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# Estimating the effects of oil price shocks on the Kazakh economy

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## Abstract

This paper explores the role of oil for the Kazakh economy. In order to assess the degree of volatility the oil price features, it, firstly, discusses the literature on oil price behaviour. Secondly, it analyzes the effect of oil price declines on key macroeconomic variables such as real GDP, inflation and real exchange rates using vectorautoregressive (VAR) models. In this respect, the paper deviates from a large number of papers on oil price effects as it considers a transition rather than a developed economy and an oil exporting rather than an oil importing country. The key findings to emerge from this paper are, first, that the price of oil is influenced by a large number of factors, which results in a considerable degree of volatility. Secondly, all variables considered in the VAR model exhibit a strong negative significant reaction on oil price declines, and, thirdly, a standard linear VAR model is appropriate for capturing the Kazakh oil-macro relationship.


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## 1. Introduction

The price of oil attracts a considerable degree of attention for many decades. Various attempts have been undertaken to explain the behaviour of the oil price as well as to assess the macroeconomic consequences of oil price shocks. On the oil price behaviour front, three main approaches can be identified. There is, first, the notion that oil is an exhaustible resource. A second line of research uses macroeconomic demand and supply frameworks in order to explain oil price behaviour. The so-called informal approach, third, is concerned with issues such as OPEC power and the role of speculation. Fattouh (2007) provides an excellent survey of this literature. On the oil-macro front Hamilton's (1983) seminal paper is of particular importance. It pointed to the strong relationship between oil price shocks and U.S. recessions for the first time and sparked enormous research efforts. Hamilton (1983) applies a vectorautoregressive (VAR) model - a model class recently popularized by Sims (1980). Henceforth, this method was the most commonly used one in the empirical oil-macro research area. The main focus of this literature, however, is the U.S. economy and the key question is how oil price increases affect macroeconomic variables such as GDP growth and interest rates. Only a few papers investigate this issue for other countries than the U.S. and consider oil exporting countries, see e.g. Mork et al. (1994) as well as Jimenez-Rodriguez and Sanchez (2005). Recent papers include Blanchard and Gali (2007) and Gronwald (2008); Kilian (2008) provides an excellent survey of this literature.

This paper is concerned with the role of oil for the Kazakh economy. This role is investigated by, first, an in-depth discussion of factors influencing the price of oil. Having a sufficient understanding of these factors is crucial for the assessment of the volatility the oil price features. Secondly, it applies a VAR model in order to investigate the macroeconomic consequences of oil price shocks. As Kazakhstan is a large oil exporter rather than oil importer and a transition rather than a developed economy, this paper differs from the largest

part of the empirical oil-macro literature. This implies that the effect of oil price decreases rather than oil price increases on key macroeconomic variables is investigated.

The key results to emerge from this paper are twofold. Firstly, the oil price is subject to a large variety of factors of influence. Thus, the price of oil features a considerable degree of volatility. Secondly, 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. Considering these two results in unison suggests that large oil price fluctuations are likely to appear also in the future and that the Kazakh economy is very vulnerable to oil shocks. Thirdly, a standard linear VAR model is appropriate for capturing the Kazakh oil-macro relationship. This last result is of particular importance as the oil-macro relationship for major economies such as the U.S. has found to be non-linear, see e.g. Hamilton (1996) and Jimenez-Rodriguez and Sanchez (2005).

The remainder of this paper is organized as follows: Section 2 discusses theoretical and empirical papers on oil price behaviour. Section 3 describes the data as well as presents the empirical methodology; Section 4 provides an overview of the Kazakh economy. Section 5 presents the empirical results and a short discussion of which and Section 6 concludes.

## 2. Oil price behaviour

Having a sufficient understanding of the behaviour of the oil price is crucial for an appropriate assessment of the results as well as the derivation of policy recommendations. Therefore, this section summarizes existing research on oil price behaviour in order to develop an academic fundament for this paper's empirical investigation of the Kazakh economy.

Various attempts to explain the behaviour of the oil price have been undertaken in the past few years. Three main approaches can be identified in this vast literature: first, Hotelling's (1931) notion of oil as exhaustible resource; second the ascertainment that the global macroeconomic situation is an important factor, and, thirdly, the notion that additional factors such as OPEC announcements as well as speculation affect the price of oil.

Regarding the first approach, Hotelling's (1931) seminal paper proposes the notion that oil is exhaustible and that the price of oil, in optimum, grows at the rate of interest. Various extensions of this rule have been suggested and are still subject of scientific debates, see e.g. Sinn (2008). Krautkraemer (1998) and Hamilton (2008) provide useful surveys of this literature. In particular Krautkraemer (1998), however, provides evidence of frequent failure of empirically testing Hotelling-type hypotheses. Dvir and Rogoff (2009) epitomize this scepticism: they apply a storage rather than a Hotelling resource extraction model in order to model oil price behaviour. Papers such as Slade (1982) and Pindyck (1999) deal with oil price behaviour in the very long run. These papers deal with the question as to whether the price of oil follows a deterministic trend. While Slade (1982) finds evidence of quadratic trends in real oil prices, Pindyck (1999) argues that the oil price fluctuates around a long-run trend. The trend itself is - due to changes in demand, extraction costs and new site discoveries – stochastically fluctuating over time. Livornis (2009) provides an excellent survey of this literature and expresses a less pessimistic view on the significance of the Hotelling rule.

In contrast to this line of research, Krichene (2002) and Dees et al. (2007) argue that the price of oil is determined by global economic conditions and employ demand and supply frameworks in order to explain the oil price. Krichene (2002) uses a structural multiple equation model of the global oil market and focuses on the calculation of demand and supply elasticities. Among the more salient findings of this paper is that short-run demand and supply

of oil is very price inelastic and that long-run oil supply elasticity significantly decreased after the first oil crisis 1973/74. Dees et al. (2008), in contrast, use a country-by-country approach and explicitly incorporate geological factors [Hubbert, 1962] as well as OPEC behaviour in their oil supply function. The model is generally able to reproduce responses of the global oil market to changes in OPEC behaviour.

The papers by Kaufmann et al. (2004) and Dees et al. (2008) also focus on the role of OPEC behaviour, but do not explicitly model oil supply. Both papers make use of an error correction approach and show that variables such as OPEC capacity utilization and OPEC quotas Granger cause real oil prices but not vice versa. While these results are more of very general character, Lin and Tamvakis (2009) show that the effect of OPEC announcements depends on whether the price of oil is high or low. Kaufman and Ullmann (2009), furthermore, show that the 2008 oil price hike can be explained by a combination of fundamental factors and speculative behaviour, and Miller and Ratti (2009), finally, provide evidence of the existence of oil price bubbles.

The oil price also attracted considerable attention from the area of financial econometrics. Issues such as oil price volatility, hedging exercises, and oil price forecasts have been discussed in a vast literature. The pure fact that sophisticated empirical techniques such as GARCH models, artificial neural networks and jump-diffusion processes are used signals that oil price behaviour is not easy to capture.

To summarize, the price of oil is affected by numerous factors and subject to a considerable degree of volatility. Hamilton (2008) nicely summarizes these findings: “Changes in the real price of oil have historically tended to be (1) permanent, (2) difficult to predict, and (3) governed by very different regimes at different points in time.”. Thus, deriving future

predictions is a very difficult task. In any case, expecting the oil price to begin a stable increase in the near future would definitely be hazardous.

## 3. Data and Methodology

Having discussed the literature on the behaviour of the price of oil, this section now describes the sources of the data used in Section 4 and 5 and briefly outlines the VAR approach. The main dataset consists of quarterly values for real GDP, budget revenues, exports, inflation, monetary aggregate M2 as s measure of the monetary base, real exchange rate and the oil price and spans a period from 1994 Q1 to 2007 Q4. Data on real GDP, budget revenues, inflation and M2 are obtained from the Agency for Statistics of the Republic of Kazakhstan. The agency compiles the statistics on national accounts in line with the international standards. Export data is taken from the Kazakh Ministry of Finance, and oil production projections are obtained from the Kazakh Ministry of Economy. As the time series on real GDP, budget revenues and exports exhibit a seasonal pattern, they are seasonally adjusted using the X12 census method.

To quantify the effects of negative oil price shocks on main macroeconomic aggregates in Kazakhstan, we employ a standard vector autoregressive (VAR) model that includes the oil price, CPI inflation and the monetary base. This baseline model is expanded by adding one of the following macroeconomic variables: real GDP, budget revenues, exports and the real exchange rate.

We estimate the VAR-models in levels and include a linear trend. Due to the shortness of the time series, we restrict the lag structure to two lags. By doing the analysis in levels we allow for implicit cointegration relationships in the data, and still have consistent estimates of the

parameters[1]. Within the impulse response analysis, the innovations of the VARs are orthogonalized using a Cholesky decomposition of the covariance matrix of the reduced form VAR. In order to ensure robustness of the results, we permute the ordering of the variables and report the mean of the impulse responses of each of the variables in the respective VAR system. The 95 % confidence intervals for the impulse responses based on the centered residuals are constructed for each ordering of the respective VAR system to reflect the estimation uncertainty[2]. Again, for robustness reasons, we report the mean values.

## 4. Overview of the Kazakh economy

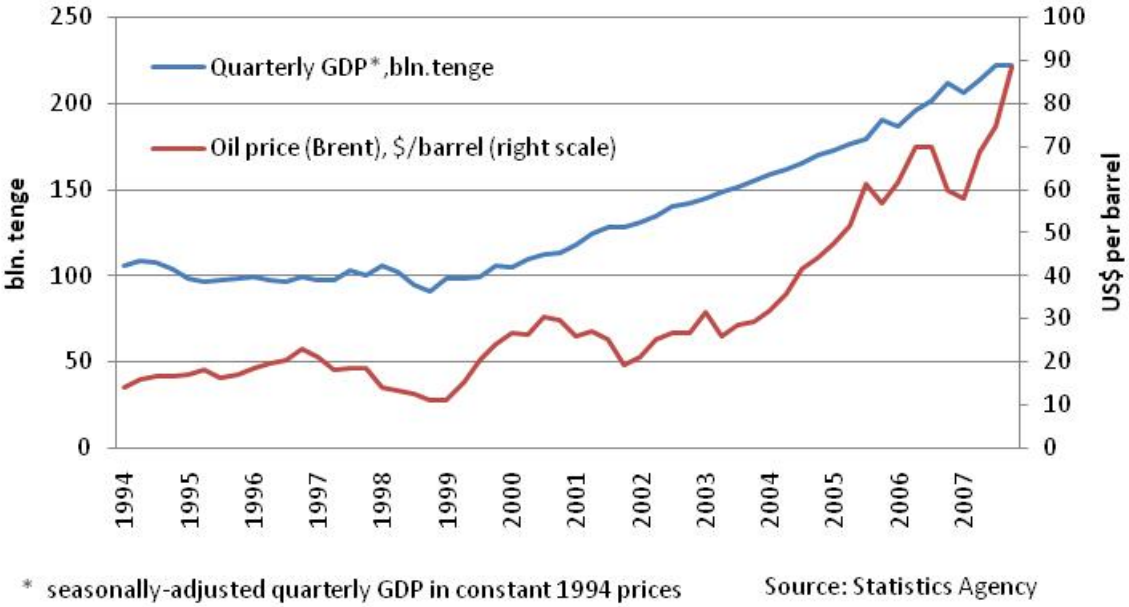
This section provides an overview of the Kazakh economy with a particular focus on the role of oil. Consulting Figure 1's time series plot of GDP as well as the oil price provides a first impression in this regard. It is evident that both variables follow a very similar pattern: a more horizontal movement is present between 1994 and 1999/2000, followed by a relatively steep increase from 2001 on. Figure 2 confirms this impression: the scatterplot shows that high levels of GDP are accompanied by high levels of the price of oil.

The consideration of the oil export – GDP ratio further illustrates this strong oil dependency of the Kazakh economy. Figure 3 displays this ratio for Kazakhstan between 2000 and 2006 and shows that this ratio is constantly between 20% and 40%. Furthermore, a slight increase of this ratio in the last few years is present. Figure 4's cross country comparison of average values for the same period shows that this ratio is higher for the Kazakh economy than for countries such as Norway and Venezuela. These economies are usually considered oil dependent. Essentially only for Gulf and a few African countries higher export-GDP ratios are present. These figures vividly illustrate that the Kazakh economy is characterized by an enormous share of oil. The extraction projections displayed in Figure 5, finally, suggest that

[1] See e.g. Sims et al (1990).
[2] In this study, we employ Hall's (1992) percentile interval.

this is likely to remain unchanged in the near future.

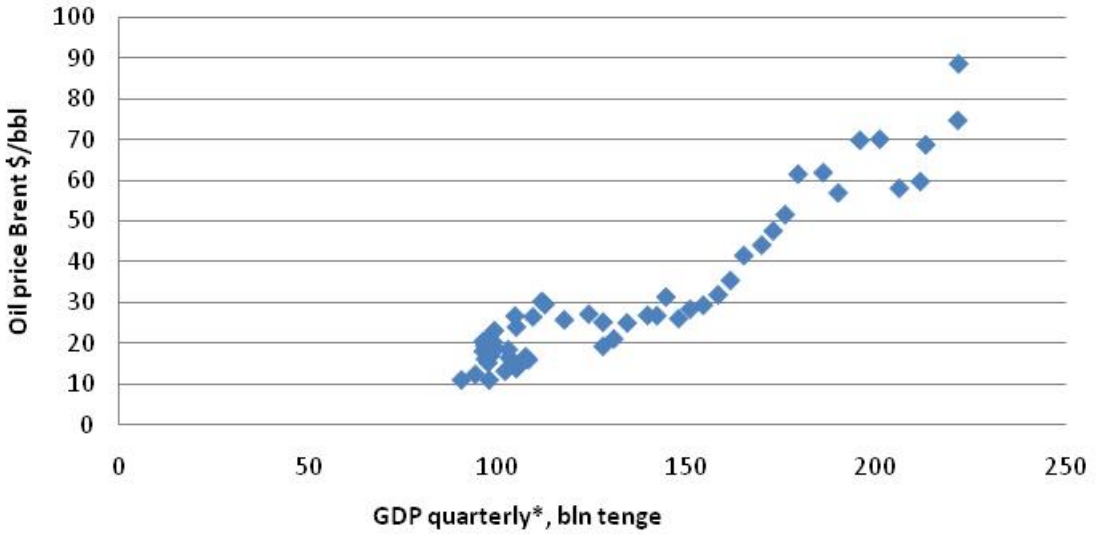
**Figure 1: Kazakh oil price – GDP relationship I**




* seasonally-adjusted quarterly GDP in constant 1994 prices

Source: Statistics Agency

**Figure 2: Kazakh oil price – GDP relationship II**




* seasonally-adjusted quarterly GDP in constant 1994 prices

Source: Statistics Agency, IFS

**Figure 3: Oil exports to GDP I**

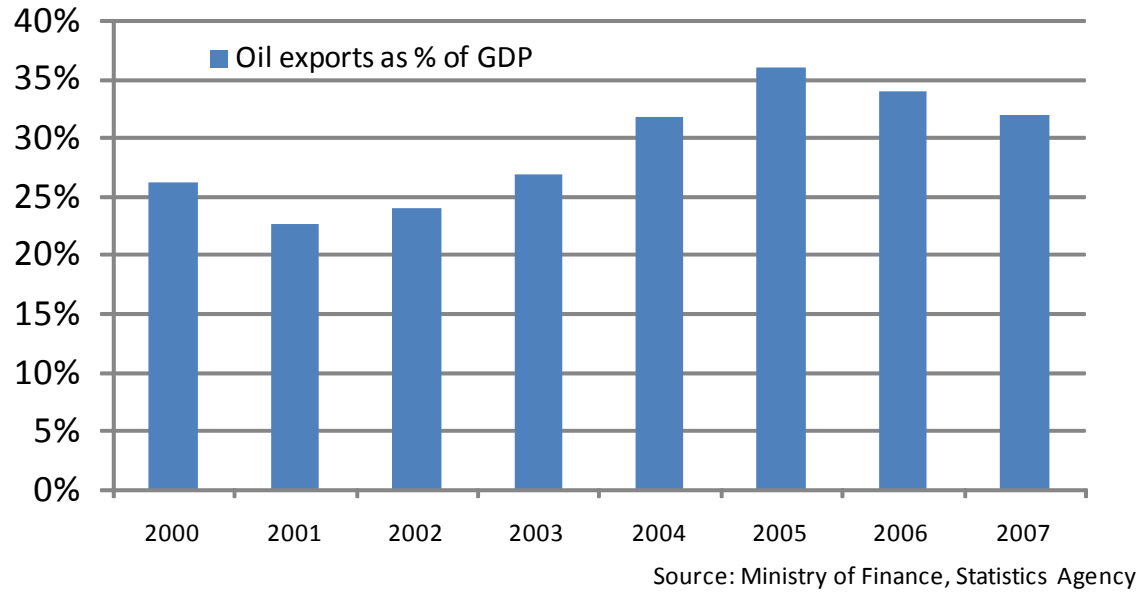



**Figure 4: Oil exports to GDP II**

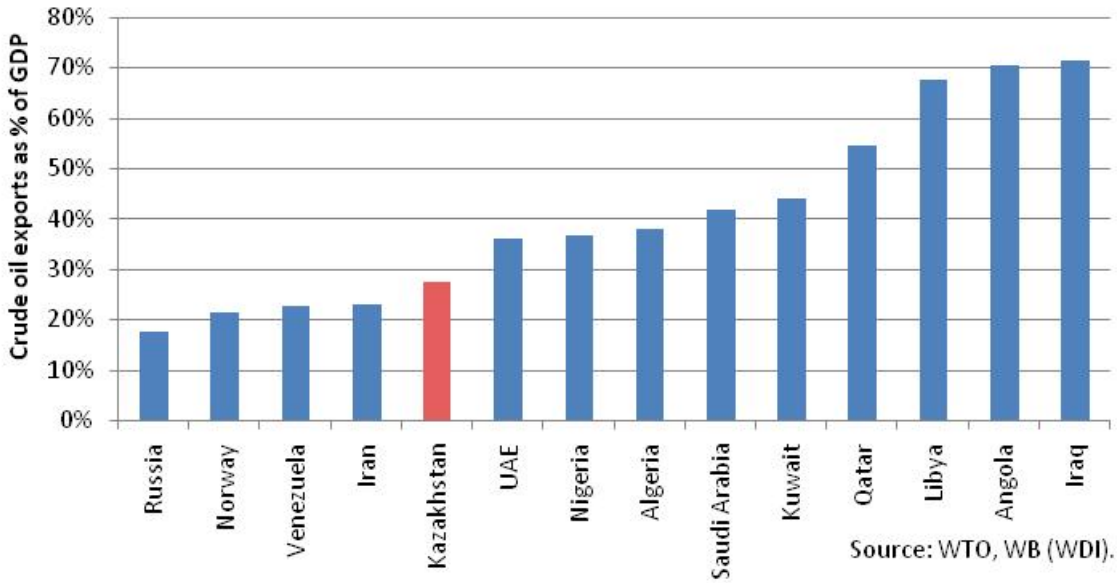
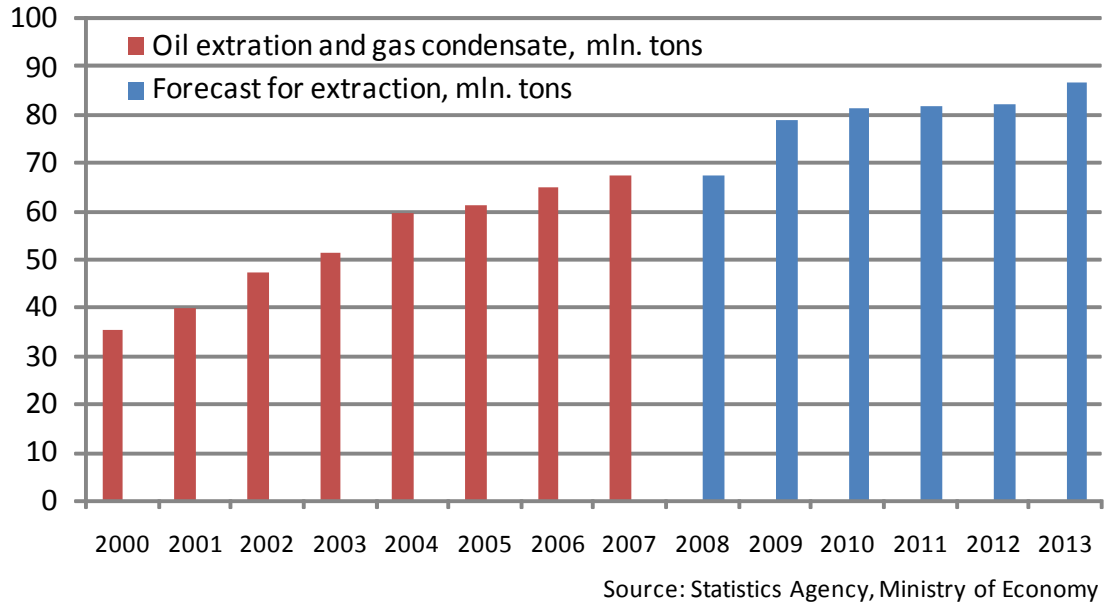


**Figure 5: Extraction**




The impact of oil price shocks on Kazakhstan´s economy is mitigated by the National Fund. It was created in 2000 as a stabilization fund that ensures that the economy will be vulnerable to price swings of oil, gas, and metals. The assets of the National Fund are monitored by the National Bank of Kazakhstan. Tax, royalty and other payments related to the use of natural resources (except region-level tax payments) are directly transferred to the National Fund. About 55 oil companies and several other extracting companies (zinc, copper, etc) pay into the fund. There is a fiscal rule that determines guaranteed transfer payments from the National Fund to the national budget. The yearly amount of guaranteed transfer ($GT_t$) is determined as a function of the value of assets of the previous year ($NF_{t-1}$), a constant determined by law (A), the average return on investment of the fund (b) and the exchange rate (e):

$$GT_t = A + b\left(NF_{t-1}\right)e$$

By law, transfers cannot be greater than a third of the total value of assets (currently about 20

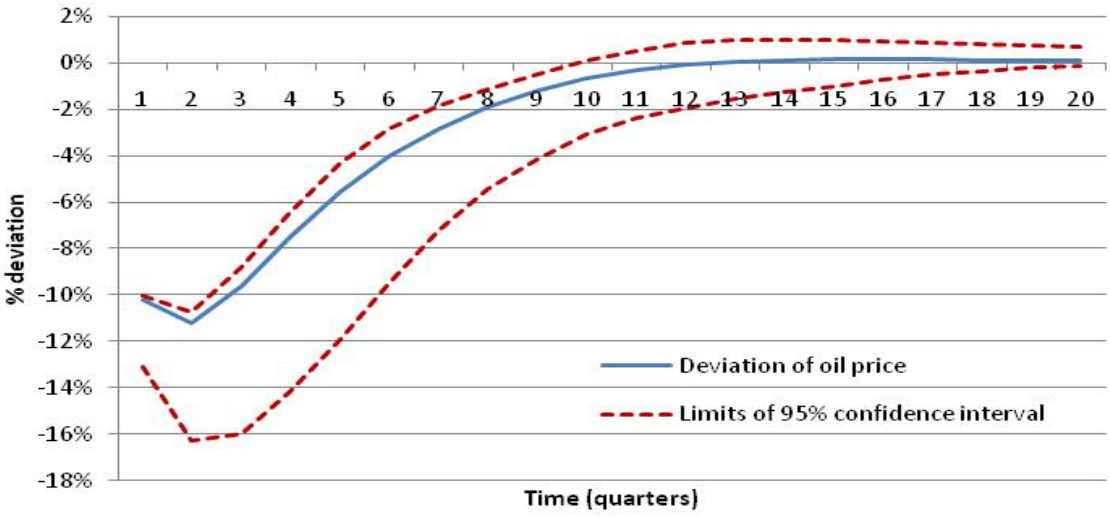
billion US Dollars).

## 5. VAR Estimation Results

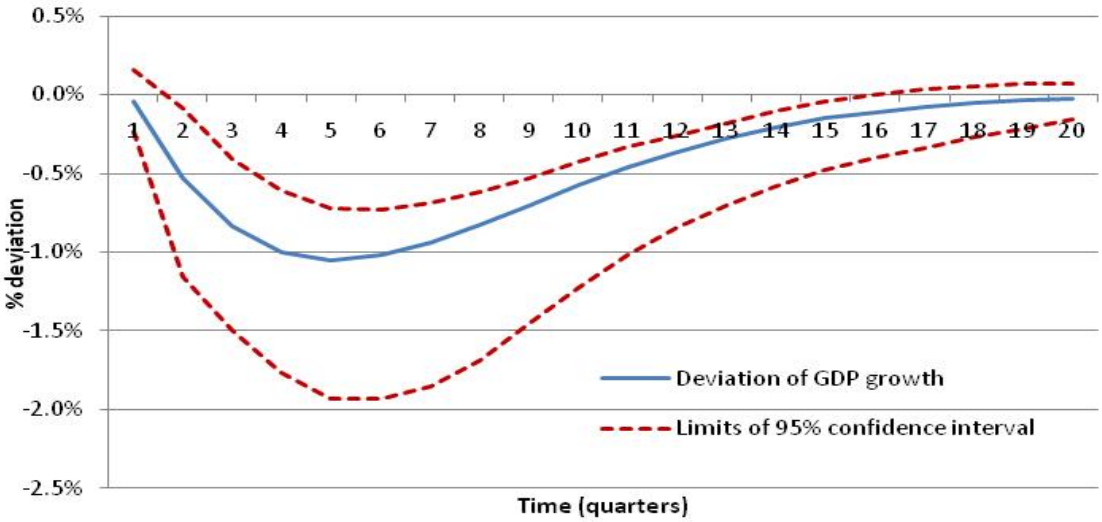
The impact of oil price shocks on key macroeconomic variables for Kazakhstan´s economy is estimated using a vector autoregressive model. The following figures display the estimated response of each of the variables to a simulated shock to the oil price of one standard deviation. This corresponds to a decline of the oil price of about 10 %.

**Figure 6: Impulse Responses I**

***Oil Price***



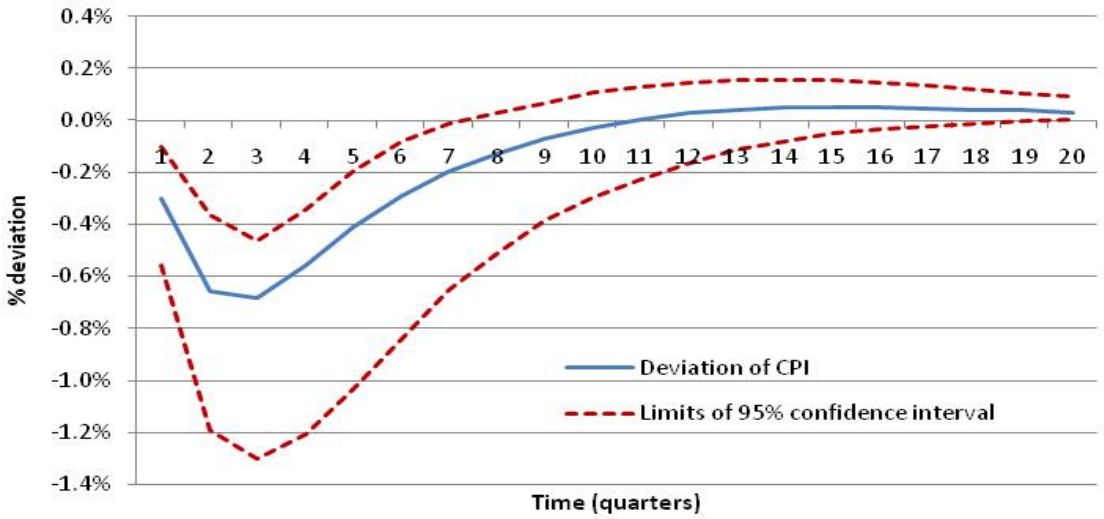

***GDP***



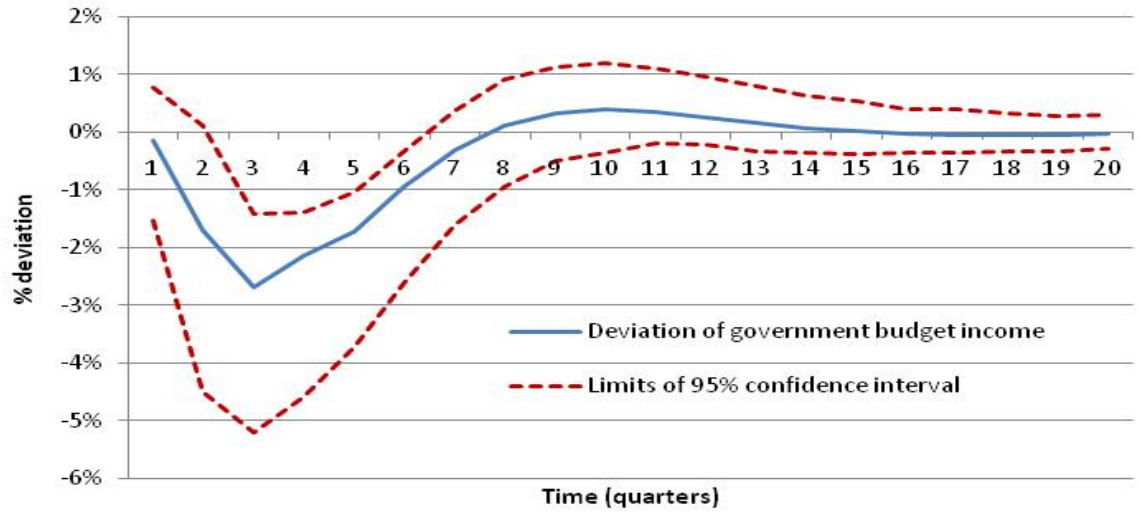
The impact of an oil price shock on real GDP growth reaches its peak after 5 quarters and a relaxation of the effect arises after about 15 quarters. This result reflects the strong oil dependency of the Kazakh economy and is anticipated from Section 4's illustration of which.

**Figure 7: Impulse Responses II**

***Inflation***




***Budget revenue***

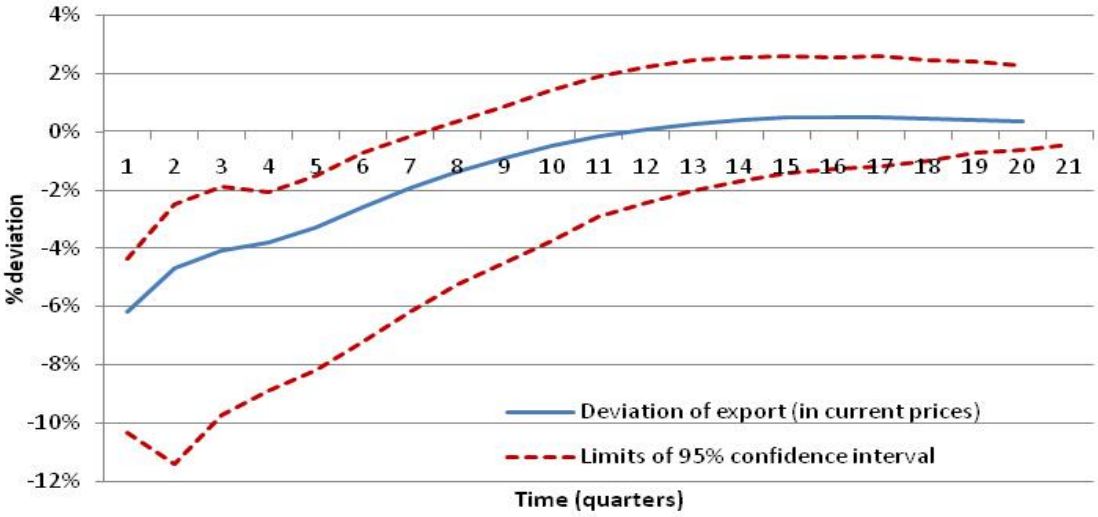



The impact of an oil price shock on inflation is considerably different: the peak emerges after 3 quarters and it vanishes after about 8 quarters already. Given the high degree of dependence

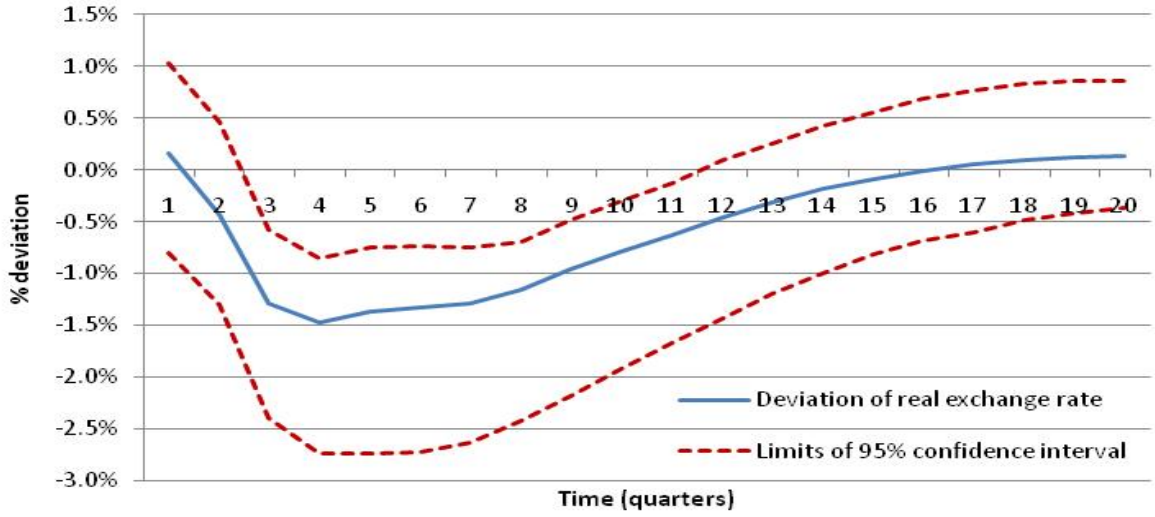
of many basic commodity prices on energy costs (e.g. transportation, processing), this result is not surprising. Budget revenues are, despite the implemented mechanism of transferring oil and gas sector taxes to the National Fund, highly dependent on the development of the oil and gas sector. Other sectors are indirectly related to the activity in oil sector, e.g. trade, transportation and construction. Hence, the observed response of government income to a decline in oil prices is not surprising either.

**Figure 8: Impulse Responses III**

***Exports***




***Real exchange rate***




The relationship between oil prices and the volume of exports is as follows (see Figure 8). Decreasing oil prices result in a decreasing value of exported oil. Given that the share of oil in

total exports is about 60%, the estimated response is reasonable (a 10% decline in prices leads to about 6% decline in exports). The impact of an oil price decline on the real exchange rate peaks after 4 quarters and lasts for another 8 quarters.

It is worth noting that these results are obtained from applying a standard linear VAR model. For countries such as the U.S., in contrast, the oil – macro relationship has found to be asymmetric and non-linear. The asymmetry-finding goes back to Mork (1989), who finds that oil price increases negatively affect macro variables, but oil price decreases do not have a correspondingly positive effect. Other papers such as Hamilton (1996) and Gronwald (2008) propose so-called non-linear oil price specifications in order to appropriately capture the U.S. oil- macro relationship.

To summarize the results of this empirical part of the paper, all macroeconomic variables under consideration in this paper exhibit a significantly negative response to oil price declines. Recall that Section 2's literature review clearly suggests that the price of oil is subject to various influences, which results in a considerable degree of oil price volatility. Thus, it is very likely that the Kazakh economy will continuously confront volatile oil price movements in the foreseeable future. The strong responses of key macroeconomic variables, in consequence, indicate that this volatility is likely to spread to the macroeconomic development of Kazakhstan. Thus, reducing the oil share of the Kazakh economy is the main policy recommendation to emerge from this study.

## 6. Conclusions

The oil price attracted considerable academic attention in the past few decades. Both explaining the oil price's behavior and investigating the macroeconomic consequences of oil price movements are subject of a vast number of papers. It is worth noting that both in lines of

research the applied methods are of similarly high complexity. This indicates that these issues are more complicated than one would probably expect. Regarding the first, the oil price is subject to various influences such as the global economic development, OPEC power, and speculative behavior. Regarding the second, a large number of papers find that the oil price – macro relationship for major economies such as the U.S. is asymmetric and characterized by non-linearities.

The aim of this paper is to shed light on the Kazakh oil – macro relationship. It applies a VAR model - the most commonly used empirical method in this research area. It, however, differs from the existing literature in two ways: it considers, first, a transition rather than a developed economy, and, second, an oil exporting rather than oil importing country. The key results to emerge from this exercise are the following: first, the price of oil is influenced by a variety of factors. This results in a considerable degree of uncertainty in this market. In consequence, the oil price features an immense volatility. Second, all macroeconomic variables under consideration exhibit a significantly negative response to oil price declines. This clearly indicates that the Kazakh economy is considerably vulnerable to oil. Moreover, the simultaneous occurrence of these two results signals that the Kazakh economy is in a precarious situation. Third, the result of a significant response of all variables to an oil price decline has been obtained by applying a standard linear VAR model rather than sophisticated non-linear extensions of which. Hence, the structure of the Kazakh economy is different to that of developed countries usually considered in the empirical oil-macro literature.

In a nutshell, the empirical oil price literature suggests that the oil price is subject to a considerable degree of volatility and that expecting the oil price to begin a stable upward trend is not realistic. The considerable high degree of oil dependency of the Kazakh economy indicates that this will lead to an instable development of the economy as well. Thus, the main policy recommendation to emerge from this paper is that any effort invested in reducing the

oil dependency of the Kazakh economy is more than justified. Moreover, it is worth considering a tightening of the stabilization fund which would lead to a less fragile economic development.

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