currencies from its reserves. However, with declining oil prices it has been more difficult for the Central Bank to maintain the stable exchange rate with regard to the US Dollar and tenge was eventually devalued in February 2014 to 185 tenge per dollar (fall in value by 20%) and still remains at this level.[1]

Kazakhstan has high level of dollarization, which could pose particular obstacles to economic development of the country (the ratios of foreign currency deposits and loans to total in Kazakhstan remain high reaching as much as 40% in 2014).[2] High dollarization generally calls for extra foreign currency reserves, and strengthens the impact of the exchange rate on the inflation rate (particularly in managed exchange rate regimes). Some economists argue that dollarization is associated with higher exchange rate pass-throughs, and limits the countercyclical capability of domestic expansionary monetary policy.

Moreover, considering that Kazakhstan is a part of an integration entity constituting Customs Union with Russia and Belarus, it has an additional exposure risks to the exchange rate fluctuations of their currencies. Since the creation of the Customs Union, the economies of Kazakhstan and Russia have become much more integrated with the trans-border trade volume in goods reaching USD $23.5 bn, while Russian FDI into the Kazakhstani economy increased 10-fold since the establishment of the

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[1] «Обесценивание тенге: как это было», *Радио Азаттык*, 11 февраля 2014 года. Доступ от 8 декабря, 2014 года. http://rus.azattyq.org/content/tenge-devaluation-history/25260905.html.

[2] IMF Country Report N14/243. Republic of Kazakhstan, International Monetary Fund, 2014, accessed 10 December, 2014, http://www.imf.org/external/pubs/ft/scr/2014/cr14243.pdf

Customs Union.[3] However, the recent imposition of the Western sanctions against Russia has decreased the value of ruble, which, in its turn, had a depreciative effect on the value of tenge (coupled with the depressed prices on oil on the international markets). The National Bank of Kazakhstan had to devalue its currency twice in a year creating panic among the population and expectations of inflationary pressure. Kazakhstani tenge has been in pegged parity with Russian ruble (except for the crisis years) since the 2000's. However, when ruble fell in value relative to the US dollar tenge lagged behind, which made Kazakhstani export less favored in Russia and forced the National Bank to devalue tenge relative to ruble in order to restore export competitiveness.[4] This decision has led to prompt increase in inflation from 4.5% to 7.2% in the beginning of 2014.

The purpose of the study is to analyze the exchange rate pass-through for Kazakhstan, which is defined as the degree to which exchange rate variations influence trade prices and, through them, other domestic prices. Understanding the nature of the adjustment of aggregate import prices to exchange rate changes, and through import prices eventually to other aggregate domestic prices, is important for anticipating inflationary developments and monetary policy responses.

Although, the recent devaluation has been due to the effect of the depreciating ruble on tenge and inflation in Kazakhstan, the author considered that the analysis of the exchange rate of the Kazakhstani tenge relative to the US dollar would be the most relevant in the light of high dollarization of the Kazakhstani economy and the fact that most traded goods are denominated and traded in US dollars (see Appendix A, Table 17).

The implications of the study will be significant not only for the forecasting purposes in conducting monetary policy in Kazakhstan, but also for the neighboring Central Asian countries contemplating the accession to the Customs Union. The inflationary spillover effect of the exchange rate depreciation in the form of imported inflation,

[3] Екатерина Быркова, «Статистика внешней торговли России в 2013 году: цифры и ключевые показатели, июль 2014. Доступ от 8 декабря 2014 года.http://провэд.рф/analytics/research/10888-statistika-vneshney-topgovli-possii-v-2013-godu-tsifpy-i-klyuchevye-pokazateli.html.
[4] Алексей Михайлов, «Нацбанк Казахстана снизил курс тенге к доллару», 12 декабря 2014. Доступ от 14 декабря, 2014.
http://slon.ru/economics/devalvatsiya_v_kazakhstane_i_devalvatsiya_v_rossii-1055387.xhtml.

conditioned by the tightened integration of the economies within the Customs Union, could have a discouraging effect on the countries planning on acceding to the Customs Union.

The structure of the work is as follows: Chapter 1 gives a brief overview of the exchange rate policy as part of a broader monetary policy conducted by the Central Bank. Chapter 2 includes the overview of the relevant literature developed so far on the topic of exchange rate pass-through, while Chapter 3 includes the empirical analysis on the degree of exchange rate pass-through in Kazakhstan and its evolution before and after the accession to Customs Union.

CHAPTER 1. OVERVIEW OF MONETARY AND EXCHANGE RATE POLICY IN KAZAKHSTAN

Since the independence, Kazakhstan followed the model of managed exchange rate regime and monetary policy that was aimed at containment of inflation. After the period of high inflation during 1990's (in 1994 the inflation rate was as much as 60.3%), the Kazakh authorities managed to tackle it and achieve steady economic growth, which made up 7.5% on average after the recent Global Financial Crisis in 2008 (for inflation dynamic see Appendix A, Figure 1).

Although, the official goal of National bank of Kazakhstan (NBK) is maintaining price stability within the economy, de facto it is the exchange rate management rather than money supply that is used as a tool for achieving price stability on the one hand, and improving terms of trade on the other . Hence, the interventions of NBK on foreign exchange rate for the purpose of stabilizing the USD/tenge exchange rate are not infrequent. Managed exchange rate regime implies the buildup of foreign currency reserves when tenge appreciates and sell off when tenge depreciates. The reason for this acute need for exchange rate stability vis-a-vis US dollar is the high degree of dollarization that prevails in Kazakh economy. However, this primacy of exchange rate management only presents additional challenge for prudent monetary policy, as the regulator is forced to choose between exchange rate stability and financial stability. The issue has become all the more prominent after the devaluation of tenge in February 2014, which was followed by spike in inflation (for the inflation dynamics in Kazakhstan see Appendix A, Figure 7). Since then, the exchange rate has been used as one of the primary tools of monetary policy by the means of sale or purchase of tenge through the open market operations.[5]

However, notwithstanding the managed exchange rate regime, there is no exchange rate targeting and no rigid exchange rate pegs. Unlike China, whose policy of exchange rate targeting is aimed at favoring export-oriented industries, Kazakh authorities normally intervene on the foreign exchange market not for the purpose of

[5] Natan Epstein, Rafael Portillo, "Monetary Policy in Hybrid Regimes: the Case of Kazakhstan", *IMF Working Paper*, WP/14/108, (June 2014): 14, accessed 25 December, 2014, http://www.imf.org/external/pubs/ft/wp/2014/wp14108.pdf

achieving specific rigid exchange rate level, but rather to cushion the excessive exchange rate fluctuations.

Kazakhstan, being a small open economy, is rather sensitive to external shocks, which have already twice forced the National Bank to devalue the national currency. In early 2009, tenge was devalued due to the sharp drop in oil prices (one of the major export commodities) by 20% relative to US dollar (150 tenge per one dollar). NBK managed to keep exchange rate stable up to September 2013, when Kazakh authorities decided to adopt a multi-currency basket (with US dollar accounting for 70%, euro – 20%, and ruble – 10%).[6] Although, this move was supposed to safeguard from excessive exchange rate volatility, tenge was devalued again in February 2014 by 18% to the level of 185 tenge per one dollar. Moreover, a rigid corridor of 1.5% has been established (see Appendix A, Figure 8).

Despite the expressed commitment by the National Bank to make transition to greater exchange rate flexibility and, eventually, toward fully floating exchange rate regime, this goal is hardly achievable in the short-term. Due to the exposure to external shocks from exported commodity price fluctuations and general inability hitherto to diversify economy away from oil revenues, the regulator has little option but to follow the crawling peg exchange rate regime.

[6] Ibid, 17

LITTERATURE REVIEW

Theoretical Literature

The phenomenon of exchange rate pass-through has been thoroughly examined within the paradigm of the "new open economy macroeconomics", which is attributed to the subclass of optimizing dynamic stochastic general equilibrium models conditioned by nominal rigidities and imperfect competition in open economies.

Although, the recent empirical research deals with macroeconomic issues, the theoretical background of the exchange rate pass-through goes back to micro-based research on market structure, price setting mechanisms, and the nature of competition. According to Dornbusch (1987), the main factors influencing the degree of the exchange rate pass-through into import prices are: market structure, the extent of market integration, product differentiation, and the interaction between the suppliers of a product. If, for instance, a market is highly integrated, then the so-called law of one price should be in effect, which means that if prices are denominated in a common currency, the same products must cost the same regardless of where they are sold. On the contrary, if markets are not integrated, but rather segmented, companies in different markets could set different prices. In this regard, the elasticity of demand for a good sold in different markets will be crucial to the determination of the exchange rate pass-through. By this token, with the assumption that the elasticity of demand is constant, the import prices in the destination currency will change proportionally to the changes in the exchange rate, i.e. the exchange rate pass-through will be complete. However, if the elasticity of demand is increasing, there will be incomplete pass-through to import prices, which Krugman (1987) introduced as "pricing-to-market".

Another important factor is the choice of the currency in which the price of a good is denominated. If it is the exporter who determines the price, then the incomplete pass-through in the exchange rate into import prices is the result of price discrimination, as well as the "pricing-to-market". If the importer sets the price, then incomplete pass-through comes from both price discrimination and expectations effects. If the prices are determined by the exporter country, referred to as producer currency pricing (PCP), the import prices denominated in the domestic currency should react correspondingly to the nominal exchange rate shock, in which case the exchange rate pass-through would be complete and prompt. However, with the assumption that the markets of the trading countries are not integrated and the law of one price does not hold, the exchange rate pass-through would be incomplete as there would be some price stickiness for a certain period of time (local currency pricing). This would be the case if the local prices were set ahead and become basically prearranged. The works of Chari et al. (2002), Monacelli (2005), and Bergin (2006) suggest that price-setting behavior in many models takes into account the expected future values of the factors affecting the price including exchange rates partially explaining the temporary price rigidity. According to Faruquee (2006), small open economies tend to set prices in foreign currencies (going for local currency pricing in their exports and producer currency pricing in their imports), while larger economies, like that of the United States and the Eurozone tend to price in domestic currencies (local currency pricing in their imports and producer currency pricing in their exports). Thus, the privilege of pricing the exports as well as imports in their domestic currencies in the large economies translates into lower pass-through effects from the exchange rate changes, while the opposite is true for small open economies that mostly engage in foreign currency pricing of traded goods.

As for the choice of the currency in which the price of a good is denominated, Bachetta and Wincoop (2005) enumerate such factors as the share of the market that a company exporting its products to another market can control, as well as the extent to which the goods of local and foreign production could be substituted. Moreover, they suggest that the exchange rate pass-through tend to be lower in the markets with steady inflationary conditions as the exporters hope to preserve stable import prices.

The exchange rate could have a direct impact on the domestic prices via the imported intermediate goods that are required in the production process as it is the imported prices that determine the marginal costs of the final goods. It is all the more important for a small open economy that imports a significant part of finished goods from abroad as Kazakhstan. According to Wolden Bache (2007), the degree of the pass-through into consumer prices depends on the degree of openness of the economy and the bias of consumption in favor of domestically produced goods. In the case of Kazakhstan, the open economy and the strong bias in favor of foreign production of technologically advanced goods both in final consumption and within the production process of undiversified economy indicate that the pass-through could be expected to turn out higher than in industrially self-sufficient advanced economies.

Empirical Literature

In the academic literature relating to exchange rate pass-throughs to domestic prices, the degree of pass-through itself is usually examined for its consequence to macro-economic policy debate in developed countries. The body of literature on the topic to date has exhibited mixed results about the response of inflation indices to exchange rate depreciation/appreciation of national currencies. Exchange rate pass-through has received much attention starting from 1980's when first strong appreciation and then abrupt depreciation of the dollar influenced the import prices in the US. The literature following this process focused on the link between the exchange rate pass-through and some particular industry characteristics.

Although, statistical connection between exchange rates and the increase in price level was showed in the works of Boyd (1989), Passell (1989), there are also many studies that question their causal relationship. For example, Hooper and Lowrey (1979), Hafer (1989) claim that as soon as the effect of domestic money supply growth is taken into account, exchange rate differentials provide no explanatory power for the increase in domestic price levels. By the same token, Woo (1984) suggests that after adjusting for the increased energy prices a 10% depreciation of the US dollar results only in 0.02% increase in the price level. However, this study was conducted with the use of single-equation approach, while the use of a time series model by Whitt, Koch, Rosensweig (1986) find the causal link between exchange rate and inflation.

Structural models also show mixed results with the difference lying in the degree of the pass-through of dollar exchange rate to domestic prices. For instance, Sachs (1985) finds that 10% depreciation of one-dollar results in only 1.66% permanent rise in inflation, while Kahn (1987) that 10% dollar depreciation will have long run effect of 4% increase in price levels.

The early research, like Marston (1990) and Knetter (1993), motivated by micro-based theoretical literature focused on the phenomenon of "pricing –to-market". The results of these studies based on the industry-level data showed that the exporters adjust the prices of their goods according to the changes in the exchange rates for the purpose of stabilizing the import prices of the destination country. And the exchange rate pass-through largely depends on the markets structure and varies across industries. For instance, Goldberg and Knetter (1997) found that the pass-through in the manufacturing industry is estimated to be 0.5 within the span of one year. Another finding is the gradual nature of the pass-through with price elasticity being lower in the short-run and higher in the long-run. The recent study of Campa and Goldberg (2005) corroborate these findings and add the empirical findings for 23 countries of the Organization for Economic Co-operation and Development (OECD) over the period of 1975-2003 showing that the exchange rate pass-through is 0.47 in the short term and 0.65 in the long term.

While many early researchers concentrated on the changes in the import and export prices, more recent works also pay attention to the pass-through effect into the consumer prices mostly expressed in the form of Consumer Price Index (CPI). However, most of the studies show that the pass-through effect is quite small. By far the most comprehensive research in this area has been conducted by Choudri and Hakura (2006), who calculated the pass-through to CPI for 70 countries of different exchange rate regimes for the period of more than 20 years (1978-2000) and found that the average pass-through to consumer prices was 0.04. However, their study supported the argument that the pass-through effect has the property of intensifying over the time as the pass-through increased to 0.15 after one year and further to 0.17 after five years. Another research conducted by Gagnon and Ihrig (2004) studied the pass-through effect in rich industrial countries in 1970-2003. They found the relationship between low exchange rate pass-through to CPI and low rates of inflation.

The issue of the decreasing pass-through in a number of countries since the 1980's has become another point of debate in empirical literature. Gagnon and Ihrig (2004) argue that the pass-through to CPI has been persistently declining throughout the 1990's. Similarly, Campa and Goldberg (2005) suggest that the pass-through into import prices in the 23 OECD countries declined in 1975-2003 due to the change in the composition of the imported manufacturing goods, while Marazzi et al. (2005) explain the decrease in the pass-through into import prices in the United States by the increasing share of imports from China and other Asian economies, which, in their turn, started pricing the exported goods in the US dollars in the turbulent post-Asian financial crisis years.

On the other hand, a number of early studies conducted in 1990's, including Lafleche (1997) and Webber (1995), suggest that the decline in pass-through could be attributed to a lower share of imported goods in the consumer basket and lower share of imported inputs used in the domestic production process. But this is the period when the effect of nominal exchange rate on inflation was examined predominantly in developed countries where the buildup of industrial capacity was faster and it is only logical that imported goods would be substituted there eventually, while no such thing is observed in a number of developing countries, which could also be referred to Kazakhstan.

As for the methodology, there is a large body of literature on the analysis of exchange rate pass-through effects into domestic price indices conducted with the application of single-equation regression models. For instance, Feenstra (1989), Olivei (2002), Campa and Goldberg (2005). However, single-equation regression models do not take into account the reverse causality problem as not only the exchange rate may affect inflation but inflation could also influence exchange rates. Hence, for the purpose of assessing the reciprocal effect of exchange rate and inflation a vector autoregression analysis (VAR) is preferable. The pass-through is perceived as an impulse response of domestic prices to a particular exogenous shock in the exchange rate. McCarthy (2000), Hahn (2003), Choudhri et al. (2005), and Faruquee (2006) used VARs to arrive at the following empirical evidence: the degree of the pass-through varies with the highest pass-through being to the prices of imported goods, lower pass-throughs to producer prices, and, finally, the lowest pass-through to consumer prices. However, their analysis is limited to developed countries and only in non-crisis periods.

The studies on the pass-through in developing countries proliferated after the currency crisis in Asia in 1997. For instance, Baig and Goldfajn (1999) used vector autoregression analysis to find statistically significant effect of the exchange rate pass-through on import prices. However, the variables considered within the model were limited to exchange rates and stock prices only. Hence, the study could not be considered as conclusive on the inflation. On the other hand, Takatoshi and Kiyotaka (2008) examined the effect of exchange rate on several price indices (including consumer price index and import prices) and found that the pass-through to CPI was low in all crisis-hit countries (except for Indonesia) while the pass-through to import prices was large and statistically significant.

Although, numerous studies have been conducted on exchange rate pass-through into domestic prices, most of them were done with regard to developed countries and none was done for the economies in transition. The present study will focus not only on the pass-through effects to general domestic price level, but will also disaggregate the effect into import prices, producer prices, and CPI. The novelty of this work will consist in the analysis of the macroeconomic exchange rate fluctuation implications that will stem not from shock-induced internal economic instability but as a result of a spillover effect from a deprecating currency of a trading partner. Special attention will be paid to any changes in pass-through thresholds prior to the falling value of the Russian ruble and after it.

CHAPTER 3: EMPIRICAL ANALYSIS

Methodology

Vector autoregression (VAR) was used in order to estimate the exchange rate pass-through into aggregate prices in Kazakhstan through the examination of the time-series behavior of the nominal bilateral exchange rate and a system of price indices. The VAR approach will allow studying the time-series behavior of the exchange rate between Kazakhstani tenge and US dollar (principle foreign currency) on the one hand and the system of domestic prices on the other. This method of estimation was chosen because it takes into consideration the problem of endogeneity that could arise from factoring the exchange rate into the model.[7] Moreover, the VAR method allows disaggregating the pass-through effect into several price indices (import, export, and consumer prices). The previous empirical studies using single equation approach have generally concentrated on the pass-through effect on single price index (usually import price index, as it shows the highest pass-through). On the other hand, the vector autoregression method allows differentiating relative pass-throughs on different stages of the pricing chain and allows the comparison of the pass-through effects in the so-called upstream and downstream prices. Moreover, the VAR methodology can help analyze the structural shocks that have an impact on the system.[8] The impulse-response functions (IRFs) will be estimated in order to identify and account for the impact that exchange rate change has on the set of domestic prices.

Firstly, structural shocks will be studies in order to examine the degree of exchange rate pass-through to domestic prices, which, in their turn, will be disaggregated into import, export, consumer and producer prices. Each price index will be included in the VAR model in turn and the results will be compared so as to identify the strongest effect along the pricing chain. It is expected that the highest pass-through into prices will be for import prices, and less for producer prices, export, and consumer prices respectively. This expectation could be attributed to the fact that the non-tradable

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[7] James H.Stock, Mark M.Watson, *Introduction to Econometrics*, (Pearson Education Limited, 2012), 512.

[8] Anthony Garatt, Kevin Lee, Hashem Pesaran, “A Structural Cointegrating VAR Approach to Macroeconometric Modelling”, *NIESR*, (1998), p. 6, accessed 14 December, 2014, http://www.econ.ed.ac.uk/papers/ni98.pdf

element in the form of distribution costs, rent, etc. constitute larger part in down the pricing chain (especially CPI), rather than in import prices.[9]

Secondly, in order to check the VAR model for robustness, a VAR model with the same variables but different ordering will be used. Furthermore, the analysis of the pass-through will be done for the period prior to the accession of Kazakhstan to the Customs Union and after it for the purpose of accounting for possible exchange rate pass-through changes.

Model

The Kazakh economy is considered to be a small open economy. The main source of external funding and foreign currency earnings come from the exports of natural resources. As the international price on global commodities like oil is subject to occasional sharp fluctuations, the economy of Kazakhstan is exposed to such external shocks, which translates into fluctuations in balance of payments. In order to identify the shocks of the change in exchange rate into the set of domestic prices, a vector autoregression analysis is conducted. VAR was initially suggested by Sims as a method that could be utilized in macroeconomics calculations in order to describe the dynamic behavior of several variables but in the absence of rigid restrictions that are required to intercept structural parameters.[10] Since 1980's the VAR method has become one of the most widely used models in time-series estimation.

The VAR system is a collection of linear regressions in which the joint time-series behavior of the Kazakhstani exchange rate relative to the US dollar and the set of price indices is examined. The *K* variables (5 variables in our case) are specified as linear functions of *p* of their own lags, as well as the *p* lags of the other *K-1* variables in the system, and, if present, exogenous variables that could affect the model. The general form of the VAR model looks the following way:[11]

$$Y_t = q + A_1Y_{t-1} + \dots + A_pY_{t-p} + B_0Z_t + B_1Z_{t-1} + \dots + B_sZ_{t-s} + u_t\,,$$

[9] Hamid Faruquee, "Exchange Rate Pass-Through in the Euro Area", *IMF Staff Papers*, 53 (2006), p. 63, accessed 13 February, 2015, https://www.imf.org/External/Pubs/FT/staffp/2006/01/pdf/faruqee.pdf

[10] Christopher A. Sims, "Macroeconomics and Reality", *Econometrica* 48, #1 (1980): 1-48, accessed 13 January, 2015, http://www.ekonometria.wne.uw.edu.pl/uploads/Main/macroeconomics_and_reality.pdf

[11] James H.Stock, Mark M.Watson. *Introduction to Econometrics*, (Pearson Education Limited, 2012), 553.

Where:

Y_t is a random vector of the dimension of K x 1;

$A_1 \dots A_p$ are matrices of parameters (dimension K x K);

Z_t is a vector of some exogenous variables (dimension M x 1);

$B_0 \dots B_s$ are matrices of coefficients (of dimension K x M);

q is vector of parameters (of K x 1 dimension);

u_t is a the so-called white noise with the assumption that:

$E(u_t) = 0$,

$E(u_t u_t') = \sum$,

$E(u_t u_s') = 0$ for $t \neq s$

With the 5 variable system that we have, the VAR(p) model will look the following way:

(1.1) $\Delta OIL_t = \sum_{i=1}^{k} \beta^{i}_{11}\ \Delta OIL_{t-i} + \sum_{i=1}^{k} \beta^{i}_{12}\ \Delta gap_{t-i} + \sum_{i=1}^{k} \beta^{i}_{13}\ \Delta M1_{t-i} + \sum_{i=1}^{k} \beta^{i}_{14}\ \Delta E_{t-i} + \sum_{i=1}^{k} \beta^{i}_{15}\ \Delta CPI_{t-i} + \varepsilon_{1t}$

(1.2) $\Delta gap_t = \sum_{i=1}^{k} \beta^{i}_{21}\ \Delta OIL_{t-i} + \sum_{i=1}^{k} \beta^{i}_{22}\ \Delta gap_{t-i} + \sum_{i=1}^{k} \beta^{i}_{23}\ \Delta M1_{t-i} + \sum_{i=1}^{k} \beta^{i}_{24}\ \Delta E_{t-i} + \sum_{i=1}^{k} \beta^{i}_{25}\ \Delta CPI_{t-i} + \varepsilon_{2t}$

(1.3) $\Delta M1_t = \sum_{i=1}^{k} \beta^{i}_{31}\ \Delta OIL_{t-i} + \sum_{i=1}^{k} \beta^{i}_{32}\ \Delta gap_{t-i} + \sum_{i=1}^{k} \beta^{i}_{33}\ \Delta M1_{t-i} + \sum_{i=1}^{k} \beta^{i}_{34}\ \Delta E_{t-i} + \sum_{i=1}^{k} \beta^{i}_{35}\ \Delta CPI_{t-i} + \varepsilon_{3t}$

(1.4) $\Delta E_t = \sum_{i=1}^{k} \beta^{i}_{41}\ \Delta OIL_{t-i} + \sum_{i=1}^{k} \beta^{i}_{4\Delta 2}\ \Delta gap_{t-i} + \sum_{i=1}^{k} \beta^{i}_{43}\ \Delta M1_{t-i} + \sum_{i=1}^{k} \beta^{i}_{44}\ \Delta E_{t-i} + \sum_{i=1}^{k} \beta^{i}_{45}\ \Delta CPI_{t-i} + \varepsilon_{4t}$

(1.5) $\Delta CPI_t = \sum_{i=1}^{k} \beta^{i}_{51}\ \Delta OIL_{t-i} + \sum_{i=1}^{k} \beta^{i}_{52}\ \Delta gap_{t-i} + \sum_{i=1}^{k} \beta^{i}_{53}\ \Delta M1_{t-i} + \sum_{i=1}^{k} \beta^{i}_{54}\ \Delta E_{t-i} + \sum_{i=1}^{k} \beta^{i}_{55}\ \Delta CPI_{t-i} + \varepsilon_{5t}$

Where:

β^{i}_{nm} is the coefficient to be calculated;

k is the maximum distributed lag length;

Δ is the difference operator (the first difference of the variables, except for the output gap is taken in order to account for the stationarity);

OIL_t – denotes the natural log of oil prices;

gap_t – output gap;

$M1_t$ – natural log of money supply (base money) as a monetary policy variable;

E_t – nominal exchange rate;

ΔCPI_t – natural log of consumer price index;

ε_{nt} are the error terms (that are independent and identically distributed);

In the regressions for other price measures, the equation (1.5) will be replaced by another with the corresponding measure of producer price index, import price index, or export price index (the corresponding variables will also replace ΔCPI_{t-i} in previous equations).

This vector autoregression system can be perceived as the reduced form of a system that consists of dynamic simultaneous equations. The reduced-form VAR (*p*) is of the following form[12]:

$X_t = c + A (L) Y_{t-1} + \mu_t$,

$E [\mu_t \mu_t'] = \Omega$

The baseline VAR model consists of the vector of five variables:

$X_t = (\Delta oil_t, \Delta M1_t, gap_t, \Delta E_t, \Delta P_t)'$

c – vector of monthly time dummies;

A – matrix polynomial of degree *p* in the lag operator L;

μ - vector of reduced-form residuals (of the 5x1 dimension) with variance-covariance matrix Ω;

P_t further disaggregates into IMP_t (import prices), EXP_t (export prices), PPI_t (producer prices), CPI_t (consumer prices).

[12] Ibid, 556.

The choice of variables to be used in the model is based on previous studies in which vector autoregression analysis was employed, like McCarthy (2000) and Hahn (2003), although these studies use seven or eight variables in their models where consumer price index, producer price index, and import price index are included jointly. For the purpose of disaggregating the effect of exchange rate pass-through to import prices, input materials prices, and inflation, each of the variables will be included in the model separately with estimated results compared. Money supply is included in order to analyze the impact of monetary policy on inflation. Previous studies, such as Gagnon and Ihrig (2004) look at the correlation between monetary policy and exchange rate pass through to consumer price index. Oil prices will also be included in line with prior studies allowing to identify supply shocks by oil price changes (the sharp oil price fall in 2009 and recent plunge since July 2014 is of special interest). The effect from he demand side will be accounted by the output gap, which is defined as the difference between the actual GDP and the potential level of output that economy could achieve. In the model the output gap is set up by using the Hodrick-Prescott (HP) filter to the industrial production index (the cyclical elements generated by HP filter serve as a proxy of output gap).[13]

The order of the variables within the model is of particular importance in order to define the structural shocks. The higher in the order is the variable, the stronger the effect it is presumed to have on other variables, while experiencing the influence on itself from the variables further down the order only with a lag.[14] The natural log of oil is placed first because the reduced-form residuals of oil prices are more likely to have an impact on all the other variables in the model, while the oil prices themselves are determined outside of the model (Kazakhstan accounting only for a slight fraction of global oil supply hardly has any influence on the global oil prices). The output gap comes second as it is affected mostly by oil price changes, but its shock could have an impact on other variables. The base money M1 variable is placed after the output gap, followed by the exchange rate and, finally, the price index (either IMP, PPI, EXP, or CPI).

[13] This method of calculating output gap and using industrial production index as a proxy is taken from Hahn (2003)

[14] James H.Stock, Mark W. Watson, "Vector Autoregressions", *University of Washington website*, (2001), p. 12, accessed 15 February, 2015, http://faculty.washington.edu/ezivot/econ584/stck_watson_var.pdf

Traditionally in the empirical literature, the price variable is ordered the last in the model in order to reflect the fact that domestic prices are affected by other variables in the model. On the other hand, there exists some variation in the ordering of the monetary variable. For instance, Hahn (2003) places the base money variable before CPI and exchange rate variable making an assumption that monetary policy responds to expected inflation. Conversely, McCarthy (2000) puts base money variable after the exchange rate in the model. Kim and Ying (2007) in their work on the macroeconomic impact of exchange rate also place base money variable before the exchange rate assuming that exchange rate responds rather quickly to the shocks in monetary policy.

Data Description

Additional control variables have been included for the purpose of solving for any possible bias in the estimation of the causal relationship between exchange rate and inflation. The monthly series of oil prices were taken from the IMF International Financial Statistics and represent an average of the three spot prices of West Texas Intermediate (WTI), UK Brent, and Dubai. Oil prices are included in the model due to the inflationary effect that they have. Oil prices represent an important cost component in the production, transportation, and the services sector. They could also affect general inflation levels indirectly when persistent rise in oil prices leads to expectations of an increase in CPI and, as a consequence, will lead to the demands for higher wages by workers as a compensation for increased cost of living. Historically, oil prices had inflationary effect on the economies, as oil prices tended to persistently increase over time (except for the period of the oil glut of 1980's). However, since June 2014, the global oil prices have plunged precipitously, which immediately translated into deflation in Europe and Japan on the one hand, and increasing inflation rates in oil exporting countries on the other. This difference in price behavior came from the fact that oil exporters (including Kazakhstan and Russia) suffered domestic currency depreciation. Inter-temporal models suggest that the prices of non-traded goods in the economy were pushed down by the negative shock in the terms of trade. The stickiness of the prices of non-traded goods propel nominal exchange rates to follow the adjustment of the nominal exchange rates. Hence, the oil prices also indirectly affect inflation in oil exporting countries through exchange rate making foreign goods more expensive if national currency depreciates, for instance.[15]

Another control variable is the so-called output gap, which serves as a measure of the difference between the actual GDP and the potential GDP that economy could achieve. A positive output gap indicates that an increase in aggregate demand is outpacing the growth in aggregate supply creating inflation. If the output gap is a negative number, it is called recessionary gap, as it indicates deflation.[16] The GDP gap is constructed by applying the Hodrick-Prescott filter to the industrial production index which serves as a proxy measure of the output gap. HP filter is used in order to remove the trend in the seasonally adjusted index.

The model also controls for money supply represented here by the narrow money M1 measure. According to the Quantity Theory of Money, if the money supply grows at a faster pace that the real output, then the excessive monetary stock will result in inflation.[17] The empirical literature on exchange rate pass-throughs regards the M1 measure as the most appropriate to account for the inflationary effects. It implicates physical currency (including coins) and other money equivalents of high liquidity that could be easily convertible into cash like demand deposits, travelers checks, and checkable deposits.

Nominal exchange rate is represented by the monthly average bilateral nominal exchange rate of Kazakhstani tenge relative to the US dollar. The empirical literature often uses a nominal effective exchange rate, which is an exchange rate index relative to the basket of other currencies. However, in this paper a nominal bilateral exchange rate is used due to the fact that most of the exports and imports is priced in US dollars and the American currency constitutes 70% of the multi-currency basket since September 2013 (while being even more prior to that). The direct quotation is used (the amount of domestic currency per one US dollar), which means that an increase in the exchange rate indicates the depreciation of the national currency, while a decrease

[15] Paul Krugman, "Oil Shocks and Exchange Rate Dynamics", *National Bureau of Economic Research*, (1983), p. 275, accessed 18 February, 2015, http://www.nber.org/chapters/c11382.pdf

[16] Cecile Denis, Daniel Grenouilleau, "Calculating Potential Growth Rates and Output Gaps", *European Economy Economic Papers*, #247 (2006), accessed 14 March, 2015, http://ec.europa.eu/economy_finance/publications/publication746_en.pdf

[17] Gregory Mankiw, "*Macroeconomics*", (Worth Publishers, edition 7, 2010), p. 314.

in the exchange rate attests to the strengthening of tenge.

Domestic prices are disaggregated into the set of monthly series of:

- Import prices, which are based on the Import Price Index (IMP). IMP measures average price changes in goods and services that are imported from abroad. In our model the IMP takes the value of 100 in the year 2000 and inflation is measured from this benchmark (for all other indices the benchmark year is also 2000).A rise in the index indicates an increase in the price level relative to the base year.
- Export prices (based on the Export Price Index). The empirical literature uses export price index as a variable not only to measure the effect that a change in exchange rate could have on export prices, but also to measure the extent to which imported input materials add value to the final cost of the product that a country exports. In our case the exchange rate pass-through into export prices is expected to be rather small due to the fact that the primary export items are crude oil, petroleum gas, refined copper, and other natural resources. Unlike the production of technologically advanced goods, the extraction of natural resources requires less added costs from imported input materials.
- Producer prices (based on the Producer Price Index). PPI is a weighted index of prices in the manufacturing and all other industries involved in the physical production of goods measured at the wholesale or producer level (also called Wholesale Price index). In our model the core PPI index is used, meaning that energy component is excluded due to the high volatility. The empirical literature considers PPI in the light of its predictive value for CPI, as it is understood that the increased costs of producers will eventually pass to consumers in the form of rising prices on finished goods. In Kazakhstan, it is expected that IMP would have more predictive value, as most manufactured goods are imported from abroad rather than produced domestically.
- Consumer prices (based on Consumer Price Index). CPI is a measure for price changes of the consumer basket that accounts for the goods and services that the households purchase. The index is considered to be the most precise measure of the inflation rate.

The processed monthly data was taken for the period of January 1994- January 2015.

All series are expressed in logarithms except for the output gap. The price indices are defined so that an increase in index translates into the monthly increase of corresponding prices. The data of the price variables was taken from the official site of the Ministry of National Economy of the Republic of Kazakhstan, the Committee on Statistics. The series on the base money M1 and the nominal exchange rate was taken from the online archives of the National Bank of Kazakhstan. In order to remove the seasonal components of the time-series data, the seasonal adjustment was performed with the help of the Census X-12 method on the Arima X-12 software.

Empirical Estimations

This section analyses the exchange rate pass-through into domestic prices in three different models of the five variable VAR. The first model includes the import price index as a price measure, the second includes producer price index, and the third – consumer price index. Due to the failure to prove that the exchange rate Granger causes export prices, the latter will not be used for VAR estimations. The impulse-response functions (IRFs) will show the cumulative response of domestic prices to the change in the exchange rate defined as a shock to the VAR system.

Unit root tests

Prior to the calculation of the exchange rate pass-through, some tests of the data were conducted. Unit root test was used in order to identify if the data was stationary. The null hypothesis is that the data contains unit root against the alternative that it does not. The Dickey-Fuller test with GLS de-trending (DFGLS) suggested by Elliot, Rothenberg, and Stock (1996) and the Phillips-Perron (PP) test showed that most of the data (except for output gap) was non-stationary in levels. The number of lags in DFGLS was determined by the Schwert criterion to be 15, while in the PP test the number of lags was 4. The unit root in level for output gap is rejected in both Dickey-Fuller and Phillips-Perron tests but for the rest of the variables it was necessary to obtain the first differences in order to arrive at stationarity. Some of the variables showed conflicting results in DFGLS and PP tests being stationary for one test and nonstationary for the other. Thus, when combining the outcomes of the tests only the output gap was considered to be stationary in level, while the rest was treated as stationary only in first differences, i.e. they are integrated –of-order-one [I(1) series].

Table 1. The Unit Root Tests

Variables	Dicey-Fuller with GLS de-trending	Phillips -Perron
CPI	-2.26	-1.63
Δ CPI	-8.85**	-9.03**
IMP	-2.51	-0.68
Δ IMP	-4.02**	-4.67**
EXP	-1.04	-0.47
Δ EXP	-4.86***	-2.61**
PPI	-1.87	-0.89
Δ PPI	-7.94**	-8.66**
gap	-6.38	-18.1
M1	-0.91	2.75
Δ M1	-2.53**	-6.9**
oil	-2.06	0.47
Δ oil	-8.36**	-12.06***
E	-1.08	1.43
Δ E	-2.11**	-7.54**

Note: The Null hypothesis of the DGFGLS and PP tests is that the variable is nonstationary. *, **, *** denote the significance level at 10%, 5%, 1% respectively. When testing in level both the time trend and a constant are included, while when testing in first differences, only a constant is included.

Co-integration tests

The variables that are individually non-stationary could be co-integrated, which means that two or more variables could have common underlying stochastic trends and they could move together along non-stationary path. If the variables are co-integrated, then a vector error correction model should be used instead of vector autoregression because the VEC model includes the error correction term which measures the deviation from the long-term equilibrium in the previous period.[18]

The most widely used method of estimating co-integrating relationships within VAR/VECM framework is the Johasen test (1995). The null hypothesis is that r = 0, while the alternative is that r = 1 (meaning at least one co-integrating relationship). The failure to reject the null hypothesis will signify that there is no co-integrating relationship between the variables and the VAR model can be used.

From Table 2 it is evident that the variables in the model where the price measure is expressed by the Import Price Index are not co-integrated (trace statistic is less than the 5% critical value at the rank equaling zero). The same could be deduced from Table 3 and Table 4, which report the results for co-integration tests for five variable models with PPI and CPI serving as a price measure. The number of lags for all tests is 15. Hence, the estimation of the model could be made within the VAR framework.

Table 2. Co-integration Test for Model 1 (ΔOIL_t, gap_t, $\Delta M1_t$, Δ E_t, Δ IMP_t).[19]

Johansen tests for cointegration

Trend: constant — Number of obs = 239

Sample: 1995m4 - 2015m2 — Lags = 15

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	355	872.94245	.	65.5916*	68.52
1	364	888.49268	0.12202	34.4911	47.21
2	371	895.24315	0.05492	20.9902	29.68
3	376	900.96108	0.04672	9.5543	15.41
4	379	905.12801	0.03427	1.2205	3.76
5	380	905.73825	0.00509		

[18] Michael Hauser, "Vector Error Correction Model, Cointegrated VAR", *Institute for Statistics and athematics Website*, WS 14/15, p. 18, accessed 16 January, 2015, http://statmath.wu.ac.at/~hauser/LVs/FinEtricsQF/FEtrics_Chp4.pdf

[19] Results generated on the STATA 12 software

Table 3. Co-integration test for Model 2 (ΔOIL_t, gap_t, $\Delta M1_t$, ΔE_t, ΔPPI_t).

Johansen tests for cointegration

Trend: constant Number of obs = 239

Sample: 1995m4 - 2015m2 Lags = 15

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	355	985.48939	.	65.2290*	68.52
1	364	998.52898	0.10338	39.1499	47.21
2	371	1008.3092	0.07858	19.5893	29.68
3	376	1014.6367	0.05157	6.9344	15.41
4	379	1018.0729	0.02834	0.0621	3.76
5	380	1018.1039	0.00026		

Table 4. Co-integration test for Model 3 (ΔOIL_t, gap_t, $\Delta M1_t$, ΔE_t, ΔCPI_t).

Johansen tests for cointegration

Trend: constant Number of obs = 239

Sample: 1995m4 - 2015m2 Lags = 15

maximum rank	parms	LL	eigenvalue	trace statistic	5% critical value
0	355	1026.9812	.	65.6180*	68.52
1	364	1038.5534	0.09230	42.4736	47.21
2	371	1048.6795	0.08125	22.2215	29.68
3	376	1054.4455	0.04711	10.6894	15.41
4	379	1059.7899	0.04374	0.0006	3.76
5	380	1059.7902	0.00000		

Granger causality tests

Due to the fact that theoretical literature suggests that there might exist the problem of reverse causality between exchange rate and inflation, a test to determine the causal relationship was conducted. The core idea of the Granger causality test suggested by Granger (1969) is that if the variable X causes the variable Y, then the changes in X should have a predictive value in the changes in Y. But while X should help predict Y, Y cannot predict X. In order to identify the causal relationship, the variable Y should be regressed on its own lagged values, as well as the lagged values of other variables in the model (X, Z, W, etc.) and test the null hypothesis that the coefficients on the lagged values of other variables is jointly zero. If the test fails to reject the null hypothesis, then a variable X does not Granger cause variable Y.[20]

As our model contains not only two variables but also control variables (although the primary purpose of the test is to see the causal relationship between the exchange rate and inflation), it will also allow to test the joint hypothesis that all of the five variables fail to Granger cause each variable in turn.

The reported Wald test in the Table 5 tests the null hypothesis that the exchange rate variable does not Granger cause change in prices. From the table below it is evident that the exchange rate Granger causes import prices (the probability is less than 5% significance level) while the import prices do not Granger cause the exchange rate. The same conclusion is driven for producer prices and consumer prices.

It is noteworthy that in the case of import prices, the money supply is also one of the factors that affect import price index (with probability of about 3%), which might be attributed to the inflationary effect through the exchange rate. For producer prices, additional factor beside exchange rate is the price of oil, while for consumer price index it is the money supply (which is in line with the theoretical explanation). As for the factors that determine exchange rate, there is only the oil price, which is also intuitively expected, as oil represents the main item of Kazakhstani export and

[20] Shuixia Guo, Christophe Ladroue, Jianfeng Feng, "Granger Causality: Theory and Applications, Fudan University Website, p. 82, accessed 18 January, 2015, http://ccsb.fudan.edu.cn/eWebEditor/uploadfile/20110316110832540.pdf

contributes a lot to the fluctuations in the exchange rate.

On the other hand, there seems to be little causal relationship between exchange rate and export prices. As seen in the Table 6, the null hypothesis of no Granger causality from exchange rate to the export prices cannot be rejected (probability being more that 10%).

Table 5. Granger causality test for Model 1

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
flnOIL	flnM1	3.7221	4	0.445
flnOIL	Outputgap	8.597	4	0.072
flnOIL	flnExch	3.7208	4	0.445
flnOIL	flnIMP	4.484	4	0.344
flnOIL	ALL	18.37	16	0.303
flnM1	flnOIL	7.3812	4	0.117
flnM1	Outputgap	2.1675	4	0.705
flnM1	flnExch	7.7566	4	0.101
flnM1	flnIMP	9.5667	4	0.048
flnM1	ALL	25.331	16	0.064
Outputgap	flnOIL	18.872	4	0.001
Outputgap	flnM1	4.0725	4	0.396
Outputgap	flnExch	6.8985	4	0.141
Outputgap	flnIMP	3.0999	4	0.541
Outputgap	ALL	26.891	16	0.043
flnExch	flnOIL	17.105	4	0.002
flnExch	flnM1	4.9651	4	0.291
flnExch	Outputgap	1.7043	4	0.790
flnExch	flnIMP	1.292	4	0.863
flnExch	ALL	27.571	16	0.036
flnIMP	flnOIL	4.4482	4	0.349
flnIMP	flnM1	10.625	4	0.031
flnIMP	Outputgap	7.937	4	0.094
flnIMP	flnExch	16.483	4	0.002
flnIMP	ALL	46.369	16	0.000

Table 6. Granger causality test for model with export prices

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
flnOIL	flnM1	15.595	12	0.210
flnOIL	gap	31.361	12	0.002
flnOIL	flnExch	9.9006	12	0.625
flnOIL	flnEXP	24.392	12	0.018
flnOIL	ALL	84.006	48	0.001
flnM1	flnOIL	23.495	12	0.024
flnM1	gap	15.557	12	0.212
flnM1	flnExch	44.457	12	0.000
flnM1	flnEXP	40.881	12	0.000
flnM1	ALL	125.76	48	0.000
gap	flnOIL	55.051	12	0.000
gap	flnM1	14.302	12	0.282
gap	flnExch	25.796	12	0.011
gap	flnEXP	11.783	12	0.463
gap	ALL	114.69	48	0.000
flnExch	flnOIL	30.042	12	0.003
flnExch	flnM1	21.066	12	0.049
flnExch	gap	7.6174	12	0.814
flnExch	flnEXP	10.536	12	0.569
flnExch	ALL	77.768	48	0.004
flnEXP	flnOIL	11.952	12	0.450
flnEXP	flnM1	4.9822	12	0.959
flnEXP	gap	5.3208	12	0.946
flnEXP	flnExch	18.517	12	0.101
flnEXP	ALL	39.646	48	0.799

Table 7. Granger causality test for Model 2

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
flnOIL	flnM1	5.2632	4	0.261
flnOIL	Outputgap	5.1989	4	0.267
flnOIL	flnExch	3.0554	4	0.549
flnOIL	flnPPI	9.9067	4	0.042
flnOIL	ALL	24.09	16	0.088
flnM1	flnOIL	7.4126	4	0.116
flnM1	Outputgap	1.9027	4	0.754
flnM1	flnExch	6.2257	4	0.183
flnM1	flnPPI	3.9725	4	0.410
flnM1	ALL	19.395	16	0.249
Outputgap	flnOIL	22.427	4	0.000
Outputgap	flnM1	3.5926	4	0.464
Outputgap	flnExch	8.852	4	0.065
Outputgap	flnPPI	10.201	4	0.037
Outputgap	ALL	34.662	16	0.004
flnExch	flnOIL	18.273	4	0.001
flnExch	flnM1	4.8275	4	0.305
flnExch	Outputgap	.93259	4	0.920
flnExch	flnPPI	5.0871	4	0.278
flnExch	ALL	31.765	16	0.011
flnPPI	flnOIL	117.63	4	0.000
flnPPI	flnM1	5.052	4	0.282
flnPPI	Outputgap	1.205	4	0.877
flnPPI	flnExch	44.036	4	0.000
flnPPI	ALL	183.23	16	0.000

Table 8. Granger causality test for Model 3

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
flnOIL	flnM1	2.9375	4	0.568
flnOIL	Outputgap	7.3997	4	0.116
flnOIL	flnExch	2.8384	4	0.585
flnOIL	flnCPI	.78378	4	0.941
flnOIL	ALL	14.467	16	0.564
flnM1	flnOIL	8.9847	4	0.061
flnM1	Outputgap	2.4339	4	0.657
flnM1	flnExch	8.5555	4	0.073
flnM1	flnCPI	27.692	4	0.000
flnM1	ALL	44.561	16	0.000
Outputgap	flnOIL	19.356	4	0.001
Outputgap	flnM1	4.217	4	0.377
Outputgap	flnExch	6.4033	4	0.171
Outputgap	flnCPI	2.4812	4	0.648
Outputgap	ALL	26.214	16	0.051
flnExch	flnOIL	17.49	4	0.002
flnExch	flnM1	5.3126	4	0.257
flnExch	Outputgap	1.568	4	0.815
flnExch	flnCPI	3.8877	4	0.421
flnExch	ALL	30.439	16	0.016
flnCPI	flnOIL	5.5193	4	0.238
flnCPI	flnM1	58.678	4	0.000
flnCPI	Outputgap	.19227	4	0.996
flnCPI	flnExch	76.724	4	0.000
flnCPI	ALL	138.5	16	0.000

Lag selection

It is widely accepted that the coefficients and the properties of the impulse response functions within the vector autoregression model could vary significantly depending on the lag order, which is why selecting the adequate lag length is a critical issue.

The lag order in the model is selected based on the Akaike information criterion (AIC). The Akaike information criterion estimates the divergence between the true model and the given model. As the difference between models should be minimized, the adequate lag length will be selected from the lowest values of FPE and AIC. The tables below show the results for the three models including different price indices. The length of lags for model 1 is 12, model 2 – 12, and model 3 – 13.

Table 9. Lag selection for model 1 with Import Price Index as a price measure

Selection-order criteria
Sample: 1995m6 - 2015m2 Number of obs = 237

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	2157.13				1.6e-13	-18.1362	-18.089*	-18.0191*
1	2178.76	43.258	16	0.000	1.5e-13	-18.1837	-18.0421	-17.8325
2	2193.53	29.528	16	0.021	1.5e-13	-18.1732	-17.9373	-17.5879
3	2219.17	51.285	16	0.000	1.4e-13	-18.2546	-17.9243	-17.4351
4	2229.44	20.532	16	0.197	1.5e-13	-18.2062	-17.7815	-17.1526
5	2234.52	10.168	16	0.858	1.6e-13	-18.1141	-17.5951	-16.8264
6	2248.72	28.39	16	0.028	1.6e-13	-18.0989	-17.4855	-16.577
7	2260.84	24.25	16	0.084	1.7e-13	-18.0662	-17.3584	-16.3102
8	2269.11	16.532	16	0.417	1.8e-13	-18.0009	-17.1988	-16.0108
9	2310.75	83.286	16	0.000	1.5e-13	-18.2173	-17.3208	-15.993
10	2334.91	48.322	16	0.000	1.4e-13	-18.2862	-17.2953	-15.8278
11	2360.62	51.429	16	0.000	1.3e-13	-18.3681	-17.2829	-15.6756
12	2397.3	73.354	16	0.000	1.1e-13*	-18.5426*	-17.363	-15.616
13	2412.99	31.37	16	0.012	1.1e-13	-18.54	-17.266	-15.3792
14	2424.84	23.707	16	0.096	1.1e-13	-18.505	-17.1366	-15.1101
15	2440.06	30.439*	16	0.016	1.1e-13	-18.4984	-17.0357	-14.8694
16	2451.36	22.602	16	0.125	1.2e-13	-18.4587	-16.9016	-14.5956

Endogenous: flnM1 gap flnExch flnIMP
Exogenous: flnOIL _cons

Note: * denotes the selected lag length by the criterion
LR – sequential modified LR test statistic
FPE – final prediction error
AIC – Akaike information criterion
HQIC – Hannan-Quinn information criterion
SCIC – Schwarz's Bayesian information criterion

Table 10. Lag selection for model 2 with Producer Price Index as a price measure

Selection-order criteria
Sample: 1995m5 - 2015m2 Number of obs = 238

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	2433.14				1.7e-14	-20.3793	-20.3323	-20.2626
1	2511.29	156.31	16	0.000	9.8e-15	-20.9016	-20.7605*	-20.5515*
2	2521.1	19.624	16	0.238	1.0e-14	-20.8496	-20.6144	-20.266
3	2546.14	50.069	16	0.000	9.6e-15	-20.9255	-20.5963	-20.1085
4	2556.18	20.075	16	0.217	1.0e-14	-20.8754	-20.4521	-19.825
5	2560.93	9.5008	16	0.891	1.1e-14	-20.7809	-20.2635	-19.497
6	2573.28	24.718	16	0.075	1.1e-14	-20.7503	-20.1388	-19.233
7	2589.04	31.515	16	0.012	1.2e-14	-20.7483	-20.0427	-18.9975
8	2604.55	31.01	16	0.013	1.2e-14	-20.7441	-19.9444	-18.7599
9	2631.82	54.545	16	0.000	1.1e-14	-20.8388	-19.9451	-18.6212
10	2653.06	42.471	16	0.000	1.0e-14	-20.8828	-19.895	-18.4318
11	2666.54	26.969	16	0.042	1.0e-14	-20.8617	-19.7798	-18.1772
12	2721.87	110.66	16	0.000	7.5e-15*	-21.1922*	-20.0162	-18.2743
13	2731.54	19.342	16	0.251	8.0e-15	-21.139	-19.869	-17.9877
14	2745.39	27.693*	16	0.034	8.2e-15	-21.1209	-19.7568	-17.7362
15	2756.85	22.922	16	0.116	8.6e-15	-21.0827	-19.6246	-17.4646

Endogenous: flnM1 gap flnExch flnPPI
Exogenous: flnOIL _cons

Table 11. Lag selection for model 3 with Consumer Price Index as a price measure

Selection-order criteria
Sample: 1995m5 - 2015m2 Number of obs = 238

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	2330.71				3.9e-14	-19.5186	-19.4716*	-19.4019*
1	2350.55	39.677	16	0.001	3.8e-14	-19.5509	-19.4097	-19.2007
2	2364.28	27.449	16	0.037	3.9e-14	-19.5317	-19.2966	-18.9482
3	2387.15	45.754	16	0.000	3.7e-14	-19.5895	-19.2603	-18.7725
4	2395.29	16.276	16	0.434	3.9e-14	-19.5235	-19.1001	-18.473
5	2406.7	22.819	16	0.119	4.1e-14	-19.4849	-18.9675	-18.201
6	2419.86	26.327	16	0.050	4.2e-14	-19.4611	-18.8496	-17.9438
7	2428.27	16.807	16	0.398	4.4e-14	-19.3972	-18.6916	-17.6465
8	2439.87	23.203	16	0.108	4.6e-14	-19.3603	-18.5606	-17.3761
9	2463.56	47.374	16	0.000	4.4e-14	-19.4248	-18.5311	-17.2073
10	2472.12	17.123	16	0.378	4.7e-14	-19.3623	-18.3745	-16.9113
11	2491.16	38.08	16	0.001	4.6e-14	-19.3879	-18.306	-16.7034
12	2534.29	86.26	16	0.000	3.6e-14	-19.6159	-18.4399	-16.698
13	2552.79	37.005	16	0.002	3.6e-14*	-19.6369*	-18.3669	-16.4856
14	2564.39	23.2	16	0.109	3.8e-14	-19.5999	-18.2358	-16.2152
15	2581.29	33.797*	16	0.006	3.8e-14	-19.6075	-18.1493	-15.9893

Endogenous: flnM1 gap flnExch flnCPI
Exogenous: flnOIL _cons

VAR estimates

From the tables below it is evident that the correlation between the exchange rate and the domestic prices is positive, although not always statistically significant. Hence, the exchange rate is one of the determining factors for import, producer and consumer prices.

The tables below show only the exchange rate as an independent variable (to see the complete tables refer to Appendix B).

Table 12. VAR Estimation for Model 1.

VARIABLES	(1) flnOil	(2) flnM1	(3) gap	(4) flnExch	(5) flnIMP
L.flnExch	0.150	0.180	-0.0246	0.143**	0.059***
	(0.229)	(0.159)	(0.0161)	(0.0655)	(0.0605)
L2.flnExch	-0.180	0.0356	0.00975	-0.00802	0.06***
	(0.237)	(0.166)	(0.0168)	(0.0683)	(0.0631)
L3.flnExch	0.389	0.243	-0.00201	-0.184***	0.0435*
	(0.243)	(0.169)	(0.0171)	(0.0696)	(0.0643)

L4.flnExch	0.00154	0.368**	0.0280	-0.0343	0.044**
	(0.243)	(0.169)	(0.0170)	(0.0693)	(0.0640)
L5.flnExch	-0.0526	0.0575	0.0252	-0.0982	0.130***
	(0.264)	(0.181)	(0.0183)	(0.0745)	(0.0688)
L6.flnExch	0.00216	0.264	0.00220	0.101	0.1317**
	(0.270)	(0.187)	(0.0189)	(0.0771)	(0.0712)
L7.flnExch	0.353	0.163	-0.00276	0.0345	0.0848
	(0.266)	(0.187)	(0.0189)	(0.0768)	(0.0709)
L8.flnExch	-0.166	0.487***	-0.0194	-0.0384	0.0377**
	(0.265)	(0.185)	(0.0187)	(0.0763)	(0.0704)
L9.flnExch	-0.276	-0.457***	0.0171	0.0618	-0.0440
	(0.250)	(0.177)	(0.0179)	(0.0727)	(0.0672)
L10.flnExch	-0.0198	-0.308*	-0.00538	0.0134	-0.00879**
	(0.252)	(0.177)	(0.0179)	(0.0728)	(0.0673)
L11.flnExch	0.0779	0.494***	-0.0457***	0.0403	0.0160
	(0.220)	(0.155)	(0.0157)	(0.0639)	(0.0590)
L12.flnExch	0.0900	-0.0585	0.0326**	0.0174	-0.0428**
	(0.182)	(0.130)	(0.0131)	(0.0533)	(0.0492)
Observations	241	241	241	241	241

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13. VAR Estimation for Model 2.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	flnOil	flnM1	gap	fnlExch	flnPPI
L.flnExch	0.160	0.144	-0.0394***	0.213***	0.134***
	(0.229)	(0.153)	(0.0150)	(0.0654)	(0.0214)
L2.flnExch	-0.170	-0.115	-0.000967	0.0368	0.0143**
	(0.237)	(0.198)	(0.0194)	(0.0845)	(0.0277)
L3.flnExch	0.409	0.00632	-0.0392**	-0.101	0.0215**
	(0.243)	(0.195)	(0.0191)	(0.0832)	(0.0272)
L4.flnExch	0.00254	0.211	-0.0218	-0.0289	0.0117**
	(0.243)	(0.194)	(0.0191)	(0.0829)	(0.0272)
L5.flnExch	-0.0426	0.247	0.0107	-0.0295	0.0209
	(0.264)	(0.194)	(0.0191)	(0.0829)	(0.0271)
L6.flnExch	0.00316	0.310	0.00535	0.00513	0.00826
	(0.270)	(0.192)	(0.0189)	(0.0820)	(0.0269)**
L7.flnExch	0.353	0.0430	-0.0118	-0.00188	0.0147
	(0.266)	(0.189)	(0.0186)	(0.0808)	(0.0265)
L8.flnExch	-0.166	0.573***	-0.0175	0.0146	-0.0666***
	(0.265)	(0.184)	(0.0180)	(0.0784)	(0.0257)
L9.flnExch	-0.236	-0.590***	0.0348*	0.0101	-0.00923**
	(0.250)	(0.181)	(0.0178)	(0.0773)	(0.0253)
L10.flnExch	-0.0198	-0.0455	0.00279	-0.0508	0.0229

	(0.252)	(0.184)	(0.0181)	(0.0787)	(0.0258)
L11.flnExch	0.0679	0.416**	-0.0269	0.0985	0.00989***
	(0.220)	(0.171)	(0.0168)	(0.0732)	(0.0240)
L12.flnExch	0.0900	0.0227	0.0115	0.0115	-0.0324
	(0.182)	(0.152)	(0.0149)	(0.0648)	(0.0212)
Observations		241	241	241	241

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14. VAR Estimation for Model 3.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	flnOil	flnM1	gap	flnExch	flnCPI
L.flnExch	0.110	0.0806	-0.0199	0.258***	0.0648**
	(0.229)	(0.158)	(0.0160)	(0.0698)	(0.0517)
L2.flnExch	-0.130	0.104	-0.00252	0.114	0.0841***
	(0.237)	(0.161)	(0.0163)	(0.0710)	(0.0525)
L3.flnExch	0.319	0.110	-0.0406**	-0.0908	0.151**
	(0.243)	(0.161)	(0.0163)	(0.0710)	(0.0525)
L4.flnExch	0.02354	0.120	0.00677	-0.0300	0.0552
	(0.243)	(0.165)	(0.0167)	(0.0729)	(0.0539)
L5.flnExch	-0.2126	0.0629	0.00145	0.0911	-0.0107**
	(0.264)	(0.164)	(0.0166)	(0.0724)	(0.0536)
L6.flnExch	0.00316	0.140	-0.000782	0.0511	-0.0624
	(0.270)	(0.161)	(0.0163)	(0.0713)	(0.0527)
L7.flnExch	0.243	-0.0531	-0.0151	-0.0419	0.00464**
	(0.266)	(0.163)	(0.0165)	(0.0718)	(0.0531)
L8.flnExch	-0.166	0.551***	-0.00562	-0.000406	0.0517
	(0.265)	(0.161)	(0.0163)	(0.0711)	(0.0526)
L9.flnExch	-0.346	-0.313*	0.0458***	0.124*	0.011**
	(0.250)	(0.162)	(0.0164)	(0.0715)	(0.0529)
L10.flnExch	-0.0198	-0.267*	0.0124	-0.0477	-0.0719
	(0.252)	(0.162)	(0.0164)	(0.0714)	(0.0529)
L11.flnExch	0.0219	0.358**	-0.0611***	0.0152	-0.0356
	(0.220)	(0.159)	(0.0161)	(0.0704)	(0.0521)
L12.flnExch	0.0710	0.0345	0.00507	0.0678	-0.000972
	(0.182)	(0.141)	(0.0142)	(0.0621)	(0.0459)
L13.flnExch	0.0610	0.00247	0.0332***	-0.0573	0.0229
	(0.184)	(0.118)	(0.0119)	(0.0521)	(0.0385)
Observations		240	240	240	240

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

In order to check the validity of the model, the eigenvalues for the system are presented in the tables of the Appendix B. In all of the three models for different price measures the estimated eigenvalues are less than one, which attests to the stability of the system. Furthermore, the tables perform the Lagrange multiplier test in order to show that there is no serial correlation in the residuals. As the probability is more than 5%, we cannot reject the null hypothesis of no autocorrelation at lag order. Thus, we assume that the three models are stable and valid.

Impulse response functions

Two variables within the vector auto-regression system with dynamic relationship could be correlated in the innovation terms. The exogenous shocks ε could have an effect on independent variable and then be transmitted to dependent variable. Impulse response functions (IRFs) help identify structural shocks by estimating the impact of an exogenous shock (in our case a shock to exchange rate) to a variable (domestic price index) within the dynamic system of VAR variables.

The Cholesky decomposition of innovations is applied in order to produce innovations ε. Based on them and the estimates of the VAR the graphs below show the cumulative effect on the domestic prices from the permanent shock to exchange rate. The horizontal axis shows the time horizon (each step equaling one month), while the vertical axis shows the percentage change of the price index. All shocks imply a 1% change in the exchange rate, the shaded areas being the 95% confidence interval.

The results indicate that the exchange rate pass-through is incomplete and rather small, which may be explained by the nature of the exchange rate regime in Kazakhstan and general anti-inflationary monetary policy conducted by the Central Bank after the period of hyperinflation in the years following the disintegration of the USSR. Over time, the effect of the depreciation on the price level rises, although marginally. As expected, the import prices tend to rise faster than producer and consumer prices. One year after the shock the import prices rise twice as much as other prices. Interestingly, producer prices and consumer prices have similar pass-through effects, although, in the long term, the pass-through has an ascending trend for the former and crawling descending for the latter.

As shown on the Figure 1, One percent change in the exchange rate leads to approximately 0.14% rise in import prices up to fourth period and then increases to 0.32 until the sixth period as the lagged effect takes hold, after which the effect stabilizes and, eventually, dies down. One year after the shock of 10% depreciation of the national currency will translate into the 3.4% increase of the import prices.

According to Figure 2, the prices on manufactured goods across all industries will grow by 0.13% following the 1% depreciation of the currency in the first period, which might be explained by the inflationary expectations of local producers overlapping the additional costs of the more expensive input materials imported from abroad. The prices will continue to grow – although marginally – throughout the year and will keep the ascending trend after 12 months, when the 10% depreciation of tenge will mean the increase in producer prices by 1.9%.

Finally, Figure 3 shows that consumer prices will promptly respond to the shock in the exchange rate by an increase of 0.1% in reaction to the 1% depreciation of the currency. Reaching the maximum level of 0.17 in the third period, the trend will stabilize and start declining toward the end of the year. In 12 months, 10% depreciation of tenge will cause only 1.6% increase in the CPI. The weak response of consumer prices to the external shock may be due to the adequate policy of the Central Bank in anchoring the expectations of inflation and accommodating the necessary monetary policy tools (Table 15 depicts the pass-through elasticities in periods 1, 6, 12)

Figure 1. Impulse-Response Path to Unit Exchange Rate Shock on Import Prices (Model 1)

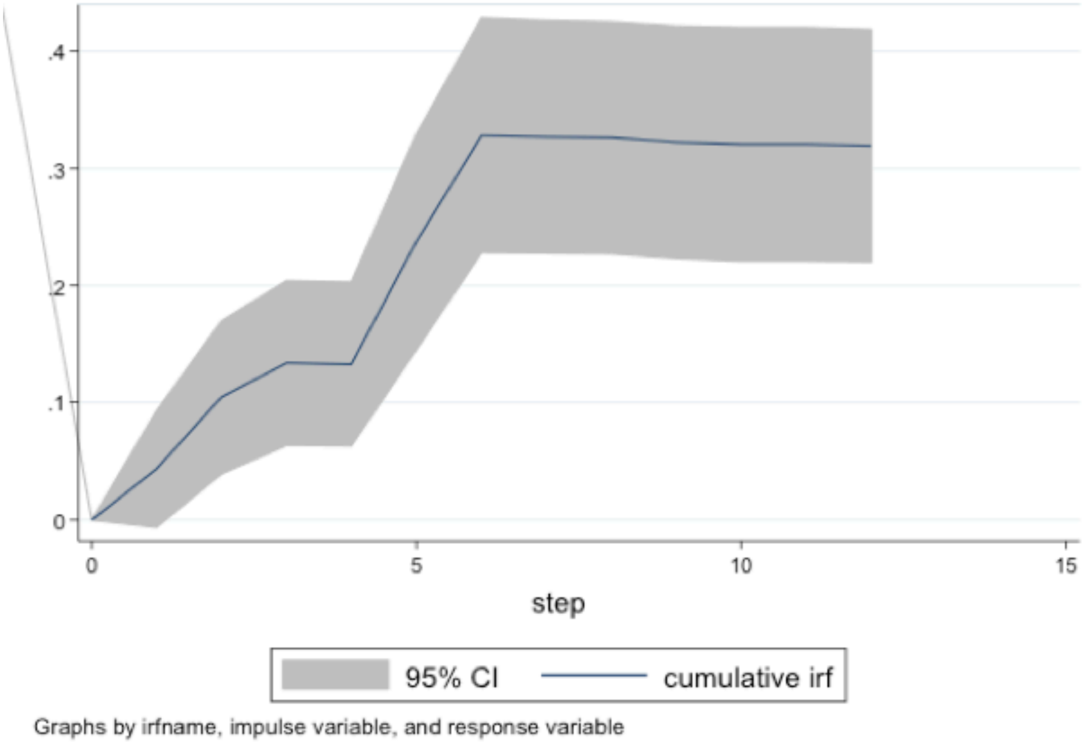


Figure 2. Model 2. Impulse-Response Path to Unit Exchange Rate Shock on Producer Prices

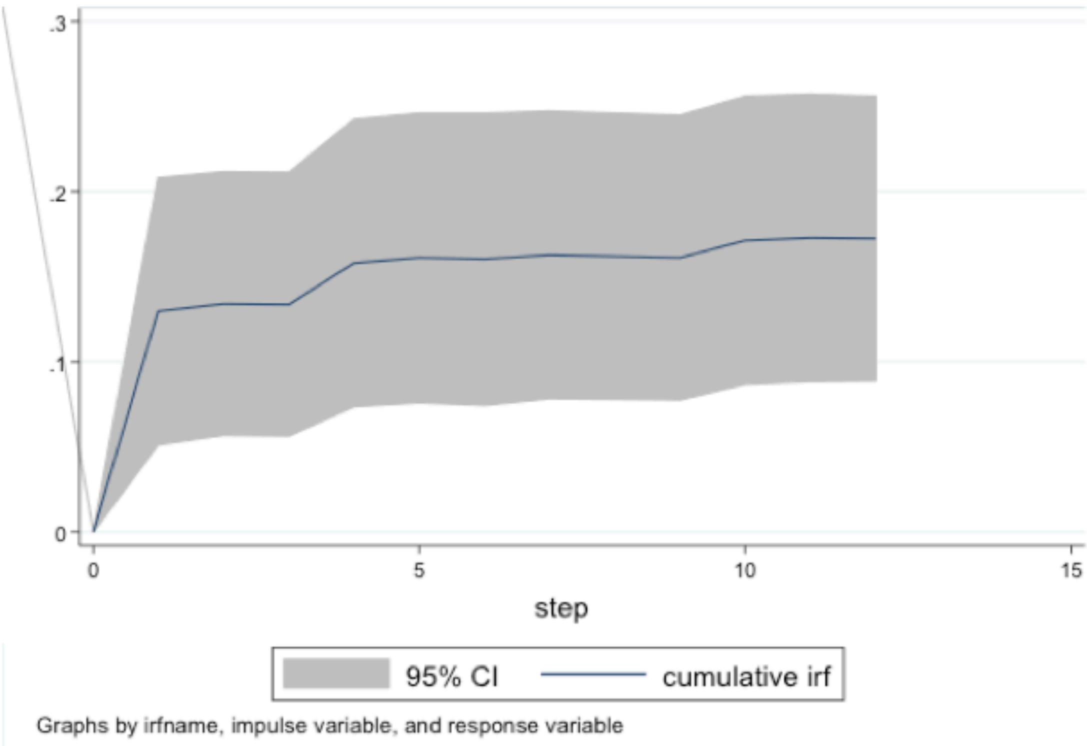


Figure 3. Model 3. Impulse-Response Path to Unit Exchange Rate Shock on Consumer Prices

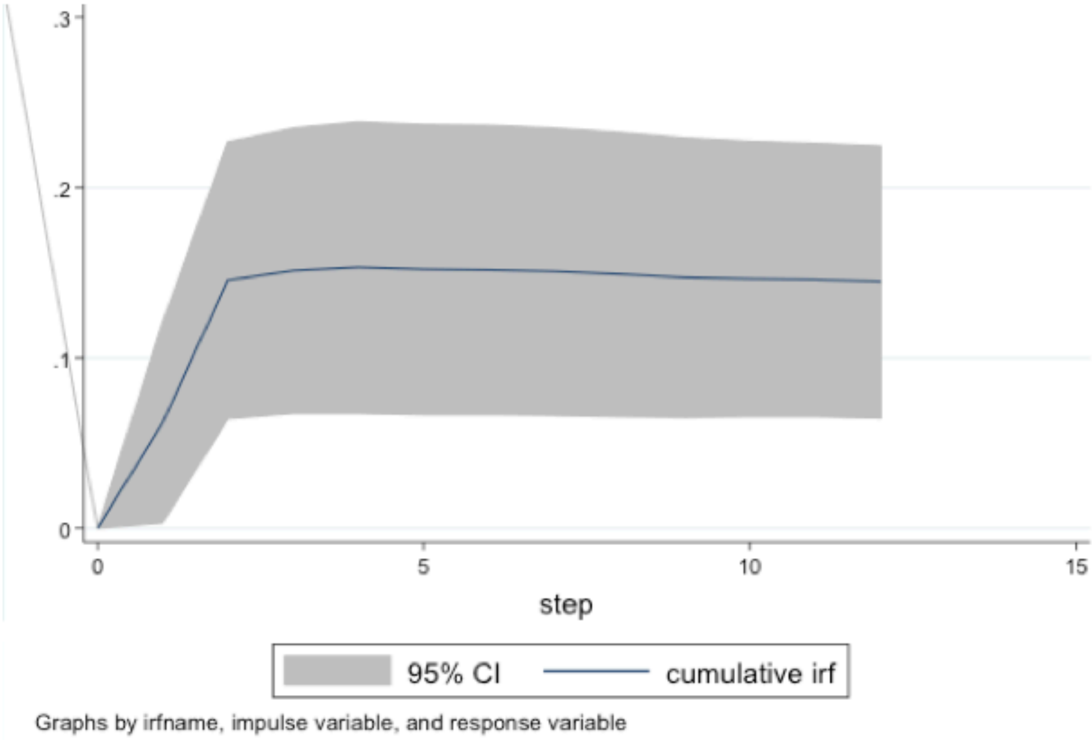


Table 15. Pass-Through Elasticities (percent change in prices divided by percent change in exchange rate)

Price index	t = 1	t = 6	t = 12
IMP	0.05	0.21	0.34
PPI	0.13	0.17	0.18
CPI	0.08	0.15	0.16

Note: Based on cumulative impulse-response functions estimated on monthly data from 1994 to 2015

Sensitivity Analysis

As the vector auto-regression method is highly sensitive to the ordering of the variables within the system, the robustness checks are necessary in order to verify the validity of the model. Considering that there are many possible reordering options in the VAR, the sensitivity analysis will focus on the change in placement between the exchange rate (fourth in the original model) and the price index (the last in the original order). The Table 16 shows that the results from the reordering are robust indicating little change from the original pass-through elasticities across the price indices. It should be noted that in the reordered VAR the exchange rate has no effect on the price indices in the first period due to the ordering within the model.

Table 16. Pass-Through Elasticities After Reordering

Price index	t = 1	t = 6	t = 12
IMP	0	0.18	0.31
PPI	0	0.19	0.20
CPI	0	0.16	0.19

The Evolution of Exchange Rate Pass-Through

In the light of the accession of Kazakhstan to the Customs Union created with Russia and Belarus in 2010, it is interesting to observe if any change in the degree of pass-through has taken place. Since the beginning of the economic integration and the removal of customs borders the trade in goods has multiplied manifold. However, after the recent geopolitical developments the Kazakhstani exporters to Russia have experienced pressure due to the fact that ruble has depreciated and rendered Kazakhstani goods uncompetitive in comparison, which forced the authorities to pursue devaluation.

The figures below show the degree of the exchange rate pass-through before and after Kazakhstan joined the Customs Union, the benchmark being July 2010. The impulse-response functions show that the pass-through effect had been slightly smaller in comparison with the results obtained for the whole sample but, on the other hand, the results after the accession to Customs Union differ significantly. For instance, the pass-through into import prices has increased from 30% at its highest point to as much as 50%. Moreover, the response has become more prompt: while it reached 0.1 level only in the fourth period prior to the integration going to highest point half a year after the exchange rate shock, after joining the Customs Union the pass-through leapt to 0.2 in the first period and increasing to the maximum of 0.5 in the third period, after which it gradually decreased until reaching 3.8 level.

Similar results could be observed for both producer and consumer prices. Producer prices respond fast to exchange rate shocks reaching maximum 0.2 level within 3 months, declining in the following few months but then gradually regaining the trend toward the end of the year. Conversely, consumer prices react more gaining the highest pass-through of 0.3 twice but then declining fast to the level of 0.16 that had been observed before the accession to the Customs Union.

The increase in the pass-through for all three price measures could possibly be explained by the inflationary expectations of local producers and consumers, which pattern their behavior on the Russian counterparts. The implications of the depreciating ruble and the sharp rise in inflation might have fueled the unjustified expectations of price increase. The situation is aggravated by speculative articles in local media against the background of weak policy communication on the part of the Central Bank. The fact that the authorities proceeded with tenge devaluation in the beginning of 2014 days after promising to keep the parity with the dollar, decreased the level of trust toward the regulator, which resulted in panicked wave of the purchase of foreign currency and magnified the inflationary fears further. However, the impulse response functions suggest that after a period of rapid growth the pass-through into CPI stabilizes and after 12 months reaches the same levels as observed prior to that.

Figure 4. Impulse-Response Path to Unit Exchange Rate Shock on Import Prices (Model 1) before (on the left) and after (on the right) Joining the Customs Union

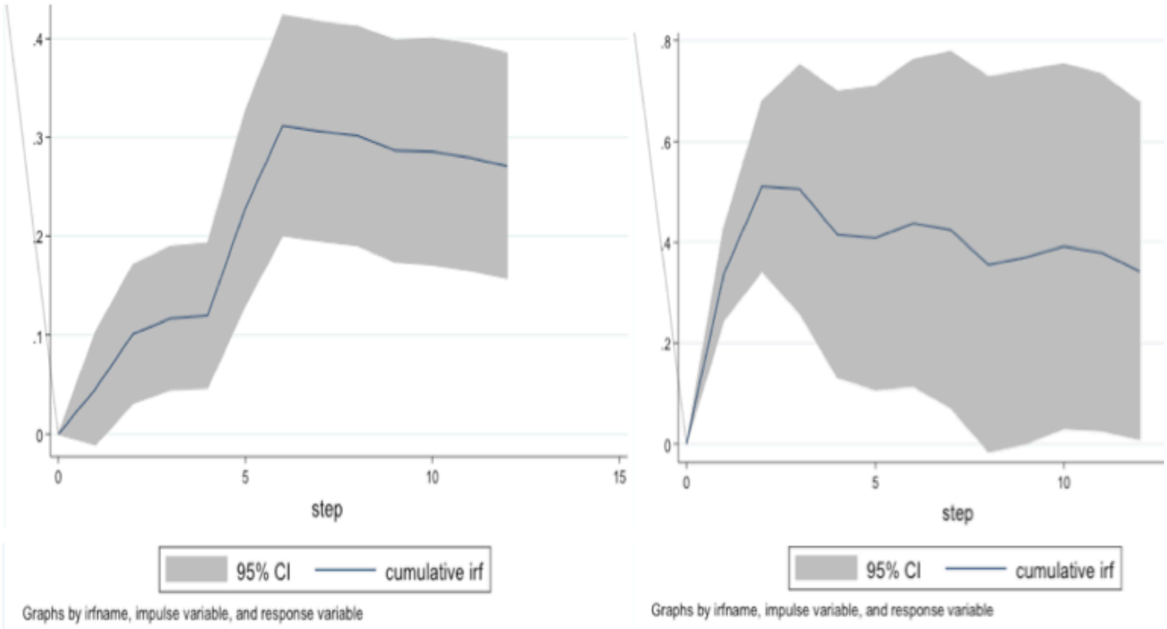


Figure 5. Impulse-Response Path to Unit Exchange Rate Shock on Producer Prices (Model 2) before (on the left) and after (on the right) Joining the Customs Union

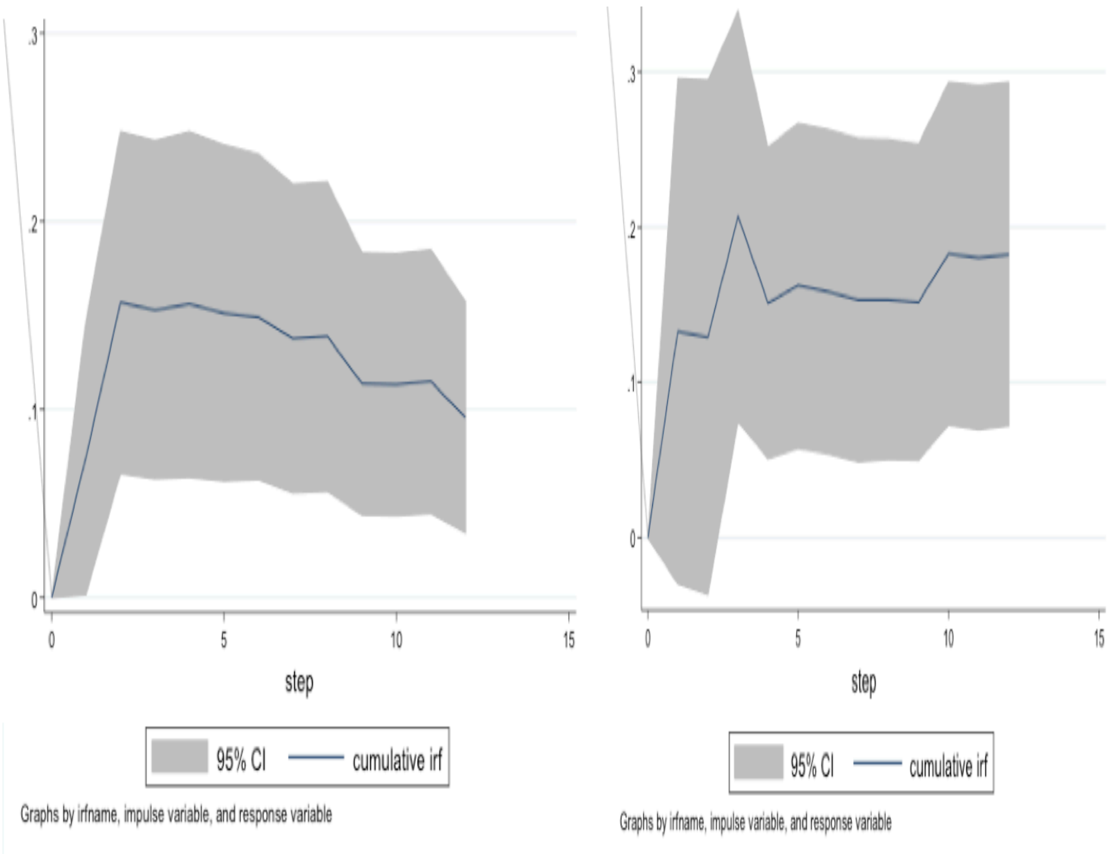
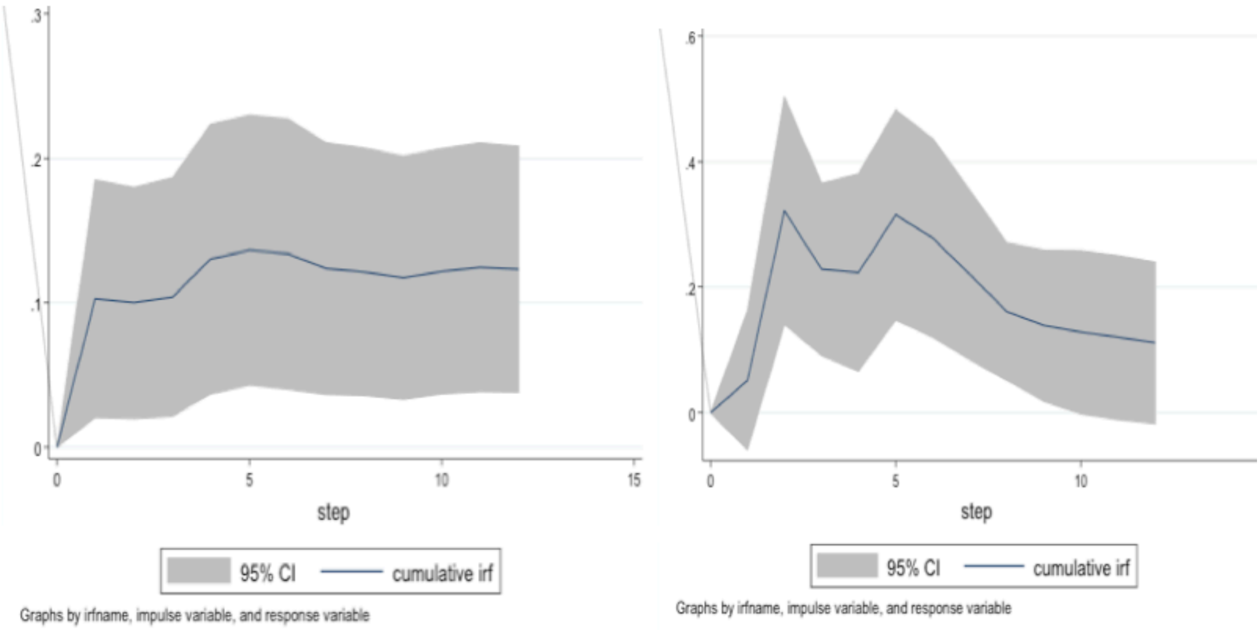


Figure 6. Impulse-Response Path to Unit Exchange Rate Shock on Consumer Prices (Model 3) before (on the left) and after (on the right) Joining the Customs Union



CONCLUSIONS

Understanding the impact of the currency fluctuations has important implications for the monetary and exchange rate policy. This study has endeavored to estimate the pass-through of the exchange rate into a set of domestic prices including import, producer, and consumer prices by conducting the vector auto-regression analysis.

The evidence from the impulse-response functions have suggested that the exchange rate pass-through in general is incomplete and small in Kazakhstan. It tends to be higher for import prices and twice as little for producer and consumer prices. However, the pass-through rises over time for import and producer prices, while remaining low for consumer prices. The difference in the pass-through effect for import prices and consumer prices may lie in the fact that local distribution costs play a major role in price determination, as well as the possibility that the goods of the consumer basket are partially produced locally, and, thus, experience less influence from the exchange rate fluctuations. Thus, the degree of pass-through naturally declines down the pricing chain due to the increase of the non-tradable component in the form of distribution costs, rents, etc.

Quite interesting results yielded the VAR estimation of the exchange rate pass-through before and after the accession of Kazakhstan to the Customs Union created with Russia and Belarus in 2010. According to the analysis of the impulse response functions, the exchange rate pass-through increased for all three price measures (import prices, producer prices, and consumer prices), which indicates the increased exposure of domestic prices to the exchange rate fluctuations. After joining the economic integration, the increase has particularly been noticeable in the case of the consumer prices, which might have resulted from exaggerated inflationary expectations and poor policy communication from the Central Bank.

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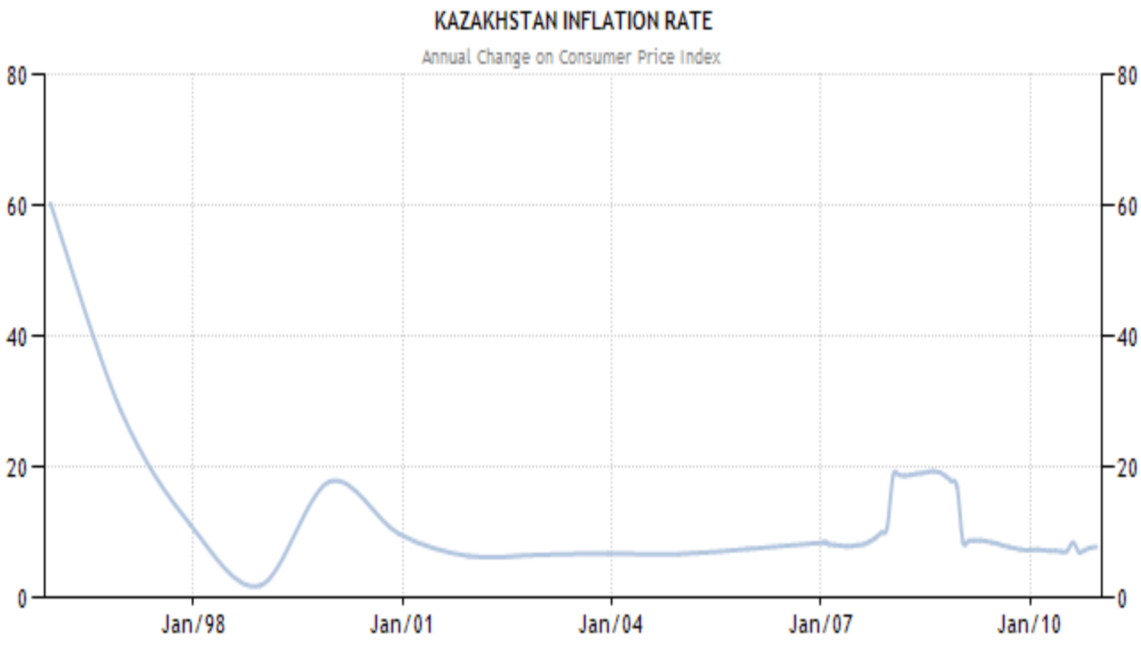
APPENDIX A.

Table 17. Trade Turnover and Imports of the Republic of Kazakhstan by Countries/Regions in 2014 (in %)

Country	Trade Turnover	Imports	Exports
Russia	15.8	33.3	6.6
Belarus	0.6	1.8	0.1
EU	44.4	20.9	56.8
China	14.4	17.9	12.5
US	2	4.8	0.5
Asian Countries (except China)	10.5	10.9	10.3
Africa	0.3	0.5	0.2
Americas (except US)	1.3	6.6	1

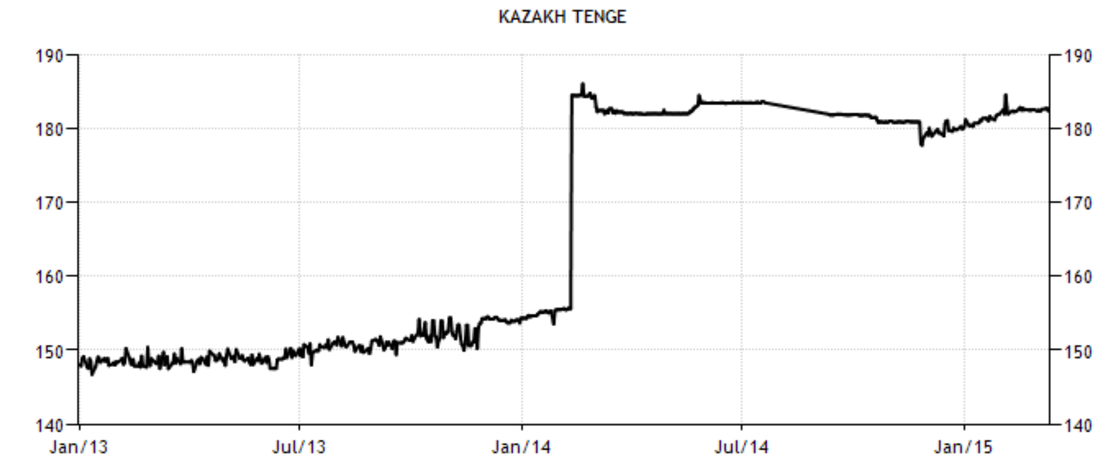
Source: Compiled from the data taken from the official site of the Ministry of National Economy of the Republic of Kazakhstan, Committee on Statistics, http://www.stat.gov.kz/faces/wcnav_externalId/homeNumbersCrossTrade?_afrLoop=1116637667768760#%40%3F_afrLoop%3D1116637667768760%26_adf.ctrl-state%3Dd7r4rxk6z_219

Figure 7. Inflation in Kazakhstan for 1995-2010



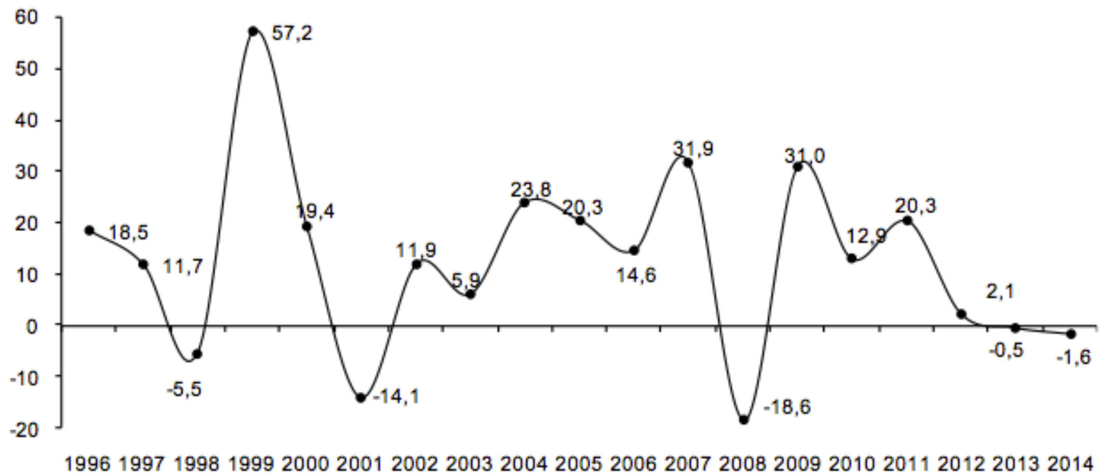
Source: Trading economics, accessed 12 march, 2015, http://www.tradingeconomics.com/kazakhstan/inflation-cpi

Figure 8. USD/KZT exchange rate January 2013 – March 2015



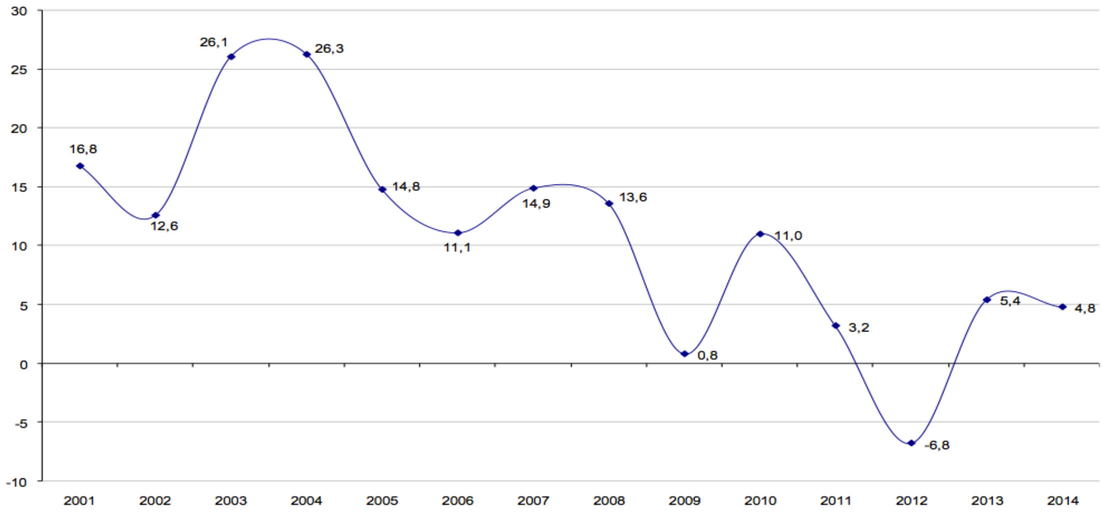
Source: Trading economics, accessed 12 March, 2015, http://www.tradingeconomics.com/kazakhstan/inflation-cpi

Figure 9. Producer Price Index Dynamics 1996-2014 (%change to the previous year)



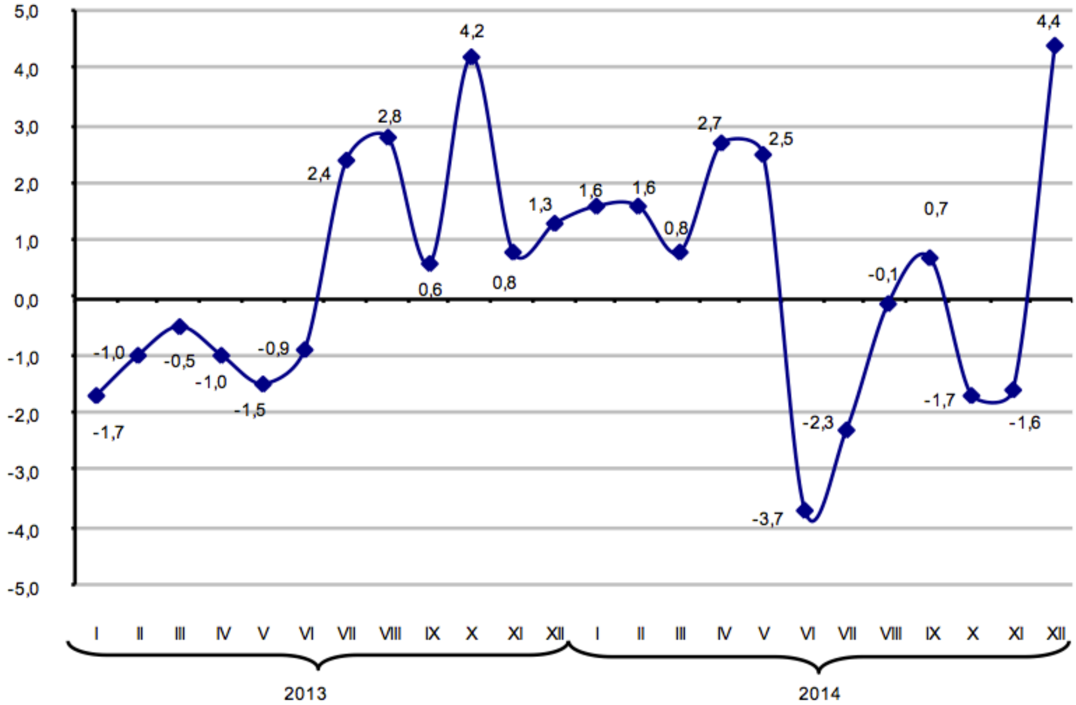
Source: The official site of the Ministry of National Economy of the Republic of Kazakhstan, the Committee on Statistics. Accessed 12 March, 2015. http://www.stat.gov.kz/faces/homePage;jsessionid=yhxhVghTJ7kkvKWLbQjnHcnzSJPQ5GW8WspZ4Jmkb3JRf5g71ccJ!2102162838?_afrLoop=83311311733552#%40%3F_afrLoop%3D83311311733552%26_adf.ctrl-state%3Dppb5734bm_4

Figure 10. Import Price Index Dynamics 2001-2014 (%change to the previous year)



Source: The official site of the Ministry of National Economy of the Republic of Kazakhstan, the Committee on Statistics. Accessed 12 March, 2015. http://www.stat.gov.kz/faces/homePage;jsessionid=yhxhVghTJ7kkvKWLbQjnHcnzSJPQ5GW8WspZ4Jmkb3JRf5g71ccJ!2102162838?_afrLoop=83311311733552#%40%3F_afrLoop%3D83311311733552%26_adf.ctrl-state%3Dppb5734bm_4

Figure 11. Import Price Index Dynamics 2013-2014 (%change to the previous month)



Source: The official site of the Ministry of National Economy of the Republic of Kazakhstan, the Committee on Statistics. Accessed 12 March, 2015. http://www.stat.gov.kz/faces/homePage;jsessionid=yhxhVghTJ7kkvKWLbQjnHcnzSJPQ5GW8WspZ4Jmkb3JRf5g71ccJ!2102162838?_afrLoop=83311311733552#%40%3F_afrLoop%3D83311311733552%26_adf.ctrl-state%3Dppb5734bm_4

APPENDIX B.

Table 18. VAR Estimates for Model 1

VARIABLES	(1) flnOil	(2) flnM1	(3) gap	(4) flnExch	(5) flnIMP
L.flnOIL	0.158**	0.0823*	0.00144	0.0586***	-0.0151
	(0.0652)	(0.0456)	(0.00443)	(0.0188)	(0.0172)
L2.flnOIL	0.0573	0.0130	0.00835*	-0.0344*	-0.0236
	(0.0686)	(0.0480)	(0.00467)	(0.0198)	(0.0181)
L3.flnOIL	-0.0471	0.0686	0.00453	0.0138	-0.0549***
	(0.0689)	(0.0482)	(0.00469)	(0.0199)	(0.0182)
L4.flnOIL	-0.0511	-0.0296	0.0101**	-0.0382*	0.0183
	(0.0707)	(0.0495)	(0.00481)	(0.0204)	(0.0186)
L5.flnOIL	0.0567	-0.0689	0.0141***	-0.0135	-0.0286
	(0.0709)	(0.0496)	(0.00482)	(0.0204)	(0.0187)
L6.flnOIL	-0.110	-0.0404	0.0112**	-0.0231	-0.0227
	(0.0701)	(0.0491)	(0.00477)	(0.0202)	(0.0185)
L7.flnOIL	0.0235	0.0685	0.0112**	0.0238	0.00294
	(0.0703)	(0.0492)	(0.00478)	(0.0203)	(0.0185)
L8.flnOIL	0.0383	0.0870*	0.00287	0.000758	0.0198
	(0.0712)	(0.0498)	(0.00484)	(0.0205)	(0.0188)
L9.flnOIL	0.0455	0.106**	0.00571	0.0268	-0.0232
	(0.0708)	(0.0495)	(0.00481)	(0.0204)	(0.0187)
L10.flnOIL	0.151**	-0.0235	-0.00451	-0.0307	0.0119
	(0.0712)	(0.0498)	(0.00484)	(0.0205)	(0.0188)
L11.flnOIL	0.124*	0.0161	0.00123	-0.0129	-0.00742
	(0.0719)	(0.0503)	(0.00489)	(0.0207)	(0.0189)
L12.flnOIL	-0.0181	0.00773	0.00618	0.00123	-0.0282
	(0.0715)	(0.0500)	(0.00486)	(0.0206)	(0.0188)
L.flnM1	0.0880	-0.170***	-0.00288	-0.0542**	0.0161
	(0.0921)	(0.0640)	(0.00646)	(0.0263)	(0.0243)
L2.flnM1	0.0918	0.0986	-0.00278	-0.00136	-0.0161
	(0.0916)	(0.0636)	(0.00642)	(0.0262)	(0.0242)
L3.flnM1	0.0499	0.170***	0.00351	-0.0668***	-0.0332
	(0.0900)	(0.0628)	(0.00634)	(0.0258)	(0.0238)
L4.flnM1	0.0712	0.106*	0.00829	-0.0546**	-0.0100
	(0.0900)	(0.0636)	(0.00643)	(0.0262)	(0.0242)
L5.flnM1	-0.00765	-0.00238	0.00286	-0.0244	0.00230
	(0.0899)	(0.0640)	(0.00647)	(0.0263)	(0.0243)
L6.flnM1	-0.237***	-0.0175	-0.0106	0.00920	0.0231
	(0.0892)	(0.0646)	(0.00653)	(0.0266)	(0.0245)
L7.flnM1	-0.131	0.0123	-0.0137**	-0.0447*	-0.00239
	(0.0866)	(0.0616)	(0.00623)	(0.0253)	(0.0234)
L8.flnM1	0.0431	-0.0129	0.000513	-0.0622**	0.0627***
	(0.0849)	(0.0601)	(0.00607)	(0.0247)	(0.0228)
L9.flnM1	0.118	0.0706	-0.00108	-0.0387	0.0121
	(0.0826)	(0.0594)	(0.00600)	(0.0244)	(0.0226)

L10.flnM1	0.144*	0.108*	0.00161	-0.0229	0.0346
	(0.0814)	(0.0587)	(0.00593)	(0.0242)	(0.0223)
L11.flnM1	0.0717	0.0258	-0.00197	-0.0120	0.0111
	(0.0547)	(0.0394)	(0.00398)	(0.0162)	(0.0150)
L12.flnM1	-0.000264	0.0915**	-0.000491	-0.0105	0.0178
	(0.0524)	(0.0375)	(0.00378)	(0.0154)	(0.0142)
L.gap	-0.458	0.494	-0.131**	0.171	0.178
	(0.810)	(0.560)	(0.0566)	(0.230)	(0.213)
L2.gap	-2.099**	-0.559	-0.199***	0.152	0.123
	(0.827)	(0.564)	(0.0570)	(0.232)	(0.214)
L3.gap	-1.901**	0.221	-0.160***	0.0680	0.215
	(0.871)	(0.570)	(0.0576)	(0.234)	(0.216)
L4.gap	-1.000	0.903	-0.0207	0.239	0.286
	(0.883)	(0.557)	(0.0562)	(0.229)	(0.211)
L5.gap	-2.539***	-0.776	0.0487	0.124	0.233
	(0.878)	(0.561)	(0.0566)	(0.231)	(0.213)
L6.gap	-3.646***	0.589	-0.0976*	-0.0237	0.317
	(0.872)	(0.563)	(0.0568)	(0.231)	(0.214)
L7.gap	-2.591***	0.741	-0.0106	0.132	0.547***
	(0.868)	(0.550)	(0.0555)	(0.226)	(0.209)
L8.gap	-2.937***	-0.603	-0.0136	0.118	0.396*
	(0.859)	(0.561)	(0.0566)	(0.230)	(0.213)
L9.gap	-2.134**	0.749	-0.145***	0.128	0.726***
	(0.843)	(0.554)	(0.0559)	(0.228)	(0.210)
L10.gap	-1.708**	0.834	-0.0301	0.131	0.456**
	(0.807)	(0.555)	(0.0560)	(0.228)	(0.211)
L11.gap	-1.408*	-0.731	-0.112**	0.477**	0.309
	(0.780)	(0.544)	(0.0549)	(0.224)	(0.206)
L12.gap	-1.159	0.300	0.468***	0.265	0.304
	(0.775)	(0.545)	(0.0550)	(0.224)	(0.207)
L.flnExch	0.150	0.180	-0.0246	0.143**	0.059***
	(0.229)	(0.159)	(0.0161)	(0.0655)	(0.0605)
L2.flnExch	-0.180	0.0356	0.00975	-0.00802	0.06***
	(0.237)	(0.166)	(0.0168)	(0.0683)	(0.0631)
L3.flnExch	0.389	0.243	-0.00201	-0.184***	0.0435*
	(0.243)	(0.169)	(0.0171)	(0.0696)	(0.0643)
L4.flnExch	0.00154	0.368**	0.0280	-0.0343	0.044**
	(0.243)	(0.169)	(0.0170)	(0.0693)	(0.0640)
L5.flnExch	-0.0526	0.0575	0.0252	-0.0982	0.130***
	(0.264)	(0.181)	(0.0183)	(0.0745)	(0.0688)
L6.flnExch	0.00216	0.264	0.00220	0.101	0.1317**
	(0.270)	(0.187)	(0.0189)	(0.0771)	(0.0712)
L7.flnExch	0.353	0.163	-0.00276	0.0345	0.0848
	(0.266)	(0.187)	(0.0189)	(0.0768)	(0.0709)
L8.flnExch	-0.166	0.487***	-0.0194	-0.0384	0.0377**
	(0.265)	(0.185)	(0.0187)	(0.0763)	(0.0704)
L9.flnExch	-0.276	-0.457***	0.0171	0.0618	-0.0440
	(0.250)	(0.177)	(0.0179)	(0.0727)	(0.0672)
L10.flnExch	-0.0198	-0.308*	-0.00538	0.0134	-0.00879**
	(0.252)	(0.177)	(0.0179)	(0.0728)	(0.0673)

L11.flnExch	0.0779	0.494***	-0.0457***	0.0403	0.0160
	(0.220)	(0.155)	(0.0157)	(0.0639)	(0.0590)
L12.flnExch	0.0900	-0.0585	0.0326**	0.0174	-0.0428**
	(0.182)	(0.130)	(0.0131)	(0.0533)	(0.0492)
L.flnIMP	0.102	0.0983	-0.0314*	0.364***	-0.252***
	(0.251)	(0.172)	(0.0174)	(0.0709)	(0.0655)
L2.flnIMP	0.216	-0.182	-0.0484**	0.192**	-0.114
	(0.276)	(0.189)	(0.0191)	(0.0777)	(0.0717)
L3.flnIMP	-0.0271	-0.486**	-0.0507***	0.0369	-0.0227
	(0.276)	(0.191)	(0.0193)	(0.0786)	(0.0726)
L4.flnIMP	-0.171	-0.255	-0.0427**	0.0506	-0.147**
	(0.277)	(0.192)	(0.0194)	(0.0791)	(0.0731)
L5.flnIMP	-0.0333	-0.142	-0.0218	0.0934	-0.0861
	(0.271)	(0.188)	(0.0190)	(0.0773)	(0.0714)
L6.flnIMP	0.130	0.0410	-0.00368	0.00377	0.102
	(0.259)	(0.181)	(0.0183)	(0.0746)	(0.0689)
L7.flnIMP	0.320	-0.298*	0.0313*	-0.0449	0.178***
	(0.256)	(0.180)	(0.0181)	(0.0738)	(0.0682)
L8.flnIMP	-0.648***	-0.174	0.0120	0.0293	0.112*
	(0.246)	(0.176)	(0.0178)	(0.0723)	(0.0668)
L9.flnIMP	-0.241	-0.524***	0.0368**	0.0342	0.0422
	(0.245)	(0.172)	(0.0174)	(0.0707)	(0.0653)
L10.flnIMP	0.216	-0.0298	0.0382**	-0.0619	0.0941
	(0.246)	(0.173)	(0.0175)	(0.0711)	(0.0656)
L11.flnIMP	-0.0622	0.231	0.0261	-0.0312	0.0955
	(0.241)	(0.169)	(0.0171)	(0.0696)	(0.0643)
L12.flnIMP	-0.0291	0.0615	-0.0154	-0.00397	-0.0239
	(0.225)	(0.157)	(0.0159)	(0.0647)	(0.0598)
Constant	-0.00278	0.0101*	0.000672	0.00693***	0.00102**
	(0.00800)	(0.00567)	(0.000572)	(0.00233)	(0.00215)
Observations	241	241	241	241	241

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 19. VAR Estimates for Model 2.

VARIABLES	(1) flnOil	(2) flnM1	(3) gap	(4) fnlExch	(5) flnPPI
L.flnOIL	0.158**	0.0823*	0.00144	0.0586***	-0.0151
	(0.0652)	(0.0456)	(0.00443)	(0.0188)	(0.0172)
L2.flnOIL	0.0573	0.0130	0.00835*	-0.0344*	-0.0236
	(0.0686)	(0.0480)	(0.00467)	(0.0198)	(0.0181)
L3.flnOIL	-0.0471	0.0686	0.00453	0.0138	-0.0549***
	(0.0689)	(0.0482)	(0.00469)	(0.0199)	(0.0182)
L4.flnOIL	-0.0511	-0.0296	0.0101**	-0.0382*	0.0183
	(0.0707)	(0.0495)	(0.00481)	(0.0204)	(0.0186)

L5.flnOIL	0.0567	-0.0689	0.0141***	-0.0135	-0.0286
	(0.0709)	(0.0496)	(0.00482)	(0.0204)	(0.0187)
L6.flnOIL	-0.110	-0.0404	0.0112**	-0.0231	-0.0227
	(0.0701)	(0.0491)	(0.00477)	(0.0202)	(0.0185)
L7.flnOIL	0.0235	0.0685	0.0112**	0.0238	0.00294
	(0.0703)	(0.0492)	(0.00478)	(0.0203)	(0.0185)
L8.flnOIL	0.0383	0.0870*	0.00287	0.000758	0.0198
	(0.0712)	(0.0498)	(0.00484)	(0.0205)	(0.0188)
L9.flnOIL	0.0455	0.106**	0.00571	0.0268	-0.0232
	(0.0708)	(0.0495)	(0.00481)	(0.0204)	(0.0187)
L10.flnOIL	0.151**	-0.0235	-0.00451	-0.0307	0.0119
	(0.0712)	(0.0498)	(0.00484)	(0.0205)	(0.0188)
L11.flnOIL	0.124*	0.0161	0.00123	-0.0129	-0.00742
	(0.0719)	(0.0503)	(0.00489)	(0.0207)	(0.0189)
L12.flnOIL	-0.0181	0.00773	0.00618	0.00123	-0.0282
	(0.0715)	(0.0500)	(0.00486)	(0.0206)	(0.0188)
L.flnM1	0.0880	-0.183***	-0.00884	-0.0400	0.0107
	(0.0921)	(0.0641)	(0.00630)	(0.0274)	(0.00897)
L2.flnM1	0.0918	0.0888	-0.00642	0.00358	0.0123
	(0.0916)	(0.0648)	(0.00637)	(0.0277)	(0.00906)
L3.flnM1	0.0499	0.144**	0.00942	-0.0811***	0.000361
	(0.0900)	(0.0629)	(0.00618)	(0.0268)	(0.00879)
L4.flnM1	0.0712	0.0881	0.00684	-0.0502*	-0.00900
	(0.0900)	(0.0629)	(0.00619)	(0.0269)	(0.00880)
L5.flnM1	-0.00765	-0.0415	-0.000424	-0.0251	0.00799
	(0.0899)	(0.0636)	(0.00625)	(0.0271)	(0.00889)
L6.flnM1	-0.237***	0.00917	-0.0160**	-0.00263	0.0110
	(0.0892)	(0.0644)	(0.00633)	(0.0275)	(0.00900)
L7.flnM1	-0.131	0.0203	-0.0187***	-0.0417	-0.0128
	(0.0866)	(0.0623)	(0.00612)	(0.0266)	(0.00871)
L8.flnM1	0.0431	-0.0189	-0.00205	-0.0609**	-0.00575
	(0.0849)	(0.0611)	(0.00600)	(0.0261)	(0.00854)
L9.flnM1	0.118	0.0727	0.00118	-0.0179	0.0167**
	(0.0826)	(0.0605)	(0.00595)	(0.0258)	(0.00846)
L10.flnM1	0.144*	0.114*	-0.00124	-0.0212	0.0222***
	(0.0814)	(0.0607)	(0.00597)	(0.0259)	(0.00849)
L11.flnM1	0.0717	0.0523	-0.00317	-0.0119	0.00477
	(0.0547)	(0.0421)	(0.00414)	(0.0180)	(0.00589)
L12.flnM1	-0.000264	0.0865**	-0.00573	0.000843	-0.00111
	(0.0524)	(0.0387)	(0.00381)	(0.0165)	(0.00542)
L.gap	-0.458	0.929	-0.111**	0.0909	-0.0909
	(0.810)	(0.567)	(0.0557)	(0.242)	(0.0793)
L2.gap	-2.099**	-0.0341	-0.125**	0.125	-0.0199
	(0.827)	(0.574)	(0.0565)	(0.245)	(0.0803)
L3.gap	-1.901**	0.743	-0.164***	0.0964	-0.0169
	(0.871)	(0.568)	(0.0558)	(0.242)	(0.0794)
L4.gap	-1.000	1.377**	-0.0316	0.231	-0.00602
	(0.883)	(0.553)	(0.0544)	(0.236)	(0.0774)
L5.gap	-2.539***	-0.341	0.0188	0.156	0.0222
	(0.878)	(0.560)	(0.0550)	(0.239)	(0.0783)

L6.gap	-3.646***	0.963*	-0.177***	0.0714	0.0520
	(0.872)	(0.562)	(0.0552)	(0.240)	(0.0786)
L7.gap	-2.591***	1.021*	-0.0713	0.172	0.0785
	(0.868)	(0.550)	(0.0541)	(0.235)	(0.0769)
L8.gap	-2.937***	-0.370	-0.0463	0.233	0.0599
	(0.859)	(0.549)	(0.0540)	(0.234)	(0.0768)
L9.gap	-2.134**	0.783	-0.238***	0.343	0.0992
	(0.843)	(0.547)	(0.0537)	(0.233)	(0.0764)
L10.gap	-1.708**	0.752	-0.0843	0.303	-0.00845
	(0.807)	(0.545)	(0.0536)	(0.233)	(0.0763)
L11.gap	-1.408*	-0.722	-0.137***	0.595***	0.0734
	(0.780)	(0.539)	(0.0529)	(0.230)	(0.0753)
L12.gap	-1.159	0.278	0.435***	0.368	0.00766
	(0.775)	(0.548)	(0.0539)	(0.234)	(0.0766)
L.flnExch	0.150	0.144	-0.0394***	0.213***	0.134***
	(0.229)	(0.153)	(0.0150)	(0.0654)	(0.0214)
L2.flnExch	-0.180	-0.115	-0.000967	0.0368	0.0143**
	(0.237)	(0.198)	(0.0194)	(0.0845)	(0.0277)
L3.flnExch	0.389	0.00632	-0.0392**	-0.101	0.0215**
	(0.243)	(0.195)	(0.0191)	(0.0832)	(0.0272)
L4.flnExch	0.00154	0.211	-0.0218	-0.0289	0.0117**
	(0.243)	(0.194)	(0.0191)	(0.0829)	(0.0272)
L5.flnExch	-0.0526	0.247	0.0107	-0.0295	0.0209
	(0.264)	(0.194)	(0.0191)	(0.0829)	(0.0271)
L6.flnExch	0.00216	0.310	0.00535	0.00513	0.00826
	(0.270)	(0.192)	(0.0189)	(0.0820)	(0.0269)**
L7.flnExch	0.353	0.0430	-0.0118	-0.00188	0.0147
	(0.266)	(0.189)	(0.0186)	(0.0808)	(0.0265)
L8.flnExch	-0.166	0.573***	-0.0175	0.0146	-0.0666***
	(0.265)	(0.184)	(0.0180)	(0.0784)	(0.0257)
L9.flnExch	-0.276	-0.590***	0.0348*	0.0101	-0.00923**
	(0.250)	(0.181)	(0.0178)	(0.0773)	(0.0253)
L10.flnExch	-0.0198	-0.0455	0.00279	-0.0508	0.0229
	(0.252)	(0.184)	(0.0181)	(0.0787)	(0.0258)
L11.flnExch	0.0779	0.416**	-0.0269	0.0985	0.00989***
	(0.220)	(0.171)	(0.0168)	(0.0732)	(0.0240)
L12.flnExch	0.0900	0.0227	0.0115	0.0115	-0.0324
	(0.182)	(0.152)	(0.0149)	(0.0648)	(0.0212)
L.flnPPI	0.102	0.177	-0.0249	0.142	0.0177
	(0.251)	(0.466)	(0.0458)	(0.199)	(0.0651)
L2.flnPPI	0.216	0.734	-0.00315	0.0427	0.0124
	(0.276)	(0.456)	(0.0448)	(0.195)	(0.0638)
L3.flnPPI	-0.0271	0.164	0.0709	0.0430	0.161**
	(0.276)	(0.454)	(0.0446)	(0.194)	(0.0634)
L4.flnPPI	-0.171	-0.615	-0.00904	0.209	0.00531
	(0.277)	(0.462)	(0.0454)	(0.197)	(0.0646)
L5.flnPPI	-0.0333	-0.720	-0.0260	0.107	0.0218
	(0.271)	(0.454)	(0.0446)	(0.194)	(0.0635)
L6.flnPPI	0.130	-0.154	0.0133	-0.0275	0.00377
	(0.259)	(0.439)	(0.0432)	(0.188)	(0.0614)

L7.flnPPI	0.320	-0.440	0.0371	-0.0878	0.265***
	(0.256)	(0.433)	(0.0426)	(0.185)	(0.0606)
L8.flnPPI	-0.648***	0.736*	0.0291	0.145	0.100
	(0.246)	(0.442)	(0.0434)	(0.189)	(0.0618)
L9.flnPPI	-0.241	-1.036**	0.0271	0.205	-0.0120
	(0.245)	(0.442)	(0.0434)	(0.189)	(0.0617)
L10.flnPPI	0.216	-0.554	-0.112**	-0.122	-0.0390
	(0.246)	(0.446)	(0.0439)	(0.191)	(0.0624)
L11.flnPPI	-0.0622	0.114	-0.0356	0.0594	0.102*
	(0.241)	(0.442)	(0.0434)	(0.189)	(0.0618)
L12.flnPPI	-0.0291	0.0609	0.153***	-0.134	-0.0196
	(0.225)	(0.356)	(0.0350)	(0.152)	(0.0498)
Constant	-0.00278	0.0114*	0.000511	0.00612**	0.000184
	(0.00800)	(0.00587)	(0.000577)	(0.00251)	(0.000821)
Observations	241	241	241	241	241

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 20. VAR Estimates for Model 3.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	flnOil	flnM1	gap	flnExch	flnCPI
L.flnOIL	0.158**	0.0823*	0.00144	0.0586***	-0.0151
	(0.0652)	(0.0456)	(0.00443)	(0.0188)	(0.0172)
L2.flnOIL	0.0573	0.0130	0.00835*	-0.0344*	-0.0236
	(0.0686)	(0.0480)	(0.00467)	(0.0198)	(0.0181)
L3.flnOIL	-0.0471	0.0686	0.00453	0.0138	-0.0549***
	(0.0689)	(0.0482)	(0.00469)	(0.0199)	(0.0182)
L4.flnOIL	-0.0511	-0.0296	0.0101**	-0.0382*	0.0183
	(0.0707)	(0.0495)	(0.00481)	(0.0204)	(0.0186)
L5.flnOIL	0.0567	-0.0689	0.0141***	-0.0135	-0.0286
	(0.0709)	(0.0496)	(0.00482)	(0.0204)	(0.0187)
L6.flnOIL	-0.110	-0.0404	0.0112**	-0.0231	-0.0227
	(0.0701)	(0.0491)	(0.00477)	(0.0202)	(0.0185)
L7.flnOIL	0.0235	0.0685	0.0112**	0.0238	0.00294
	(0.0703)	(0.0492)	(0.00478)	(0.0203)	(0.0185)
L8.flnOIL	0.0383	0.0870*	0.00287	0.000758	0.0198
	(0.0712)	(0.0498)	(0.00484)	(0.0205)	(0.0188)
L9.flnOIL	0.0455	0.106**	0.00571	0.0268	-0.0232
	(0.0708)	(0.0495)	(0.00481)	(0.0204)	(0.0187)
L10.flnOIL	0.151**	-0.0235	-0.00451	-0.0307	0.0119
	(0.0712)	(0.0498)	(0.00484)	(0.0205)	(0.0188)
L11.flnOIL	0.124*	0.0161	0.00123	-0.0129	-0.00742
	(0.0719)	(0.0503)	(0.00489)	(0.0207)	(0.0189)
L12.flnOIL	-0.0181	0.00773	0.00618	0.00123	-0.0282
	(0.0715)	(0.0500)	(0.00486)	(0.0206)	(0.0188)
L.flnM1	0.0880	-0.175***	-0.00442	-0.0459	-0.0136
	(0.0921)	(0.0647)	(0.00654)	(0.0286)	(0.0211)
L2.flnM1	0.0918	0.0978	-0.0112*	0.0251	0.00126
	(0.0916)	(0.0644)	(0.00651)	(0.0284)	(0.0210)

L3.flnM1	0.0499	0.188***	0.00292	-0.0716**	-0.0170
	(0.0900)	(0.0630)	(0.00637)	(0.0278)	(0.0206)
L4.flnM1	0.0712	0.106*	0.00731	-0.0574**	0.00291
	(0.0900)	(0.0641)	(0.00649)	(0.0283)	(0.0210)
L5.flnM1	-0.00765	-0.0355	0.00429	-0.0270	-0.0137
	(0.0899)	(0.0644)	(0.00651)	(0.0284)	(0.0210)
L6.flnM1	-0.237***	-0.0432	-0.0103	0.00248	-0.0241
	(0.0892)	(0.0649)	(0.00657)	(0.0287)	(0.0212)
L7.flnM1	-0.131	-0.0228	-0.0166**	-0.0348	-0.00535
	(0.0866)	(0.0652)	(0.00659)	(0.0288)	(0.0213)
L8.flnM1	0.0431	-0.00704	-0.00229	-0.0428	0.00138
	(0.0849)	(0.0617)	(0.00624)	(0.0273)	(0.0202)
L9.flnM1	0.118	0.0862	-0.000621	0.0102	2.56e-06
	(0.0826)	(0.0599)	(0.00606)	(0.0265)	(0.0196)
L10.flnM1	0.144*	0.114**	-0.00655	-0.00526	-0.00841
	(0.0814)	(0.0573)	(0.00580)	(0.0253)	(0.0187)
L11.flnM1	0.0717	-0.00780	-0.00168	-0.0190	-0.0193
	(0.0547)	(0.0559)	(0.00566)	(0.0247)	(0.0183)
L12.flnM1	-0.000264	0.0997***	-0.00390	-0.00314	0.00787
	(0.0524)	(0.0384)	(0.00389)	(0.0170)	(0.0126)
L13.flnM1	-0.458	0.0410	0.00569	0.0204	0.00941
	(0.810)	(0.0377)	(0.00381)	(0.0166)	(0.0123)
L.gap	-2.099**	0.511	-0.0462	0.271	0.120
	(0.827)	(0.617)	(0.0625)	(0.273)	(0.202)
L2.gap	-1.901**	-0.218	-0.132**	0.133	0.131
	(0.871)	(0.552)	(0.0558)	(0.244)	(0.180)
L3.gap	-1.000	0.785	-0.140**	0.0882	0.178
	(0.883)	(0.541)	(0.0548)	(0.239)	(0.177)
L4.gap	-2.539***	1.263**	-0.0445	0.148	0.126
	(0.878)	(0.542)	(0.0549)	(0.240)	(0.177)
L5.gap	-3.646***	-0.220	0.0255	0.117	0.194
	(0.872)	(0.533)	(0.0539)	(0.235)	(0.174)
L6.gap	-2.591***	0.991*	-0.139**	0.0261	0.187
	(0.868)	(0.541)	(0.0547)	(0.239)	(0.177)
L7.gap	-2.937***	0.890*	-0.0838	0.0975	-0.0472
	(0.859)	(0.538)	(0.0545)	(0.238)	(0.176)
L8.gap	-2.134**	-0.362	-0.0582	0.247	0.134
	(0.843)	(0.533)	(0.0539)	(0.235)	(0.174)
L9.gap	-1.708**	0.695	-0.222***	0.308	0.173
	(0.807)	(0.526)	(0.0532)	(0.232)	(0.172)
L10.gap	-1.408*	0.750	-0.103*	0.260	0.0435
	(0.780)	(0.543)	(0.0549)	(0.240)	(0.177)
L11.gap	-1.159	-0.776	-0.155***	0.559**	0.262
	(0.775)	(0.537)	(0.0543)	(0.237)	(0.175)
L12.gap	0.150	0.284	0.454***	0.308	0.189
	(0.229)	(0.541)	(0.0548)	(0.239)	(0.177)
L13.gap	-0.180	0.0943	-0.138**	-0.319	-0.142
	(0.237)	(0.604)	(0.0611)	(0.267)	(0.198)
L.flnExch	0.389	0.0806	-0.0199	0.258***	0.0648**
	(0.243)	(0.158)	(0.0160)	(0.0698)	(0.0517)

L2.flnExch	0.00154	0.104	-0.00252	0.114	0.0841***
	(0.243)	(0.161)	(0.0163)	(0.0710)	(0.0525)
L3.flnExch	-0.0526	0.110	-0.0406**	-0.0908	0.151**
	(0.264)	(0.161)	(0.0163)	(0.0710)	(0.0525)
L4.flnExch	0.00216	0.120	0.00677	-0.0300	0.0552
	(0.270)	(0.165)	(0.0167)	(0.0729)	(0.0539)
L5.flnExch	0.353	0.0629	0.00145	0.0911	-0.0107**
	(0.266)	(0.164)	(0.0166)	(0.0724)	(0.0536)
L6.flnExch	-0.166	0.140	-0.000782	0.0511	-0.0624
	(0.265)	(0.161)	(0.0163)	(0.0713)	(0.0527)
L7.flnExch	-0.276	-0.0531	-0.0151	-0.0419	0.00464**
	(0.250)	(0.163)	(0.0165)	(0.0718)	(0.0531)
L8.flnExch	-0.0198	0.551***	-0.00562	-0.000406	0.0517
	(0.252)	(0.161)	(0.0163)	(0.0711)	(0.0526)
L9.flnExch	0.0779	-0.313*	0.0458***	0.124*	0.011**
	(0.220)	(0.162)	(0.0164)	(0.0715)	(0.0529)
L10.flnExch	0.0900	-0.267*	0.0124	-0.0477	-0.0719
	(0.182)	(0.162)	(0.0164)	(0.0714)	(0.0529)
L11.flnExch	0.102	0.358**	-0.0611***	0.0152	-0.0356
	(0.251)	(0.159)	(0.0161)	(0.0704)	(0.0521)
L12.flnExch	0.216	0.0345	0.00507	0.0678	-0.000972
	(0.276)	(0.141)	(0.0142)	(0.0621)	(0.0459)
L13.flnExch	-0.0271	0.00247	0.0332***	-0.0573	0.0229
	(0.276)	(0.118)	(0.0119)	(0.0521)	(0.0385)
L.flnCPI	-0.171	-0.124	-0.0627***	0.00115	-0.114
	(0.277)	(0.214)	(0.0216)	(0.0945)	(0.0699)
L2.flnCPI	-0.0333	-0.582***	-0.0157	-0.0325	-0.0595
	(0.271)	(0.221)	(0.0223)	(0.0974)	(0.0721)
L3.flnCPI	0.130	0.285	0.0231	0.0261	0.0517
	(0.259)	(0.221)	(0.0224)	(0.0977)	(0.0723)
L4.flnCPI	0.320	0.288	0.0142	0.135	0.0140
	(0.256)	(0.219)	(0.0221)	(0.0966)	(0.0715)
L5.flnCPI	-0.648***	0.407*	0.0277	-0.0877	-0.180**
	(0.246)	(0.221)	(0.0224)	(0.0976)	(0.0722)
L6.flnCPI	-0.241	-0.327	-0.0287	-0.0677	0.0642
	(0.245)	(0.224)	(0.0227)	(0.0990)	(0.0733)
L7.flnCPI	0.216	-0.263	0.0177	-0.0174	0.0277
	(0.246)	(0.226)	(0.0228)	(0.0997)	(0.0738)
L8.flnCPI	-0.0622	-0.610***	0.0118	0.0974	-0.0445
	(0.241)	(0.223)	(0.0226)	(0.0986)	(0.0730)
L9.flnCPI	-0.0291	-0.181	-0.0107	-0.0911	-0.0371
	(0.225)	(0.224)	(0.0226)	(0.0987)	(0.0731)
L10.flnCPI	-0.00278	0.164	-0.0129	0.0826	-0.0498
	(0.00800)	(0.215)	(0.0218)	(0.0951)	(0.0704)
L11.flnCPI	-0.171	-0.121	-0.0261	0.0637	0.0787
	(0.277)	(0.216)	(0.0219)	(0.0956)	(0.0707)
L12.flnCPI	-0.0333	-0.109	0.0113	-0.0419	0.00937
	(0.271)	(0.213)	(0.0216)	(0.0942)	(0.0697)
L13.flnCPI	0.130	-0.581***	0.0360	-0.0295	0.00130
	(0.259)	(0.219)	(0.0221)	(0.0965)	(0.0714)

Constant	-0.00278	0.0114*	0.000956	0.00653**	0.00645***
	(0.00800)	(0.00623)	(0.000631)	(0.00275)	(0.00204)
Observations	240	240	240	240	240

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 21. Eigenvalues for Model 1

Eigenvalue stability condition

Eigenvalue	Modulus
.01075419 + .9742829*i*	.974342
.01075419 − .9742829*i*	.974342
−.8266213 + .4978797*i*	.96498
−.8266213 − .4978797*i*	.96498
.4675542 + .8407499*i*	.962012
.4675542 − .8407499*i*	.962012
−.9615554	.961555
.9330944	.933094
−.4553644 + .8014147*i*	.92175
−.4553644 − .8014147*i*	.92175
.8038655 + .4018901*i*	.89873
.8038655 − .4018901*i*	.89873
.7307006 + .5187101*i*	.896093
.7307006 − .5187101*i*	.896093
.8815631 + .1336636*i*	.891639
.8815631 − .1336636*i*	.891639
−.8902122	.890212
−.2958987 + .8043775*i*	.857076
−.2958987 − .8043775*i*	.857076
.433335 + .7373164*i*	.855228
.433335 − .7373164*i*	.855228
−.7462111 + .4128883*i*	.852823
−.7462111 − .4128883*i*	.852823
−.4254235 + .7324199*i*	.847009
−.4254235 − .7324199*i*	.847009
.3134797 + .7781147*i*	.838887
.3134797 − .7781147*i*	.838887
−.5976767 + .5788073*i*	.832007
−.5976767 − .5788073*i*	.832007
.6199359 + .5528604*i*	.830647
.6199359 − .5528604*i*	.830647
.09894539 + .8242768*i*	.830194
.09894539 − .8242768*i*	.830194
−.1589836 + .7979643*i*	.813648
−.1589836 − .7979643*i*	.813648
−.7648848 + .1749276*i*	.784633
−.7648848 − .1749276*i*	.784633
−.7189989 + .3129572*i*	.784157
−.7189989 − .3129572*i*	.784157
.6944645 + .2694546*i*	.744907
.6944645 − .2694546*i*	.744907
.4803933 + .431852*i*	.645967
.4803933 − .431852*i*	.645967
−.4223396 + .4464445*i*	.61456
−.4223396 − .4464445*i*	.61456
−.01904576 + .558523*i*	.558848
−.01904576 − .558523*i*	.558848
.3002427	.300243

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

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Table 22. Eigenvalues for Model 2

Eigenvalue stability condition

Eigenvalue			Modulus
.00994616	+	.9728172*i*	.972868
.00994616	−	.9728172*i*	.972868
−.8234401	+	.5010723*i*	.963912
−.8234401	−	.5010723*i*	.963912
−.9600831			.960083
.4710774	+	.8364081*i*	.959944
.4710774	−	.8364081*i*	.959944
.9444902			.94449
−.4573904	+	.8042237*i*	.925193
−.4573904	−	.8042237*i*	.925193
−.3100545	+	.8445017*i*	.89962
−.3100545	−	.8445017*i*	.89962
.6954061	+	.5657389*i*	.896465
.6954061	−	.5657389*i*	.896465
.8067736	+	.3884169*i*	.895406
.8067736	−	.3884169*i*	.895406
−.1295813	+	.8798428*i*	.889334
−.1295813	−	.8798428*i*	.889334
−.764466	+	.4532481*i*	.888731
−.764466	−	.4532481*i*	.888731
.7130629	+	.5172411*i*	.880907
.7130629	−	.5172411*i*	.880907
.8709759	+	.1176635*i*	.878888
.8709759	−	.1176635*i*	.878888
−.5004509	+	.7223232*i*	.87875
−.5004509	−	.7223232*i*	.87875
.4270856	+	.7630419*i*	.874434
.4270856	−	.7630419*i*	.874434
.3668417	+	.7876662*i*	.868902
.3668417	−	.7876662*i*	.868902
.0734429	+	.8606276*i*	.863756
.0734429	−	.8606276*i*	.863756
−.843537			.843537
.7685103	+	.3379089*i*	.839518
.7685103	−	.3379089*i*	.839518
−.8002649	+	.2072942*i*	.826677
−.8002649	−	.2072942*i*	.826677
−.8167822			.816782
−.5464293	+	.6043077*i*	.814723
−.5464293	−	.6043077*i*	.814723
−.719737	+	.3561176*i*	.80302
−.719737	−	.3561176*i*	.80302
.7255105			.72551
.2642435	+	.6511406*i*	.702715
.2642435	−	.6511406*i*	.702715
−.2436886	+	.5350208*i*	.587904
−.2436886	−	.5350208*i*	.587904
.3725335			.372534

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

Table 23. Eigenvalues for Model 3

Eigenvalue stability condition

Eigenvalue			Modulus
.00894311	+	.9751008*i*	.975142
.00894311	−	.9751008*i*	.975142
−.9632069			.963207
−.8233094	+	.4966423*i*	.961505
−.8233094	−	.4966423*i*	.961505
.4783192	+	.8297779*i*	.957769
.4783192	−	.8297779*i*	.957769
−.4554181	+	.8074818*i*	.927056
−.4554181	−	.8074818*i*	.927056
.4452644	+	.7924164*i*	.908947
.4452644	−	.7924164*i*	.908947
.8129124	+	.3929096*i*	.902887
.8129124	−	.3929096*i*	.902887
−.5217627	+	.7162854*i*	.886172
−.5217627	−	.7162854*i*	.886172
.879454	+	.0782797*i*	.882931
.879454	−	.0782797*i*	.882931
−.7528796	+	.4521167*i*	.878201
−.7528796	−	.4521167*i*	.878201
−.8508814	+	.200263*i*	.874131
−.8508814	−	.200263*i*	.874131
−.2663246	+	.8268736*i*	.868705
−.2663246	−	.8268736*i*	.868705
.1141671	+	.8548684*i*	.862458
.1141671	−	.8548684*i*	.862458
.7152266	+	.4753167*i*	.858764
.7152266	−	.4753167*i*	.858764
.7232009	+	.4462274*i*	.849787
.7232009	−	.4462274*i*	.849787
−.3753634	+	.7487817*i*	.837599
−.3753634	−	.7487817*i*	.837599
−.1331375	+	.8219332*i*	.832646
−.1331375	−	.8219332*i*	.832646
−.8051101			.80511
.7626543	+	.1577507*i*	.778798
.7626543	−	.1577507*i*	.778798
.2733571	+	.7227593*i*	.772726
.2733571	−	.7227593*i*	.772726
.6420068	+	.3695154*i*	.740753
.6420068	−	.3695154*i*	.740753
−.5773558	+	.4182855*i*	.712953
−.5773558	−	.4182855*i*	.712953
−.6852066	+	.1936939*i*	.712057
−.6852066	−	.1936939*i*	.712057
.336369	+	.54336*i*	.639049
.336369	−	.54336*i*	.639049
.1287362			.128736
.0056745			.005675

All the eigenvalues lie inside the unit circle.
VAR satisfies stability condition.

Table 24. Tests for Serial Correlation in Residuals for Model 1

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	9.0929	4	0.05882
2	7.6511	4	0.10523
3	1.3000	4	0.86138
4	6.4203	4	0.16988
5	3.6629	4	0.45354
6	3.0210	4	0.55431
7	7.5856	4	0.10799
8	4.8451	4	0.30357
9	4.3353	4	0.36253
10	2.2994	4	0.68088
11	1.4160	4	0.84142
12	5.0802	4	0.27917

H0: no autocorrelation at lag order

Table 25. Tests for Serial Correlation in Residuals for Model 2

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	3.8533	4	0.42623
2	7.3484	4	0.11858
3	3.0506	4	0.54940
4	1.5438	4	0.81885
5	9.1480	4	0.05750
6	7.0151	4	0.13509
7	3.3845	4	0.49566
8	0.6422	4	0.95827
9	2.8265	4	0.58727
10	1.1588	4	0.88484
11	1.1524	4	0.88588
12	1.2650	4	0.86729

H0: no autocorrelation at lag order

Table 26. Tests for Serial Correlation in Residuals for Model 3

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	0.5082	4	0.97270
2	0.7630	4	0.94334
3	4.6654	4	0.32338
4	8.7251	4	0.06835
5	1.9320	4	0.74827
6	2.5815	4	0.63011
7	3.1102	4	0.53956
8	5.5966	4	0.23136
9	7.7928	4	0.09947
10	1.5786	4	0.81263
11	1.6227	4	0.80471
12	0.5851	4	0.96471

H0: no autocorrelation at lag order