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The impact of oil price shocks on selected Kazakhstan's macroeconomic indicators

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Abstract. This article studies the correlation between world oil prices and the selected Kazakhstan's macroeconomic variables using the method of vector auto-regression (VAR). As expected, the macroeconomic variables under consideration demonstrate a significant correlation with oil price fluctuations. However, the results of the research show a certain discrepancy with the earlier researches, which considered previous negative oil price shock of 2008 in the form of quicker reaction to such shocks. This means that the dependence of Kazakh economy on oil price fluctuations increased since the previous oil price plunge[1]. In this regard, it is worth pointing out that none of these researches targeted the relationship between oil prices and Kazakh macro-economy after June 2014, when the last oil price shock began. Another important result is the timeframe during which the influence of oil price shocks is actually significant. These results are important for understanding the processes happening in the economies of Kazakhstan and other oil-exporting countries.

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1. INTRODUCTION

Earlier scientific papers have found serious dependence of main macroeconomic variables of oil-exporting countries on oil price fluctuations. The focus of the current research is to investigate how these variables react to oil price movements in Kazakhstan's economic environment. The table below serves a good illustration of how economies of the biggest oil exporters reacted to the last two oil price plunges. The rest of the article studies the situation in Kazakhstan while considering it as a typical oil-exporting country.

[1] Words "plunge" and "negative oil shock" are used interchangeably throughout this article.

Table 1

GDPs of the biggest oil exporters before and after the last two oil price plunges, US$

No	Country	GDP in 2008	GDP in 2009	% of change	GDP in 2014	GDP in 2016	% of change
1	Saudi Arabia	520	429	-17.4%	756.6	645	-14.8%
2	Russia	1661	1223	-26.4%	2064	1285	-37.7%
3	Iraq	132	112	-15.1%	235	172	-26.9%
4	United Arab Emirates	316	254	-19.7%	403	357	-11.4%
5	Canada	1549	1371	-11.5%	1799	1536	-14.6%
6	Nigeria	208	169.5	-18.5%	568.5	405	-28.8%
7	Kuwait	147	106	-28.2%	162.6	111	-31.8%
8	Angola	84	76	-10.3%	127	95	-24.8%
9	Kazakhstan	133	115	-13.6%	221.4	137	-38.0%
10	Norway	463	387	-16.4%	499.3	371	-25.7%

Source: Own construction based on the World Bank data[2]

From 2008 to 2009 the oil price (Brent) decreased by 36.6% and from 2014 to 2016 -- by 55.8%. The author selected the years 2008 and 2009, 2014 and 2016 as the years of beginning and end of the last two oil price shocks.

The key research question of this article is how oil price shocks affect the selected Kazakhstan's macroeconomic variables. This question deserves due attention because, in spite of the significance of oil in the economy of this country, which is one of the biggest oil exporters, the number of empirical researches on the effect of oil price shocks on Kazakh economy is still scarce. And, as it has been already mentioned in the abstract, none of the earlier studies have investigated the influence of oil price shocks on Kazakh macroeconomic variables after June 2014, when the last oil price shock began.

2. LITERATURE REVIEW

The influence of oil price shocks on macroeconomic variables has been extensively studied by different scientists because, as rightly mentioned by (Baumeister & Kilian, 2016a), "The reason why economists care about oil price shocks is that these shocks affect economic decisions". Considering these sources, we should start with the seminal work of (Hamilton, 1983). This paper was the first to address the relationship between oil price shocks and US economic recessions and stimulated serious interest and discussions among scientists worldwide. For example, (Mork, 1989) noticed that the Hamilton's "study pertained to a period in which all the large oil price movements were upward, and thus it left unanswered the question whether the correlation persists in periods of price decline. Moreover, the price variable he used was somewhat distorted by price controls in the 1970s." So Mork's "note investigates whether Hamilton's results continue to hold when the sample is extended to include the recent oil market collapse and the oil price variable is corrected for the effects of price controls." Hamilton continued his scientific research and did a lot to increase our understanding of "the historical correlation between oil shocks and recessions" in this (Hamilton, 1996) and other scientific papers.

It is worth mentioning other influential papers, which have expanded our knowledge about the causes and effects of oil price shocks, the role of price variability and other serious topics. For example, (Lee, Ni,

[2] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

& Ratti, 1995) argued "that an oil price change is likely to have greater impact on real GNP in an environment where oil prices have been stable, than in an environment where oil price movement has been frequent and erratic." (Allsopp & Fattouh, 2011) focused "on issues surrounding international oil markets within the wider context of international energy, the global economy, and conflicting agendas such as energy security and climate change. It is suggested that important aspects of the current situation appear 'unsustainable' – increasing uncertainty and raising methodological difficulties for any assessment of likely future developments." (Segal, 2011) "examines the impact of oil price shocks and attempts to explain why the rise in oil prices up to 2008 had little impact on the world economy. It makes three main arguments. First, that oil prices have never been as important as is popularly thought. Second, that the most important route through which oil prices affect output is monetary policy: when oil prices pass through to core inflation, monetary authorities raise interest rates, slowing growth... The third argument is that high oil prices have not reduced growth in recent years because they no longer pass through to core inflation, so the monetary tightening previously seen in response to high oil prices is absent. It also argues that oil prices had little impact on the global recession of 2008-9". (Kilian, 2014) noted that "the real price of oil is endogenous with respect to economic fundamentals and that oil price shocks do not occur ceteris paribus, making it necessary to account for the deeper structural shocks underlying oil price shocks when studying their transmission to the domestic economy". (Baffes, 2015) are of the view that "The decline in oil prices has significant macroeconomic, financial and policy implications. If sustained, it will support growth and reduce inflationary, external, and fiscal pressures in a large number of oil-importing countries. On the other hand, sharply lower oil prices will weaken fiscal and external positions and reduce economic activity in a few oil-exporting countries." Such prominent authors as (Bernanke, Gertler, Watson, & Sims, 1997) increased our understanding of the role of monetary policy in postwar U. S. business cycles. Having examined over 40 years of data, (Difiglio, 2014) revealed that „oil price shocks are invariably followed by 2-3 years of weak economic growth and weak economic growth is almost always preceded by an oil price shock." (Van Robays, 2016) showed that „higher macroeconomic uncertainty causes higher oil price volatility. Oil market dynamics are found to differ when uncertainty in the global economy is elevated as oil prices become more reactive to changes in oil demand and supply. This effect is statistically and economically significant as the reaction of oil prices following a similar change in oil supply or demand might easily double when it hits the economy in uncertain". Other serious contributions into this field of knowledge include (Ferderer, 1996), (Finn, 2000), (Ebrahim, Inderwildi & King, 2014) and (van de Ven & Fouquet, 2017).

For obvious reasons, the developed oil-importing countries like the USA, China, Japan, Germany, etc. received overwhelmingly more attention. However, more and more scientists address the dependence between oil price shocks and dynamics of macroeconomic indicators in oil-exporting countries. For instance, (Eltony & Al-Awadi, 2001) examined "the impact of oil price fluctuations on seven key macroeconomic variables for the Kuwaiti economy". (Mehrara & Oskoui, 2007) considered the sources (with oil price shocks being one of them) of macroeconomic fluctuations in such countries through the examples of Iran, Saudi Arabia, Kuwait, and Indonesia. (Korhonen & Mehrotra, 2009) assessed "the effects of oil price shocks on real exchange rate and output in four large energy-producing countries: Iran, Kazakhstan, Venezuela, and Russia." (El Anshasy & Bradley, 2012) empirically investigated the role that oil prices play in determining fiscal policy in oil-exporting countries. (Pomfret, 2012) analysed "resource management experiences of seven resource-rich Asian transition economies" having among other countries Azerbaijan and Kazakhstan as examples. (Hou, Mountain, & Wu, 2016) used the example of Canada to study how oil price shocks affect an oil-exporting economy. (Cunado, Jo, & Perez de Gracia, 2015) investigated macroeconomic effects of oil price shocks in Asian economies. (Mohn, 2016) looked at the "the relationship between household saving and government saving in Norway" though this country represents a completely different case when comparing with other oil-exporting countries.

An interesting though controversial observation was made by (Rafiq, Sgro, & Apergis, 2016) that "a decline in oil prices is beneficial to oil exporters due to the quantity effect outweighing the price effect, while for oil importers a stable oil price is more desirable than a price decline. These results are important to take into account if we are to gain a full understanding on the magnitude of the trade and macroeconomic effects of oil price changes and what the policy responses should be."

As mentioned above, the amount of such literature is substantially smaller than the one for oil-importing countries. However, there is a growing number of scientific publications exploring this subject including the works of (Mehrara, 2008), (Gronwald, Mayr, & Orazbayev, 2009), (Alikhanov & Taylor, 2015), (Basnet & Upadhyaya, 2015), (Nurmakhanova, 2016), (Dikkaya & Veli Doyar, 2017), (Ybrayev, 2017), etc. Their findings can be summarized as follows:

- (Mehrara, 2008): "output growth is adversely affected by the negative oil shocks, while oil booms or the positive oil shocks play a limited role in stimulating economic growth.";
- (Gronwald, Mayr, & Orazbayev, 2009): "all variables under consideration in the VAR model – GDP, inflation, budget revenue, exports, and the real exchange rate - exhibit a significantly negative response to oil price declines";
- (Dikkaya & Veli Doyar, 2017): "we decide that there are unidirectional causalities running from oil prices to GDP, from exchange rate to GDP and oil prices to exchange rate for Kazakhstan.";
- (Nurmakhanova, 2016): "From the economic policy perspective, Kazakhstan should continue to decrease its dependency on energy prices in the longer run through reform policies."

Understandably, not very many literature sources address the period after the beginning of the last oil price plunge (after June 2014). However, the number of such papers is growing and we should mention the works of (Aastveit, Bjørnland, & Thorsrud, 2015), (Baffes, 2015), (Verleger, 2015), (Baumeister & Kilian, 2016b), (Kitous et al., 2016), (Aleksandrova, 2016), etc. One of the first such attempts was the article by (Tokic, 2015), which "suggests that the 2014 oil price collapse was possibly triggered by the falling Euro versus the US Dollar… The key argument presented in this article is that, as long as there are temporary economic growth divergences between the US and the EU, the resulting exchange rate volatility is likely to create the pricing inefficiencies in crude oil, which in fact are mean-reverting, as the economic growth divergences eventually dissipate." Describing global implications of lower oil prices (Husain et al., 2015) advise that "oil exporters will need fiscal adjustments, with their magnitude and pace varying according to the size of buffers (fiscal vulnerability)." An interesting paper was published by (Vandyck et al., 2018) who estimated "the macroeconomic impacts of a 60% oil price drop for all regions in the world." They also reflected "on the broader implications (such as migration flows) of macroeconomic responses to oil prices and look ahead to the challenge of structural change in a world committed to limiting global warming." Unfortunately the number of scientific papers devoted to oil-importing countries is substantially bigger than the number devoted to oil-exporting ones. This article is an attempt to close this gap.

3. METHODOLOGY

3.1. Data

This paper studies how oil price changes influence such macroeconomic variables as inflation, government revenues and exports. Choosing these variables the author intended to compare his results with the earlier researches, in particular with the results obtained by (Gronwald et al., 2009) who also considered the same macroeconomic variables. Even though many authors of similar articles consider the influence of oil price shocks on exchange rate, this is not possible for Kazakhstan where the exchange rate regime is often conditioned by political considerations.

The author abstained from considering bigger number of macroeconomic variables because they require longer time series, which are not available. Also, the author wanted to avoid collinearity of the variables under consideration.

The following four variables were selected:

1. OP – Crude oil price (Brent), US$/barrel;
2. CPI – Consumer price index used as a measure of Inflation;
3. GR – Government revenues, Kazakhstan tenge million (national currency);
4. E – Exports, US$ million.

Data on consumer price index, government revenues and exports were obtained from the Statistics Committee of Kazakhstan web-site and data on Brent crude oil price were obtained from the Bloomberg markets web-site.

Quarterly data from the beginning of 2003 till the end of 2017 are used in this research. The author did not consider earlier data because the country joined the IMF's Special Data Dissemination Standard (SDDS) in 2003 and to achieve this Kazakhstan had to amend some of its statistics methodologies.

All variables presented in logarithmic form. Time series plot of these variables is shown on Figure 1 below.

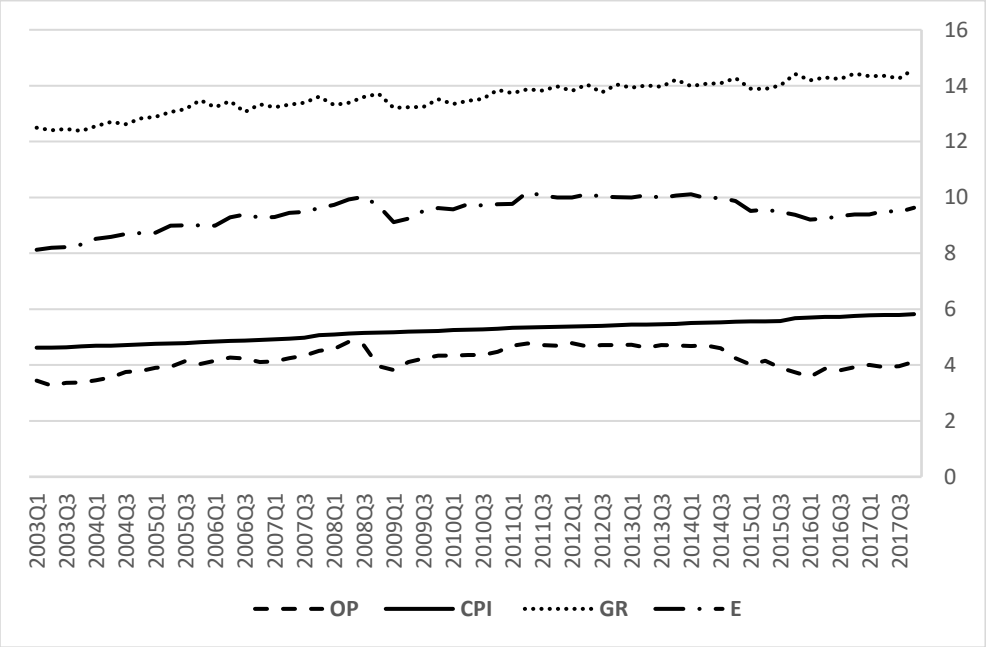

Figure 1. Time series plot

Source: Own construction based on Statistics Committee of Kazakhstan and Bloomberg markets data

3.2. Research methods

Since the seminal work by (Sims, 1980) vector autoregressive models, in which all variables are considered as endogenous, have become one of the main instrument in macroeconomic studies. The relevant literature considers VAR as one of the best models for studying the relationship between oil prices and macroeconomic variables in oil-exporting countries, and, as mentioned in the Literature review above, numerous authors applied VAR models for studying consequences of oil price shocks. The same model is usually employed for investigating the effect of oil price shocks on the economy of Kazakhstan and is applied in this article.

The foundation of the VAR model presented in this article is based on the classic research on the relationship between oil prices and macroeconomic indicators. The VAR theory is well known and omitted here for brevity.

Tests and explanations below demonstrate that the selected method as well as the data used are acceptable for the purpose of the present article.

3.2.1. Unit root test

Estimation of the VAR parameters requires the time series to be covariance stationary. ADF (Augmented Dickey Fuller) test was applied to check stationarity.
The author started the test from 10 lags using Akaike information criterion.

Table 2

Results of the ADF unit root test

Level				First order difference			
Variables	**Lag**	**t-statistic**	**P-value**	**Variables**	**Lag**	**t-statistic**	**P-value**
OP	1	-2.72672	0. 06946	d_OP	1	-5.67315	7.031e-007
CPI	0	-0.337332	0. 9124	d_CPI	0	-6.41104	8.046e-007
GR	5	-1.79982	0.3811	d_GR	6	-3.77656	0.003171
E	1	-2.58435	0.1019	d_E	1	-5.81966	3.213e-007

Source: own calculation
d_ - first order difference operator

The test shows that the selected time series become stationary in the first difference form, which will be used further.

3.2.2. Selection of lag

Three different lags of orders 8, 4 and 2 were tested using different information criteria. The lag order 4 demonstrated the best values and was finally selected. It is worth mentioning that the lag order 4 is normally recommended for quarterly data.

3.2.3. Estimating the VAR

Initial estimation
Below are the excerpts from the VAR estimation:

VAR system (lag order 4)
OLS (Ordinary least squares) estimates of observations 2004:2-2017:4 (T = 55)
Log-likelihood = 315.13556
Determinant of covariance matrix = 1.2396981e-010
AIC = -8.9867
BIC = -6.5050
HQC = -8.0270
Portmanteau test: LB(13) = 158.882, df = 144 [0.1874]

3.2.4. Tests

Table 3

Test for autocorrelation, order up to 4

	Rao F	**Approx. dist.**	**p-value**
lag 1	1.289	F(16, 95)	0.2205
lag 2	0.790	F(32, 101)	0.7744
lag 3	0.744	F(48, 90)	0.8688
lag 4	0. 715	F(64, 76)	0.9155

Source: own calculation

The author could not reject the null-hypothesis of no autocorrelation as p-value exceeds 5% for all lags. The absence of autocorrelation indicates that the estimators are consistent as the data are independently distributed.

Table 4

ARCH Test, order up to 4

	LM	**Df**	**p-value**
lag 1	106.285	100	0.3148
lag 2	195.222	200	0.5822
lag 3	297.222	300	0.5345
lag 4	414.208	400	0.3015

Source: own calculation

The null hypothesis is that there is no ARCH (autoregressive conditional heteroskedasticity) effect present. The author could not reject the null hypothesis at 10%. The absence of ARCH effect implies conditional homoscedasticity.

Table 5

Normality of residuals test
Residual correlation matrix, C (4 x 4)

1	0.20733	-0.056653	0.65909
0.20733	1	0.41409	0.15420
-0.056653	0.41409	1	-0.073443
0.65909	0.15420	-0.073443	1

Source: own calculation

Eigen values of C
0.338
0.533395
1.37772
1.75089
Doornik-Hansen test
Chi-square (8) = 24.2703 [0.0021]

The Doornik-Hansen test gives the p-value less than 5%. This result indicates that this VAR is not normally distributed. To understand where the problem is, there is a need to test the normality of residuals

for each series. Based on the results received, the author rejected the normality of residuals for the Inflation equation as having the p-value less than 5%.

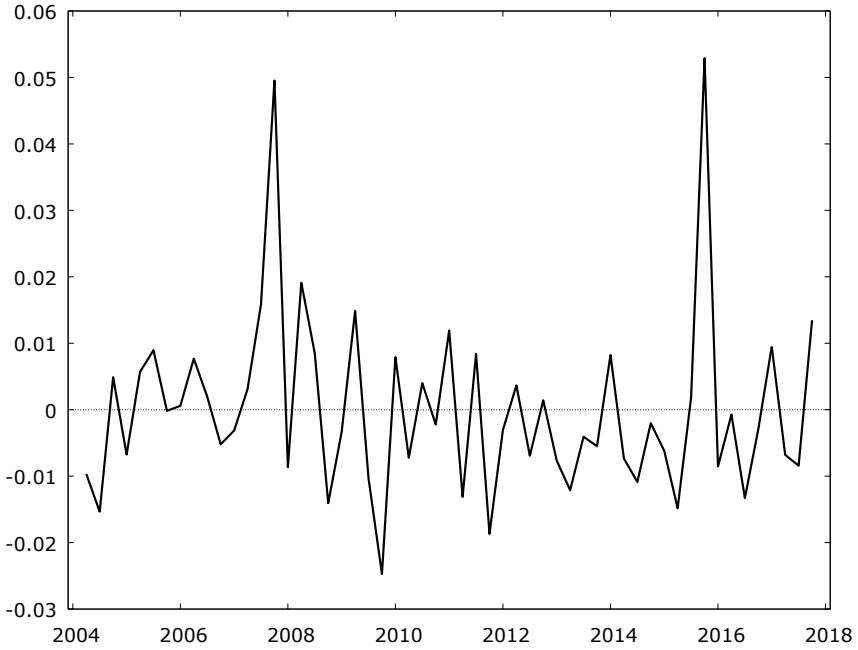

Figure 2. Residuals plot for the Inflation equation

Source: Own construction

The inclusion of two dummy variables corresponding to the outliers of 4th quarter 2007 and 4th quarters 2015 makes this VAR normally distributed. Now it can be presented as follows:

VAR system (lag order 4)
OLS estimates, observations 2004:2-2017:4 (T = 55)
Log-likelihood = 360.18589
Determinant of covariance matrix = 2.4091136e-011
AIC = -10.3340
BIC = -7.5603
HQC = -9.2614
Portmanteau test: LB(13) = 182.283, df = 144 [0.0170]

Worth pointing out that these two outliers correspond to the crisis on the Kazakh real estate market of the second half of 2007 and the introduction of the freely floating exchange rate regime in Kazakhstan in August 2015.

This VAR also passes autocorrelation and ARCH tests.

3.2.5. Asymmetry of oil price shocks and the application of structural VAR approaches

Even though both approaches widely applied in similar researches, the author decided not to employ them in this article because of the following:

- The already mentioned (Korhonen & Mehrotra, 2009) reported that "we are not able to reject the null hypothesis of linearity for Iran, Kazakhstan or Russia." (Nurmakhanova,

2016) who studied this situation pointed out that their work was "The only study that tested whether the impact of oil prices on economic activity of Kazakhstan". The author of this article was not able to find such studies either.

- (Gronwald et al., 2009) found that "a standard linear VAR model is appropriate for capturing the Kazakh oil-macro relationship." Also, in Table 1 above, Kazakhstan demonstrated the highest GDP decrease from 2014 to 2016. This is a very strong sign of high dependency of the Kazakh economy on oil price fluctuations.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1. Impulse response functions

Impulse responses of macroeconomic indicators to oil price shocks are given on plots below and clearly demonstrate the dependence of macroeconomic variables under consideration on oil price fluctuations.

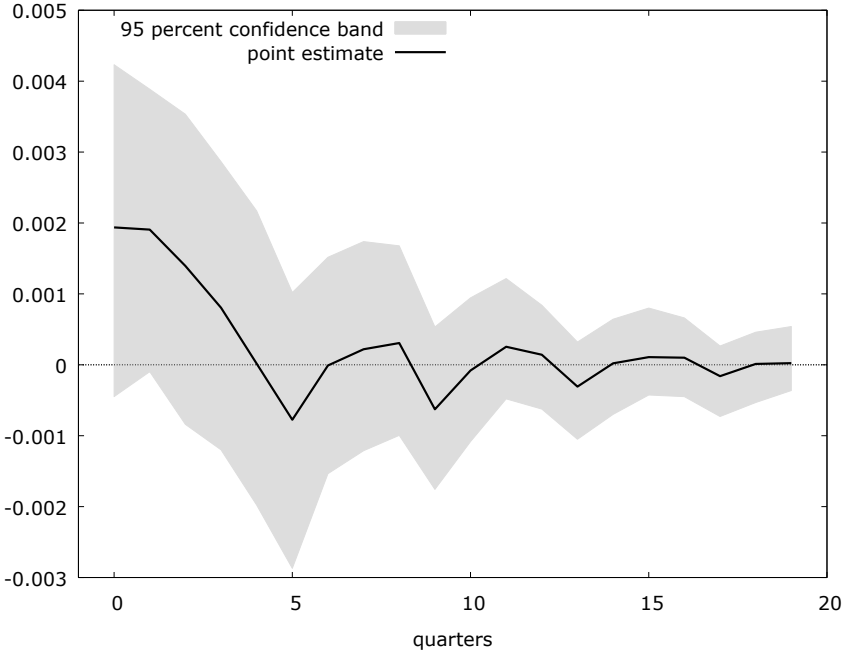

Figure 3. Impulse response: Inflation to a shock in oil price

Source: Own construction

The peak of impact of an oil price shock on inflation remains high during the 1st and the beginning of the 2nd quarter and a relaxation emerges after about 5 quarters. The results of (Gronwald et al., 2009) are different. They reported that "the peak emerges after 3 quarters and it vanishes after about 8 quarters already." This means that after 2009 the dependence of inflation on oil price movements in Kazakhstan became even bigger.

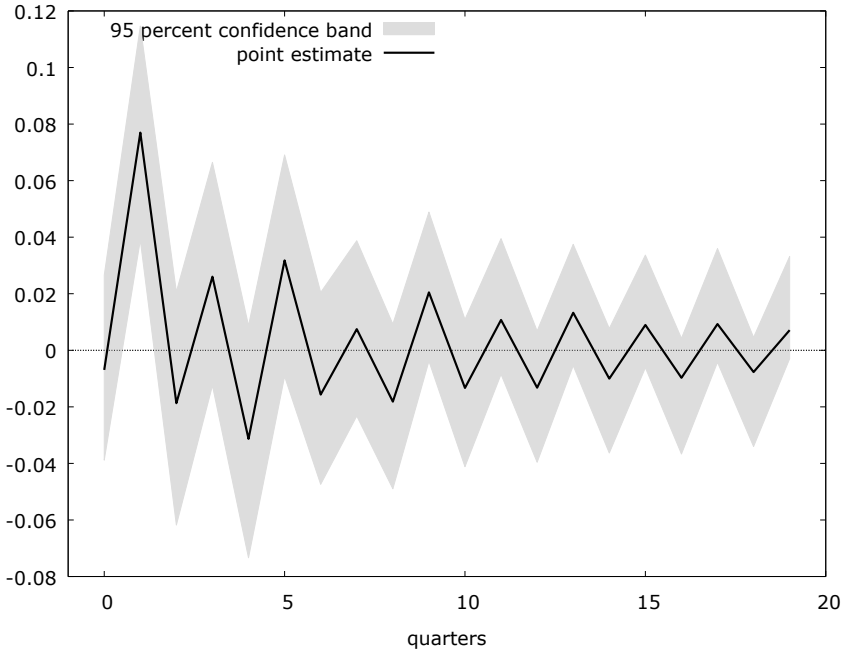

Figure 4. Impulse response: Government revenues to a shock in oil price

Source: Own construction

The impact of an oil price shock on government revenues reaches its peak during the 1st quarter, remains substantial until the 5th quarter and decreases soon after. (Gronwald et al., 2009) reported somewhat different situation (3rd and 5th quarters respectively). This is another confirmation of the increased dependency of the Kazakh economy on oil price fluctuations.

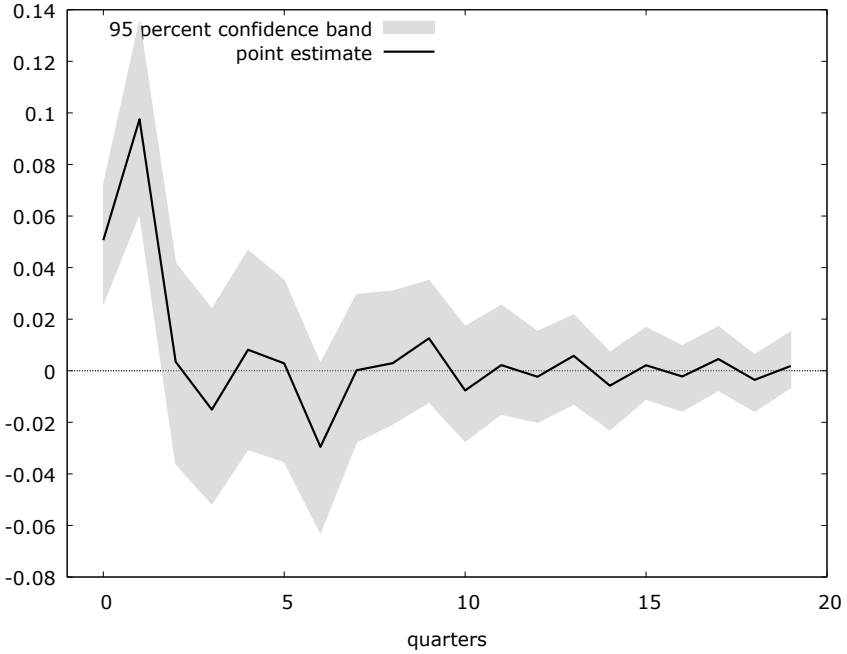

Figure 5. Impulse response: Exports to a shock in oil price

Source: Own construction

The plot above demonstrates how oil prices and exports are correlated. Again the picture is very close to the reported by (Gronwald et al., 2009) who found that "a 10% decline in prices leads to about 6% decline in exports". For the time period considered in the present article this decline is equal to 5%.

4.2. Variance decomposition

The results of the forecast error variance decomposition show the proportion of the changes in a variable due to its own shocks versus shocks to the other variables. These results are shown in Attachment 1.

The results once again demonstrate how essential the role of oil in the Kazakh economy is. Interestingly, inflation is the most isolated from the oil price fluctuations. This is happening because until mid-2015 the Kazakh government was controlling inflation keeping it within a certain limit. However, since August 2015 when the Kazakh government introduced the freely floating exchange rate regime, inflation grew rapidly from 4.38% in the 3rd quarter of 2015 to 13.53% in the 4th quarter of the same year and remained high (from 15% to 17%) till the 4th quarter of 2016. The year of 2017 demonstrated the downward trend with inflation going down to 7.1%. For the other macroeconomic variables under consideration the role of oil price fluctuations is also very substantial.

The influence of government revenues on inflation is also noticeable, which in case of Kazakhstan is a sign of pro-cyclical fiscal policy. High budget revenues take place during economic expansion. At the same time, in the Kazakhstan's environment economic expansion itself causes inflation. Again, in the Kazakhstan's environment, high budget revenues loose the fiscal regime and this in turn further overheats the economy. This approach to the fiscal regime makes the government budget unbalanced when its revenues decrease.

The oil price was high during 2011-2013 period, which resulted in unprecedented levels of government revenues. However, the government continued to withdraw sizeable amounts from the National Oil Fund ($9.2 billion per annum), which accelerated inflation during that period. And when the oil prices dropped, the government faced primary deficits over 10% of GDP (2015-2016).

5. CONCLUSION

The presented research is important because of two main considerations:

- As mentioned above, the oil-importing countries like the USA, China, Japan, Germany, etc. receive overwhelmingly more attention in comparison with oil-exporting ones:
- This research is one of very few, which studies the influence of oil price shocks on the Kazakh economy and the first research, which considers this influence of oil price shocks on the Kazakh economy after the last oil price plunge, which started in June 2014.

Therefore, this article is trying to fill these two significant gaps in our knowledge.

Even though the main results described in this article generally support earlier researches on the same subject. However, there is a certain discrepancy with them. As in the earlier researches, the macroeconomic variables under consideration demonstrated significant correlation with oil price fluctuations, but the main difference with these researches is that the dependence of the Kazakh economy on oil price fluctuations substantially increased since the previous oil price plunge of 2008. Specifically, it is demonstrated that for two variables under consideration, namely inflation and government revenues, the peak of impact of an oil price shock on these variables takes place quicker than before. There is no substantial difference for exports, but this is easily explained by the big share of oil in Kazakh exports.

Another important result is the timeframe during which the influence of oil price shocks is actually significant. This result has important implications for the Kazakh government planning purposes. Actually

not only Kazakh because the economic situations in such oil-exporting neighbours of Kazakhstan as Azerbaijan and Russia are very similar.

These results corroborate the need to decrease the dependence of oil-exporting countries on oil price fluctuations. Among the ways to achieve this goal, are such measures as stringent counter-cyclical economic policies and economic diversification.

Kazakhstan and other oil-exporting countries. The author is planning to continue studying this subject and to undertake a comparison of how several oil-exporting countries react to oil price shocks.

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