The effect of fiscal policy on oil revenue fund: the case of Kazakhstan

Journal of Eurasian Studies 5 (2014) 157–183

Contents lists available at ScienceDirect

Journal of Eurasian Studies

journal homepage: www.elsevier.com/locate/euras

The effect of fiscal policy on oil revenue fund: The case of Kazakhstan☆

Dina Azhgaliyeva*

Department of Economics, University of Essex, Wivenhoe Park, Colchester, Essex, CO4 3SQ, UK

ARTICLE INFO

Article history:
Received 3 January 2014
Accepted 24 April 2014

Keywords:
Sovereign Wealth Fund
Natural resource revenue
Oil-producing country
Stabilization fund

ABSTRACT

Setting an optimal fiscal policy in oil-producing countries is challenging, due to the exhaustibility of oil resources and unpredictability of oil prices. Recently it has become popular among oil-producing countries to establish oil revenue funds, which are believed to stabilize the economy and provide inter-generational redistribution of oil wealth. The effectiveness of oil revenue funds and their design have received considerable attention from researchers and policymakers recently. Using empirical model, it is found that an oil revenue fund in Kazakhstan stabilized the government expenditure, but did not stabilize real effective exchange rates.

1. Introduction

Oil-producing countries often face the "Resource curse" coming from the volatility, exhaustibility and uncertainty of resources. Some countries create an oil revenue fund (fund) as a mechanism to reduce the impact of volatile revenue on the government and the economy (Davis, Ossowski, Daniel, & Barnett, 2001). There is an opinion that oil revenue funds can help oil-producing countries avoid the "Resource curse".

Controversy exists in the literature about the impact of funds, which discuss whether the creation of funds have a positive effect on economy. The results of Davis et al. (2001) show no significant effect of the creation of funds on government expenditure. Results of Shabsigh and Ilahi (2007) show a significant effect of funds on inflation, broad money volatility and price volatility.

The existing literature studies only the effect of the existence of funds, but not the role of fiscal policy. The creation of funds may not be enough for oil-producing economies to avoid volatility and achieve higher growth. The creation of funds is not always an easy or appropriate solution to problems arising in oil-producing economies. Whether the

SOROS.KZ

☆ This research was funded by Fund Soros Kazakhstan. The views expressed in this article are those of the author and do not necessarily reflect those of the Fund Soros Kazakhstan.

* Present address: CPS, Nazarbayev University, 53 Kabanbay Batyr avenue, Astana, 010000, Kazakhstan. Tel.: +77172705987.
E-mail address: d.azhgaliyeva@ucl.ac.uk.

Peer review under responsibility of Asia-Pacific Research Center, Hanyang University

Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.euras.2014.05.001
1879-3665/

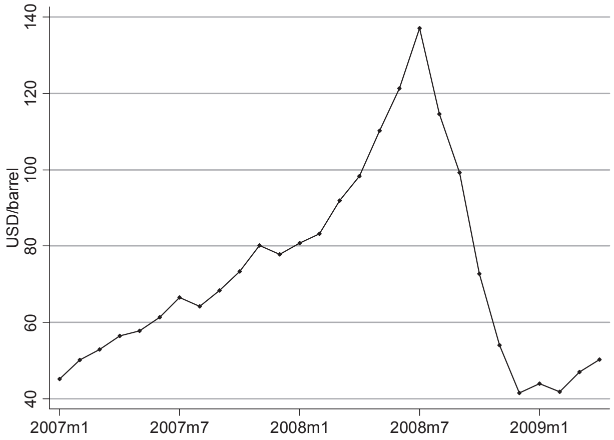

Fig. 1. World oil prices. Data source: The Energy Information Administration, available at www.eia.doe.gov.

establishment of funds contributes to the economy may depend on whether the appropriate fiscal policies are in place. Recent volatility in oil prices has made this question far more relevant to many oil-dependent countries (Fig. 1).

This paper attempts to answer the question "How does fiscal policy affect oil revenue fund in Kazakhstan and how effective is this fund? ". In this paper, the term fiscal policy is narrowed down to include only taxation of oil, the existence of a fund and its size. Taxation of resources is a combination of per unit, per revenue and lump sum taxes. An appropriate design of fiscal policy is significant to avoid high volatility of oil revenue: per-revenue tax allows for higher revenue when the resource price is high; per unit tax allows a country to secure resource revenue even when resource price is low; and lump sum tax allows a country to receive revenue even when the level of oil production is low. Countries set different taxes on resources and change them over time.

The theoretical model and the empirical model for the effect of taxation of resources (value-added tax, tax on oil exports and significant changes in oil taxation in 2004 and 2009) on its production are developed in this paper. To support the theoretical model the effects of fiscal policy on oil production, the fund's revenue and gross international reserves (GIR) in Kazakhstan were estimated using data for Kazakhstan over the period January 1994–July 2013. The effect of the establishment of a fund and changes in its accumulation and withdrawal rules and its impact on stabilization of government expenditure and REER were shown using data for Kazakhstan over the period January 1994–July 2013.

This paper is structured as follows. Section 2 provides a review of existing literature studying the effect of taxation on oil production and oil exploration (Section 2.1) and the effect of oil revenue funds on the economy (Section 2.2). Section 3 describes fiscal policy in Kazakhstan. A theoretical model showing the effect of constant, price-dependent and quantity-dependent ad valorem taxes on oil production and oil exploration assuming variable oil prices is developed in Section 4. Empirical models showing the effect of taxes on oil production and exploration and showing the effect of oil revenue funds on government expenditure and REER are developed in Section 5. Conclusions are in Section 6. The main contributions of this chapter are in Sections 4.2.3 and 5.

2. Literature review

2.1. The effect of taxation on oil production and oil exploration

Research on the taxation of oil for most oil-producing countries, such as the OPEC nations, the Gulf countries, Mexico, Norway, UK, and the USA, is abundant. Research in this area for Kazakhstan is lacking.

In order to understand the model of how taxes affect oil production and oil exploration, it is important to understand the main principles of oil taxation. Boadway and Flatters (1993) provide principles and policy issues for taxation of both renewable and nonrenewable natural resources. They provide policy issues of different taxes on natural resources such as export taxes, production taxes, royalties, and property taxes. The authors argue that export taxes discriminate between the domestic resource market and the world resource market and are frequently used by developing countries as a source of revenue. If the portion of resources consumed domestically is too small compared to the amount exported, which is the case in many countries, there is no additional efficiency for the domestic market due to this discrimination. The authors note that many countries have tended to eliminate export taxes on natural resources in favor of other more general taxes. Boadway and Flatters (1993) predict that "Even in cases where the resource-exporting country might have a long term comparative advantage in further processing, the use of export taxes to speed up process can be very costly." (Boadway & Flatters, 1993, p. 49). They provide principles of taxation of nonrenewable natural resources, including export tax, and provides intuition of their implementation. According to the paper, taxes on oil can have a different effect on oil production depending on whether the tax rate is per unit or ad valorem. Also, tax rates can be constant or variable with price, quantity or quality of oil. Literature that provides analysis of the tax effect on oil production exists. One such study is that of Conrad and Hool (1984), which comes up with a model measuring the effect of taxes on intertemporal extraction of mineral resources. The authors build models showing effects of different types of taxes on oil production (per unit, ad valorem and profits taxes). They examined not only fixed-rate taxes, but also variable-rate taxes. They distinguish between three basic types of variable tax rates: time-dependent per unit taxes, price-dependent ad valorem taxes and progressive profit taxes. Conrad and Hool (1984) define each of these taxes as following: the tax base for a variable per unit tax is an amount of output sold and the tax rate of the per unit tax may vary over time; a variable ad valorem tax rate is set as a percentage of market value of output sold and the tax rate per unit may vary with price (a higher tax rate is set for higher price); a progressive profit tax is set as a percentage of company's profit and the rate of the tax is set at a rate progressive to the profit. Conrad and Hool (1984) build a model to show the effect of variable-rate taxes on a company's decision of optimal production and exploration. The authors find that variability in taxes, whether they vary with output, value, or profits, affects allocation incentives differently than if tax rates are fixed. This difference depends on whether the growth of tax rate is sufficiently different from the discount rate. The limitation of Conrad and Hool (1984) is that they analyze the intertemporal problem of extraction choice for only two periods, thus a lifetime of reserves is given.

Unlike previous paper and similar to the current paper, Burness (1976) considers the effect of resource taxation on production, assuming a lifetime of reserves as an endogenous variable in order to show how taxation of oil affects this variable. For this reason, the author uses a dynamic optimization method. Similar to Conrad and Hool (1984), Burness (1976) considers tax rates that vary over time.

The variable – the available reserves – is an exogenous variable, and thus, cannot demonstrate the effect of taxes on oil exploration. However Heaps and Helliwell (1985) develop a model where exploration is an endogenous variable. Heaps and Helliwell (1985) predict that taxation affects not only the choice of extraction rates but also the amount of resources employed to explore oil reserves. The authors show the effect on reserves exploration through the effect on the cost of exploration, assuming that "initial reserves can be augmented by a certain exploration process at a cost "$C(R)$" (Heaps & Helliwell, 1985, p. 452), which is the present value of past exploration and development expenses at the moment when the company starts the extraction of reserves. The same assumption is used in the current chapter to show the effect of taxes on oil exploration. Heaps and Helliwell (1985) develop a profit maximization problem for the producer of natural resources, choosing the reserve's lifetime and an extraction plan so as to maximize the present value of profit. The model of Heaps and Helliwell (1985) shows the effect of different types of taxes, such as per unit taxes, net profit taxes, a license fee, property taxes, and resource rent taxes, on production choice. They consider time-variable tax rates. The main results of the analysis are that taxes affect the slope of the extraction path, and if tax rates are variable over time, the slope of the extraction path depends on whether the tax rate increases at a rate greater or lesser than the discount rate. The main limitation of this study is that it assumes a fixed oil price.

More recent work on taxation includes Manzano's (2000) reviews of the Hotelling model. Hotelling's study (1931) is a pioneering work on the taxation of natural resources. It provides a classical view on the subject. Similar to Hotelling (1931), Manzano shows the effect of royalties and income taxes on oil production and oil exploration. The main findings of Manzano (2000) are that royalties and income taxes cause a reduction in oil exploration and this reduction depends on the shape of a development and exploration cost of oil reserves.

All theoretical models described above assume a fixed oil price, an assumption, which needs reviewing in light of the fluctuating nature of oil prices at present. Also, to the best of our knowledge, there is no theoretical model showing the effect of price-dependent ad valorem taxes on oil production and oil exploration assuming variable oil prices.

2.2. The effect of oil revenue funds on the economy

An oil revenue fund is a mechanism designed to reduce the impact of resource revenue volatility on the economy (Davis et al., 2001), but do oil revenue funds really help with that? Davis et al. (2001) try to answer the question "how effective are oil revenue funds?" in two parts: 1) what is the effect of oil revenue funds on government expenditure?; and 2) what is the effect of oil revenue funds on resource export receipts? To answer these questions, Davis et al. (2001) compare the effect of resource prices on government expenditure and resource export receipts before and after the countries created oil revenue funds using data of 12 countries with oil revenue funds (Chile, Kuwait, Norway, Oman, Papua New Guinea, Algeria, Bahrain, Mexico, Saudi Arabia, UAE, UK, and Venezuela) over the 34-year period 1965–1999. Their empirical estimation shows statistically significant negative correlation between government expenditure and changes in oil prices. But the test shows no statistically significant effect of oil revenue funds on government expenditure and resource export receipts. These empirical results, according to Davis et al. (2001), are limited by data availability, quality, and the small sample size.

A similar test is performed by Shabsigh and Ilahi (2007), who test whether oil revenue funds help reduce macroeconomic volatility using data of 15 countries heavily reliant on the export of oil over the 30-year period 1973–2003. Unlike Davis et al. (2001), who compares only those countries with funds, Shabsigh and Ilahi (2007) include countries that have oil revenue funds, as well as six countries that do not have oil revenue funds. According to Shabsigh and Ilahi (2007), the inclusion of countries that do not have oil revenue funds helps to avoid heterogeneity and, thus, biased results. This is because whether a country created an oil revenue fund or not could be due to unobserved characteristics.

Unlike the results of Davis et al. (2001), which show no statistically significant effect of oil revenue fund, the results of Shabsigh and Ilahi's (2007) econometric estimation show that correlation between the presence of an oil revenue fund and broad money and CPI is statistically significant and negative, while correlation between the presence of oil revenue funds and real effective exchange rates is negative but not statistically significant. Shabsigh and Ilahi (2007) conclude that oil revenue funds stabilize broad money and prices. However, there is no statistical evidence that oil revenue funds stabilize real effective exchange rates.

3. Fiscal policy in Kazakhstan

After its independence from the Soviet Union, Kazakhstan has become an important player in the world energy market due to its significant oil reserves. With the collapse of the Soviet Union in 1991 the economy moved into transition. During that transition and until now, significant fiscal reforms have been introduced such as taxation of oil and privatization of property and businesses.

By January 2009, nearly 160 deposits of oil and gas with oil reserves worth 30 billion barrels were discovered within Kazakhstan's territory (the Energy Information Administration). The development of Kazakhstan's oil sector has been mainly through foreign direct investments in the form of sharing agreements.

As of 2008, Kazakhstan's production capacity is 1.49 million barrels daily, and its refining capability is 345,000 thousand barrels daily (the Energy Information Administration). Most oil producers in Kazakhstan export crude oil and are not keen to produce refined oil locally. Fig. 2 compares oil production, world oil prices and domestic consumption from 1991 to 2008. It shows that the export of Kazakhstan's crude oil might have a positive relationship with world oil prices – it follows the increasing trend of world oil prices. Domestic consumption (oil production less oil exports), meanwhile, decreased contrary to the increasing behavior of oil prices from 1991 to 2008.

Among the oil producers, Kazmunaigaz is the only oil company that is wholly-owned by Kazakhstan – the rest are largely foreign-owned companies. The major players include: Chevron, Agip, Eni, Exxon Mobil, Petrokazakhstan, ConocoPhillips, Royal Dutch Shell, Tasbulat Oil, Total, British Gas, LukAcro, Lukoil.

Apart of usual taxes oil producers have to pay oil taxes. The main objective of oil taxation is to receive a share of oil since oil belongs to the country. The government of Kazakhstan has imposed the following taxes on oil companies from January 1, 2009 (The Ministry of Finance of the Republic of Kazakhstan, 2009):

- tax on the export of crude oil is a price-dependent ad valorem tax based on the value of oil exported with tax rates from 0 to 32 percent (depending on the oil price);
- excess profit tax is a progressive tax with tax rates from 10 to 60 percent, depending on the ratio of income and cost;
- special payments from subsurface users[1];
- bonuses are payments made by subsurface users for the right to use the subsurface in the Republic of Kazakhstan, which can be a fixed lump sum or at the rate of 0.1 percent of the estimated value of proven extractable resources every time a commercial discovery of mineral resources in Kazakhstan is made;
- royalties tax is a quantity-dependent ad valorem tax based on the value of oil produced with rates from 7 to 20 percent (depending on the amount of oil produced) and can be paid either in cash or in oil;
- production share of Kazakhstan is defined as the total value of profit less the production share of subsurface users. The production share of subsurface users is determined as the lesser of the percentage values obtained from the following three triggers:
    1. profitability indicator – the ratio of the cumulative income of a subsurface user to cumulative project expenses,
    2. the internal rate of return of a contractor – the discount rate at which the real net present value reaches zero,
    3. price coefficient – the ratio of subsurface user's income to the volume of production;
- taxation of business profit, such as corporate income tax and branch profits tax;
- indirect taxation such as value-added tax, excise and customs duties;
- other taxes such as environmental fees, property tax, land tax, vehicle tax, and other fees and licenses.

Before 2004, most taxes on oil were set by contracts with oil producers and not by the tax law (The Ministry of Finance of the Republic of Kazakhstan, 2001; The Ministry of State Income of the Republic of Kazakhstan, 1991, 1995). From 2004 on, all taxes on oil were set by the tax law (The Ministry of Finance of the Republic of Kazakhstan, 2004). Also in 2004, a tax on oil exports was introduced. This tax discriminates oil sold in the world oil market, as compared to oil sold in the domestic market. Creating oil export taxes by lowering the oil price in the domestic market reduces government revenue from other taxes that are based on the revenue from the domestic oil market. According to Boadway and Flatters (1993), the use of an export tax rather than the equivalent royalties tax on all sales, export and domestic, leads to a reduction of government revenues. This loss, they add, is proportional to the tax rate and the elasticity of the domestic oil market. The above argument against an export tax can be limited if a country exporting oil has monopoly power in the world market. The main reason for the government of Kazakhstan to impose a tax on oil exports rather than the equivalent royalties tax is to promote the development of oil refining industries. Export taxes on oil give domestic refining companies the advantage (on top of the transport cost advantage) of access to oil at prices lower than the competitive world price.

The recent changes in oil taxation were introduced by the tax law in 2009 (The Ministry of Finance of the Republic of Kazakhstan, 2009). From 2009 royalties tax rates set at a different scale (depending on the amount of oil produced) and at greater tax rates. The scale of taxation on oil exports was changed significantly. Before 2009, tax rates set for oil

[1] Subsurface users pay taxes according to their signed contracts. A contract states the tax regime for the subsurface user, which can either be excess profit tax regime or production sharing agreement regime. With excess profit tax regime companies are not eligible to pay a production share to Kazakhstan, but pay all other taxes. With a production sharing agreement companies pay a production share to Kazakhstan and not liable to pay tax on export of crude oil, royalties, excise tax on crude oil, excess profit tax, land tax, tax on property.

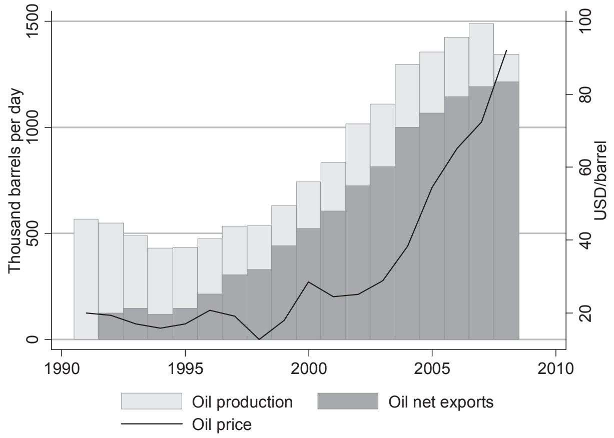

Fig. 2. Kazakhstan's oil production, export and world oil prices. Data source: The Energy Information Administration, available at www.eia.doe.gov.

exported at prices from 19 to 40 US dollars per barrel with zero tax rate for oil exported at prices below 19 US dollars per barrel. From 2009 the tax on oil exports were set at an increasing rate for oil exported at prices from 40 to 200 US dollars per barrel with a zero tax rate on oil exported at prices below 40 US dollars per barrel. Taking into account a significant fall in oil prices up to 40–50 US dollars per barrel, the tax on oil exports must be paid at a rate of zero or seven percent, which are significantly lower than before 2009 for the same price (33 percent). These changes in 2009 in the tax on oil exports did not allow for taxation of oil exports at a greater rate for higher oil prices, but only tax oil exports at a lower rate for low oil prices in 2009. It is very difficult to find an optimal scale for price-dependent taxes due to the large variation of oil prices. The data for oil prices from 1861 to 2007 (Fig. 3) shows that oil prices can be as low as 10 US dollars per barrel and as high as 100 US dollars per barrel.

In order to secure oil revenue during periods of low oil prices, the government can set a per unit tax, allowing a certain level of revenue even when oil prices are very low, while an ad valorem tax allows to achieve higher revenue during high oil prices. A combination of different types of taxes can help to reduce volatility in oil revenue due to high variability in oil prices.

In order to manage oil revenue more effectively, the government of Kazakhstan created the National Fund of the Republic of Kazakhstan (the National fund) in 2000 (The President of the Republic of Kazakhstan, 2000). However the first deposit of 660 million US dollars was made in January 2001. We assume that the National fund started to work in January 2001. The general objectives of the National fund are to stabilize the economy and achieve intergenerational redistribution. The following payments must be deposited in the National Fund according to the President of the Republic of Kazakhstan (2001, 2005, 2010): corporate income tax, excess profit tax and rent tax on oil and gas exports, bonuses, royalties, production share, additional payments according to production sharing agreements, fines and penalties (excluding fines and penalties which form local budgets) paid by selected petroleum sector corporations, proceeds from the privatization of state property in the mining and manufacturing sectors, proceeds from sales of agricultural land and investment income of the Fund. Other income that is not prohibited by law of the Republic of Kazakhstan can also accumulate the fund. The list of petroleum sector corporations which payments accumulate the fund is set by the government. From 2001 till June 2006 petroleum sector corporations which payments accumulate the National fund were set for every tax which must be deposited in the National fund (the Government of the Republic of Kazakhstan, 2001). These lists were changed several times (decreased). From July 2006 the single list of petroleum sector corporations was set for all taxes (the Government of the Republic of Kazakhstan, 2006) and was significantly expanded (from 8 to 55). From 2009 the list of petroleum sector corporations must be set for every year (The Republic of Kazakhstan, 2008) and was significantly expanded from 55 to 152. Till June 2006 not all payments listed above accumulated the National fund, but only payments above planed by the government (The President of the Republic of Kazakhstan, 2001). Planned payments were calculated using the budgeted (reference) oil price at 19 US dollars per barrel (The President of the Republic of Kazakhstan, 2005). From July 2006 all payments listed above made by selected petroleum sector corporations must be deposited in the National fund according to the Code of the Republic of Kazakhstan (2004) with changes in article 23 according to the Law of the Republic of Kazakhstan (2006) and Budget Code of the Republic of the Kazakhstan (2008). The asset-split of the National fund is 100 percent foreign. Domestic investments by the National fund are not allowed. This is done in order to protect exchange rate of local currency, tenge. Kazakhstan receives oil revenue in foreign currency. These windfalls of foreign currency can affect exchange rate of tenge. By investing in foreign assets windfalls of foreign currency is taken abroad and brought back to Kazakhstan slowly. By May 1, 2009, the fund had accumulated some 22 billion US dollars (The National Bank of the Republic of Kazakhstan, 2008), or roughly 17 percent of the country's GDP during the period from January 2001 to May 1, 2009. Around 19.5 million US dollars (The National Bank of the Republic of Kazakhstan, 2008), or 90 percent of the National fund, are gross international reserves.

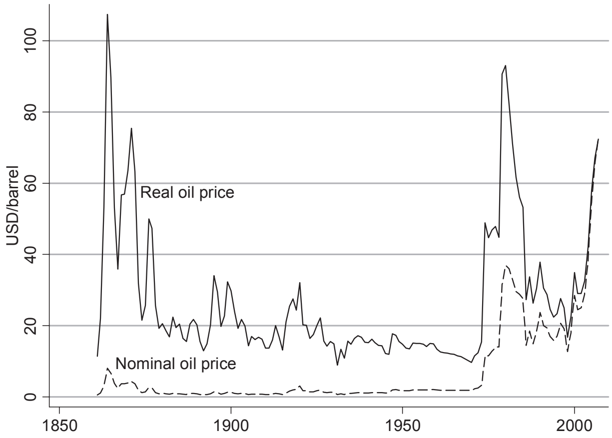

Fig. 3. World real and nominal oil prices. Data source: The Energy Information Administration, available at www.eia.doe.gov.

The surplus of the National fund continues to increase every year. From the time of the creation of the National fund, the major revenue was non-tax (sales of property and agricultural lands), but every year the tax-revenue share is becoming a larger portion of the total revenue of the National fund (Fig. 4).

Davis et al. (2001) suggest measuring the effectiveness of the oil revenue fund by its effect on the relationship between the government expenditure and resource export earnings. The data shows a possible positive correlation between Kazakhstan's government expenditure and export of oil (Fig. 5). Also, the correlation looks stronger before 2001, while from 2001 on (after creation of the National fund), government expenditure looks less correlated with oil exports.

Nevertheless, there is a strong relationship between the government's revenue and expenditure with oil prices (Fig. 6).

Kazakhstan's proven reserves of oil are about 30 billion barrels (The Energy Information Administration), which is projected to sustain the current production level of 1400 barrels daily for more than 59 years.

An economy's dependency on oil resources can be measured in two ways (Liuksila, Garcia, & Bassett, 1994): external dependency shows how a country relies on oil exports to obtain foreign exchange (the share of oil export to total export), while fiscal dependency on the other hand, measures how the public sector relies on oil revenues (the share of oil taxes to total fiscal revenue). Data which is necessary to calculate external dependency of Kazakhstan is available, but oil revenue of Kazakhstan, which is needed to calculate fiscal dependency, is not available. That is why payments of oil and gas companies to the government of Kazakhstan from National Reports on the implementation of the extractive industry transparency initiative in Kazakhstan 2005–2011 (available at www.eiti.org) were used as approximate data. These reports provide payments of selected oil, gas and mining companies. During the period 2005–2008 payments by oil and gas companies are not separated from payments by mining companies. From 2009 only tax payments to the budget from the oil and gas companies (excluding mining companies) were used. Since in 2005 only payments of 38 oil, gas and mining companies available, while in 2006–2011 payments of 103–170 oil, gas and mining companies are available, we calculated fiscal dependency over the period 2006–2011. Oil revenue is divided between the government budget and the National

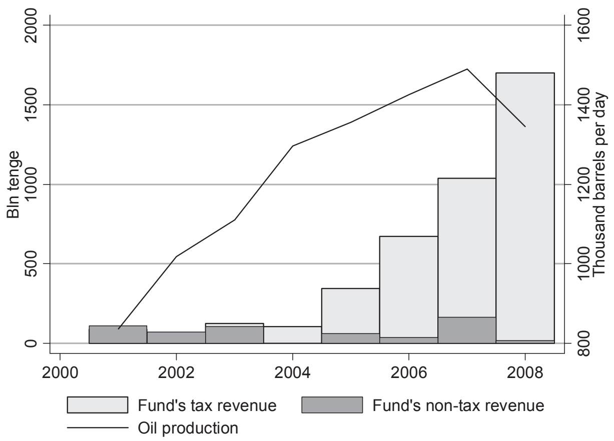

Fig. 4. The National fund's revenue and oil production. Data sources: The Energy Information Administration, available from www.eia.doe.gov; and The State Budget of the Republic of Kazakhstan, the Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz.

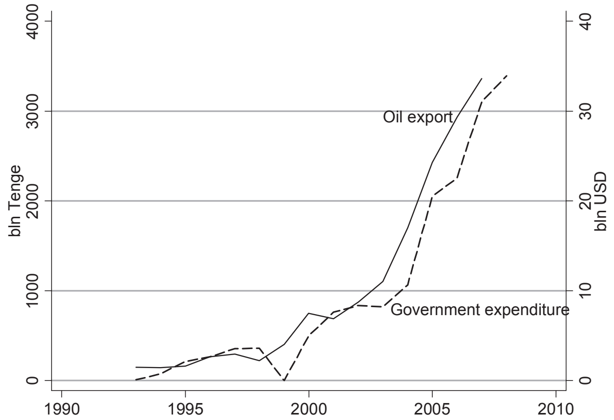

Fig. 5. Kazakhstan's government expenditure and oil exports. Data sources: The Energy Information Administration, available from www.eia.doe.gov; and The State Budget of the Republic of Kazakhstan, the Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz.

fund. That is why total fiscal revenue was calculated as a sum of government revenue and payments of oil companies which were deposited into the National fund. Employing these measurements and plotting the share of Kazakhstan's oil exports to its total exports against the share of oil revenue to total revenue shows that Kazakhstan has a high external oil dependency (Fig. 7). About 70 percent of export earning and 40 percent of the fiscal revenue can be definitively associated with the economic activities of the oil sector. For comparison, Fig. 8, based on the work of Liuksila et al. (1994) shows that Nigeria, Saudi Arabia and Venezuela, which are also oil-dependent countries, have over 60 percent external and fiscal dependency (Fig. 8).

As is the case for most oil-producing countries, Kazakhstan has benefited from the upward trend in oil prices that is largely attributable to the strong demand for energy products over the past few years. A simple test of correlation depicted in the graph below affirms the positive correlation between Kazakhstan's GDP and the world oil price and between Kazakhstan's GDP and the country's oil production (Figs. 9 and 10).

The portion of fund's revenue in Kazakhstan's total revenue is constantly increasing (Fig. 11).

4. Theoretical analysis

In this section we use a theoretical model to show the effect of different taxes on oil production and exploration when oil prices vary. Knowing the effect of taxation on oil production, it is straightforward to estimate the revenue of the National fund.

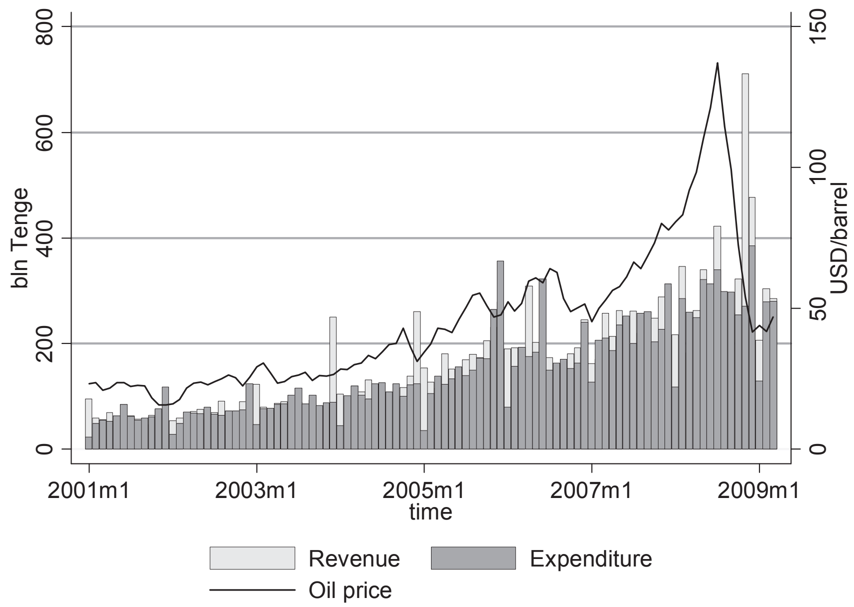

Fig. 6. Kazakhstan's government expenditure, revenue and world oil prices. Data sources: The Energy Information Administration, available from www.eia.doe.gov; and The State Budget of the Republic of Kazakhstan, the Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz.

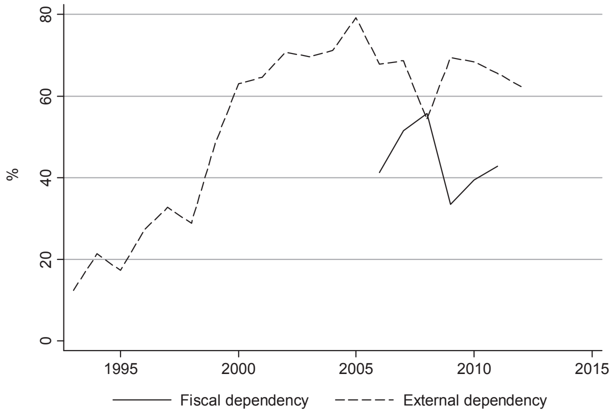

Fig. 7. Oil dependency of Kazakhstan. Data sources: The Energy Information Administration, available from www.eia.doe.gov; Statistical Bulletin, Ministry of Finance of the Republic of Kazakhstan, available from www.minfin.kz; and The State Budget of the Republic of Kazakhstan, Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz.

4.1. Theoretical framework

Oil is an exhaustible and a nonrenewable resource. Its production follows these stages: exploration of oil reserves, development of oil reserves, extraction of oil and processing of oil. The exploration of oil involves risks associated with uncertainty of the size of the reserves that will be discovered and the future volatility of oil prices.

According to Heaps and Helliwell (1985), an oil producer chooses the reserve's lifetime, T, an amount of extracted oil, q, and reserves, R, that maximize the present value of profits across the lifetime of the reserves, V, given by the formula:

$$\max_{R,q,T} V = \int_0^T \pi(q)e^{-rt}\,dt - C(R) \tag{1}$$

subject to transition equation $dR(t)/dt = -q(t)$, initial oil reserves equation $R(0) = R$ and the transversality condition equation $R(T) = 0$, where π is the profit of the oil company, r is the discount rate, $C(R)$ is the cost of oil exploration and R is the discovered oil reserves.

The transversality equation means that the entire oil reserves must be extracted. Otherwise the oil producer can increase the present value of profit by extending the extraction period. This problem can be solved by constructing the present value Hamiltonian function (Pontryagin, 1934) for a profit maximizing oil-producing company:

$$H = e^{-rt}\pi[q(t)] - C(R) + \lambda(t)[-q(t)], \tag{2}$$

where λ is the present-value shadow price of the reserves, which represents the present value (discounted to time zero) of the stream of future profits of an increment of reserves at time t, it is also called costate variable. Here control variable is an amount of oil extracted (it is also called a choice variable) and state variable is oil reserves. The necessary conditions for an optimum can be expressed as follows:

$$\frac{\partial \pi(q)}{\partial q(t)}e^{-rt} - \lambda(t) = 0. \tag{3}$$

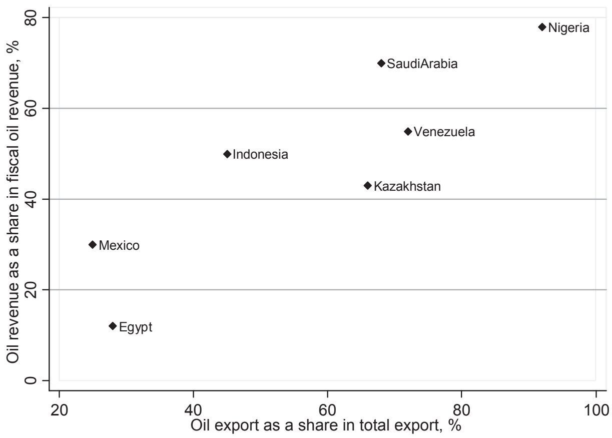

Fig. 8. Oil dependency of selected oil-producing countries. Data sources: For all countries except Kazakhstan, data source is Liuksila et al., 1994. For Kazakhstan: The Energy Information Administration, available at www.eia.doe.gov; Statistical Bulletin, Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz; and The State Budget of the Republic of Kazakhstan, available at www.minfin.kz.

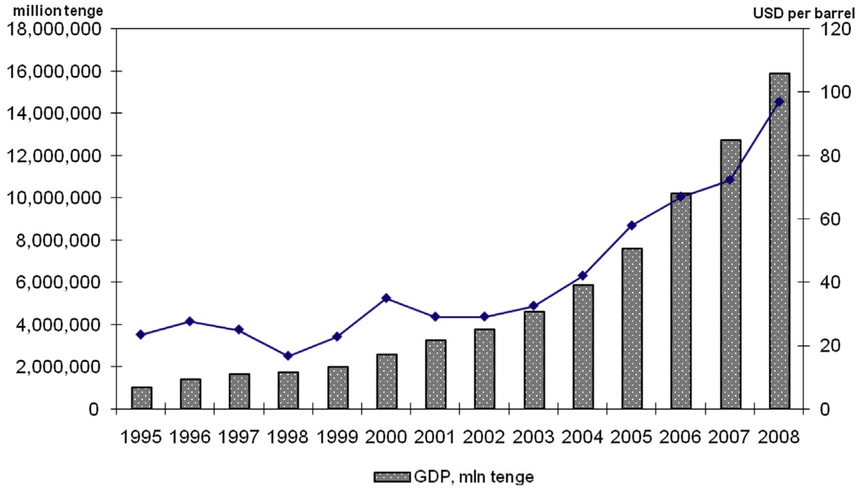

Fig. 9. Kazakhstan's GDP and world oil prices. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz; and the Energy Information Administration, available at www.eia.doe.gov.

This equation means that discounted marginal profits should be the same at all points in time:

$$C'(R) = \frac{\partial\lambda(t)}{\partial(t)}. \tag{4}$$

This equation means that the present-value shadow price of additionally explored reserves must be equal to the marginal cost of oil exploration.

Transversality condition requires that:

$$\lambda(T)R(T) = 0. \tag{5}$$

If Hamiltonian function, H, is concave in R, then the conditions above are sufficient for a maximum. The solution of necessary conditions (equations (3)–(5)) implies that:

$$\frac{\partial^2\pi}{\partial q^2}\frac{dq}{dt} = r\frac{\partial\pi}{\partial q} - \frac{\partial^2\pi}{\partial q\partial t}, \tag{6}$$

where $\mathrm{d}q/\mathrm{d}t$ is the slope of the extraction path and equals to:

$$\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial\pi/\partial q}{\partial^2\pi/\partial q^2} - \frac{\partial^2\pi/(\partial q\partial t)}{\partial^2\pi/\partial q^2}. \tag{7}$$

It is assumed that the profit function is concave in q, so that $\partial^2\pi/\partial q^2 < 0$. Heaps and Helliwell (1985) predict that $\partial^2\pi/\partial q\partial t$ is small if the oil price is not rising too fast. In this case the slope of the extraction path $(\mathrm{d}q/\mathrm{d}t)$ is negative, and thus, decreases over time. If $(\partial^2\pi/\partial q\partial t)$ is large enough, if the oil price is rising fast enough, the slope of the extraction path is positive, thus, the extraction rate increases over time.

The solution of the Hamiltonian function is:

$$\frac{\partial\pi}{\partial q}e^{-rT} - C'(R) = 0. \tag{8}$$

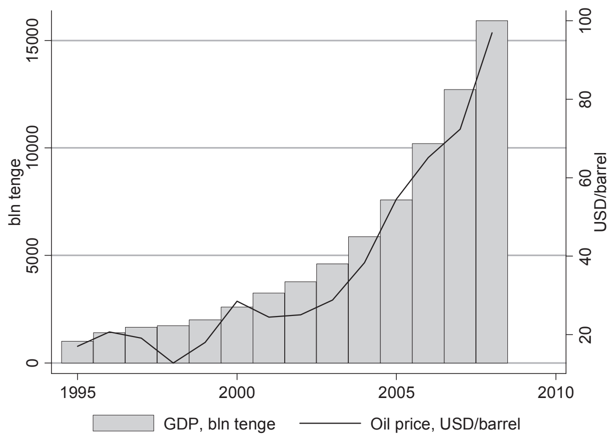

Fig. 10. Kazakhstan's GDP and oil production. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz; and the Energy Information Administration, available at www.eia.doe.gov.

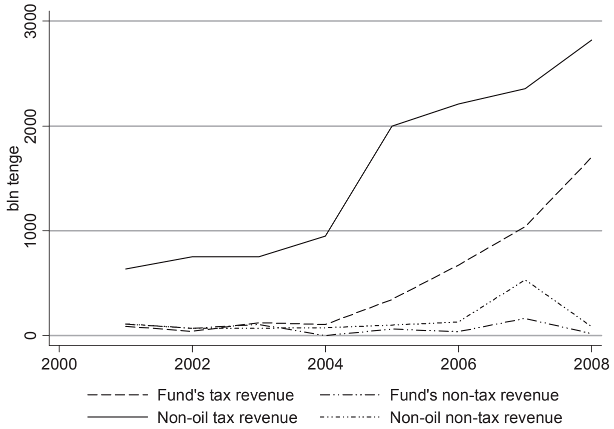

Fig. 11. The National fund's revenue and the government revenue. Data source: The State Budget of the Republic of Kazakhstan, the Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz.

4.2. *The effect of taxation on oil production*

Oil companies are eligible to pay different types of taxes: ad valorem, per unit and lump sum taxes. Tax rates can be fixed or vary with oil price or an amount of oil produced. There is plenty of literature showing the effect of different taxes on oil production assuming non-variable oil prices and non-variable tax rates. As a contribution to existing literature, the following sections show the effect of price-dependent and quantity-dependent ad valorem taxes assuming variable oil prices. In Kazakhstan, two taxes on oil are set at variable tax rates: royalties which rates vary with an amount of oil produced and export tax which rates vary with the oil price. In Section 4.2.1, a baseline model with non-variable tax rate and non-variable oil prices is shown. In the following sections, these assumptions are relaxed. In Section 4.2.2, we developed a model with non-variable tax rate but with variable oil prices; this is the case of value-added tax in Kazakhstan. In Section 4.2.3, the model is developed to show the effect of a tax on oil that varies with prices on oil production and oil exploration with variable oil prices; this is the case of tax on oil exports in Kazakhstan. In Section 4.2.4, the model is developed to show the effect of a tax that varies with quantity on oil production and oil exploration; this is the case of royalties tax in Kazakhstan.

4.2.1. *The effect of ad valorem taxes*

The equation below shows the problem of profit maximizing when an oil producer is eligible to pay tax as a portion of oil revenue, assuming that prices and the tax rate is fixed:

$$\max_{R,q,T} V = \int_0^T \pi^\tau(q(t))e^{-rt}\,\mathrm{d}t - C(R) \tag{9}$$

subject to transition equation $\mathrm{d}R(t)/\mathrm{d}t = -q(t)$,initial oil reserves equation $R(0) = R$ and transversality condition equation $R(T) = 0$, where π^τ is the profit of an oil company after tax. It is assumed that the oil company is eligible to pay tax as a portion of oil revenue, thus:

$$\pi^\tau(q(t), p) = \pi(q(t), p) - q(t)p\tau, \tag{10}$$

where τ is a rate of ad valorem tax and p is an oil price. This problem can be solved by constructing the present-value Hamiltonian function for a profit maximizing oil-producing company:

$$H = e^{-rt}(\pi(q(t), p) - q(t)p\tau) - C(R) + \lambda(t)[-q(t)]. \tag{11}$$

The necessary conditions for an optimum can be expressed as follows:

$$\left(\frac{\partial \pi}{\partial q} - \tau p\right)e^{-rt} = \lambda(t), \tag{12}$$

$$C'(R) = \frac{\partial \lambda(t)}{\partial t}, \tag{13}$$

and

$$\lambda(T)R(T) = 0. \tag{14}$$

If H is concave in R, then the conditions above Eqs. (12)–(14) are sufficient for a maximum. The solution of necessary conditions (12)–(14) implies that:

$$\frac{\partial^2 \pi}{\partial q^2}\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial \pi}{\partial q} - \frac{\partial^2 \pi}{\partial q \partial t} - rp\tau, \tag{15}$$

where $\mathrm{d}q/\mathrm{d}t$ is the slope of the extraction path and equals to:

$$\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial \pi/\partial q}{\partial^2 \pi/\partial q^2} - \frac{\partial^2 \pi/(\partial q \partial t)}{\partial^2 \pi/\partial q^2} - rp\tau\frac{1}{\partial^2 \pi/\partial q^2}. \tag{16}$$

As in Section 4.1, it is assumed that the profit function is concave in q, so that $\partial^2 \pi/\partial q^2 < 0$. As explained in Section 4.1, $\partial^2 \pi/\partial q \partial t$ can be small or large. If $\partial^2 \pi/\partial q \partial t$ is small, the slope of the extraction path is negative. If $\partial^2 \pi/\partial q \partial t$ is large enough, the slope of the extraction path is positive. The last term on the right-hand side is the only difference between the slope of the extraction path with a tax and without a tax. The tax makes the slope of the extraction path less negative, and, thus, flatter. The size of the effect of the tax on the slope of the extraction path depends on the slope of the profit function and the oil price.

The solution of necessary conditions (12)–(14) of the Hamiltonian function implies:

$$\frac{\partial \pi}{\partial q}\, e^{-rT} - C'(R) \;=\; p\tau\, e^{-rT}. \tag{17}$$

The only difference with the no tax equation (8) is the right-hand side $p\tau\, e^{-rT}$. If the tax increases at T, it cannot at the same time raise reserve R (assuming a rising marginal exploration cost). A higher extraction path is not optimal, instead a lower extraction path is optimal. Thus, ad valorem tax on oil revenue reduces efforts to explore reserves and reduces the extraction of oil.

4.2.2. The effect of ad valorem taxes with variable oil prices

In Kazakhstan, value-added tax is set at a non-variable tax rate as a portion of the value of oil sold on domestic market. When the oil producer is eligible to pay tax as a portion of oil revenue, assuming that the tax rate does not vary over time (value-added tax) and oil prices vary, it faces the same profit maximizing problem as in equation (9). Assuming that the oil company is eligible to pay tax as a portion of revenue from oil sold on domestic market, the profit of oil producer after tax as following:

$$\pi^{\tau}(q(t),p(t)) \;=\; \pi(q(t),p(t)) - \frac{q(t)}{d}p(t)\tau, \tag{18}$$

where d is a portion of oil sold in domestic market. This problem can be solved by constructing the present-value Hamiltonian function for a profit maximizing oil-producing company when oil prices are variable:

$$H = e^{-rt}\left[\pi(q(t),p(t)) - \tau p(t)\frac{q(t)}{d}\right] - C(R) + \lambda(t)(-q(t)) \tag{19}$$

subject to transition equation $\mathrm{d}R(t)/\mathrm{d}t = -q(t)$, initial oil reserves equation $R(0) \;=\; R$ and transversality condition $R(T) = 0$.

The necessary conditions for an optimum can be expressed as follows:

$$\left[\frac{\partial \pi}{\partial q} - \frac{\tau p}{d}\right]e^{-rt} \;=\; \lambda(t), \tag{20}$$

$$C'(R) \;=\; \frac{\partial \lambda(t)}{\partial t}, \tag{21}$$

and

$$\lambda(T)R(T) \;=\; 0. \tag{22}$$

If H is concave in R, then the conditions above are sufficient for a maximum. The solution of the necessary conditions (20)–(22), assuming a fixed tax rate and a variable oil price $p(t)$, implies the following equation:

$$\frac{\partial^2 \pi}{\partial q^2}\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial \pi}{\partial q} - \frac{\partial^2 \pi}{\partial q \partial t} + \left(\frac{\mathrm{d}p}{\mathrm{d}t} - rp\right)\frac{\tau}{d} - \frac{\partial^2 \pi}{\partial q \partial p}\frac{\mathrm{d}p}{\mathrm{d}t}, \tag{23}$$

where $\mathrm{d}q/\mathrm{d}t$ is a slope of the extraction path and equals to:

$$\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial \pi/\partial q}{\partial^2 \pi/\partial q^2} - \frac{\partial^2 \pi/(\partial q \partial t)}{\partial^2 \pi/\partial q^2} + \left(\frac{\mathrm{d}p}{\mathrm{d}t} - rp\right)\frac{\tau}{d}\frac{1}{\partial^2 \pi/\partial q^2} - \frac{\left[\partial^2 \pi/(\partial q \partial p)\right](\mathrm{d}p/\mathrm{d}t)}{\partial^2 \pi/\partial q^2}. \tag{24}$$

As in Section 4.1, it is assumed that the profit function is concave in q, so that $\partial^2 \pi/\partial q^2 < 0$. As explained in Section 4.1, $\partial^2 \pi/\partial q \partial t$ can be small or large. If $\partial^2 \pi/\partial q \partial t$ is small, the slope of the extraction path is negative. If $\partial^2 \pi/\partial q \partial t$ is large enough, the slope of the extraction path is positive. The only difference with the slope of the no-tax extraction path (equation (7)) is the last two terms of the right-hand side of the equation. How the third term affects the slope of the extraction path depends on its sign. If $(\mathrm{d}p/\mathrm{d}t - rp) < 0$, the oil price increases at a greater rate than the interest, the slope of the extraction path is less negative, and, thus, flatter than the no-tax extraction path. If $(\mathrm{d}p/\mathrm{d}t - rp) > 0$, the oil price increases at a rate less than the interest, this makes the slope of extraction path more negative and, thus, steeper than the no-tax extraction path. According to Heaps and Helliwell (1985), if $(\mathrm{d}p/\mathrm{d}t - rp) \;=\; 0$, the oil price increases at the same rate as interest; however, it does not mean that the above equation takes the same form as in the case of no tax. Instead the extraction path with tax differs from the no-tax extraction path. This is because the following equation, which is the solution of the necessary conditions (equations (20)–(22)) of the Hamiltonian function, requires:

$$\frac{\partial \pi}{\partial q}e^{-rT} - C'(R) \;=\; \frac{p\tau}{d}e^{-rT}. \tag{25}$$

So a different extraction path satisfying equation (25) will be used. Thus, when the oil price rises at the same rate or below the rate of interest, the optimal extraction path is lower than the no-tax extraction path. This is because if tax increases at T, it cannot at the same time raise the reserve R (assuming rising marginal exploration cost). Oil production will be reduced and fewer reserves will be discovered, although the degree of the negative effect depends on the tax rate and the portion of oil sold in the domestic market in total oil production. If the portion of oil sold domestically equals zero, all produced oil is exported, leading to a zero effect on oil extraction and oil exploration from the value-added tax. If the portion of oil sold domestically equals one, all oil is sold on the domestic market and the effect of the value-added tax is similar to royalties.

4.2.3. The effect of price-dependent ad valorem taxes with variable oil prices

In Kazakhstan, the tax on oil exports is set at tax rates that vary with oil prices: a higher tax rate is set for a higher oil price. An export tax is similar to royalties, the only difference being that the former applies to exported oil and not on oil consumed domestically.

When an oil producer is eligible to pay an oil export tax as a portion of revenue from oil exports, assuming that tax rates vary with oil prices and oil prices vary over time, it faces the profit maximizing problem same as in equation (9). Assuming that an oil company is required to pay tax on exported oil as a portion of revenue from exported oil with oil prices variable over time and the tax rate varying with the oil price, the profit of an oil producer after tax as following:

$$\pi^{\tau}(q(t),p) = \pi(q(t),p(t)) - \frac{q(t)}{x}p(t)\tau(p(t)), \tag{26}$$

where x is a portion of exported oil and $\tau(p(t))$ is a rate of a price-dependent ad valorem tax on oil exports. Here it is assumed that τ is not fixed and depends on the oil price, thus: $\tau(p(t))$. This problem can be solved by constructing the present-value Hamiltonian function for a profit maximizing oil-producing company:

$$H = e^{-rt}\left[\pi(q(t),p(t)) - \tau(p(t))p(t)\frac{q(t)}{x}\right] - C(R) + \lambda(t)(-q(t)) \tag{27}$$

subject to transition equation $\mathrm{d}R(t)/\mathrm{d}t = -q(t)$, initial oil reserves equation $R(0) = R$ and transversality condition equation $R(T) = 0$.

The necessary conditions for an optimum can be expressed as follows:

$$\left[\frac{\partial\pi}{\partial q} - \frac{\tau p}{x}\right]e^{-rt} = \lambda(t), \tag{28}$$

$$C'(R) = \frac{\partial\lambda(t)}{\partial t}, \tag{29}$$

and

$$\lambda(T)R(T) = 0. \tag{30}$$

If H is concave in R, the conditions above are sufficient for a maximum. The solution of necessary conditions (28)–(30) implies that:

$$\frac{\partial^2\pi}{\partial q^2}\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial\pi}{\partial q} - \frac{\partial^2\pi}{\partial q\partial t} + \left(\frac{\mathrm{d}p}{\mathrm{d}t} - rp\right)\frac{\tau}{x} + \frac{\mathrm{d}\tau}{\mathrm{d}p}\frac{\mathrm{d}p}{\mathrm{d}t}p - \frac{\partial^2\pi}{\partial q\partial p}\frac{\mathrm{d}p}{\mathrm{d}t}, \tag{31}$$

where $\mathrm{d}q/\mathrm{d}t$ is a slope of the extraction path and is equal to:

$$\frac{\mathrm{d}q}{\mathrm{d}t} = r\frac{\partial\pi/\partial q}{\partial^2\pi/\partial q^2} - \frac{\partial^2\pi/(\partial q\partial t)}{\partial^2\pi/\partial q^2} + \left(\frac{\mathrm{d}p}{\mathrm{d}t} - rp\right)\frac{\tau}{x}\frac{1}{\partial^2\pi/\partial q^2} + \frac{\frac{\mathrm{d}\tau}{\mathrm{d}p}\frac{\mathrm{d}p}{\mathrm{d}t}}{\partial^2\pi/\partial q^2}p - \frac{[\partial^2\pi/(\partial q\partial p)](\mathrm{d}p/\mathrm{d}t)}{\partial^2\pi/\partial q^2}. \tag{32}$$

As in Section 4.1, it is assumed that the profit function is concave in q, so that $\partial^2\pi/\partial q^2 < 0$. As explained in Section 4.1, $\partial^2\pi/\partial q\partial t$ can be small or large. If $\partial^2\pi/\partial q\partial t$ is small, the slope of the extraction path is negative. If $\partial^2\pi/\partial q\partial t$ is large enough, the slope of the extraction path is positive. The main difference between the slope of the extraction path with a price-dependent ad valorem tax (equation (32)) and the extraction path with ad valorem tax (equation (24)) is the fourth term of the right-hand of equation (32). A price-dependent ad valorem tax on oil exports is set at a higher rate for a higher price; thus, the oil price has a positive effect on tax rate, or $\mathrm{d}\tau/\mathrm{d}p > 0$. Therefore, the sign of the third term depends on the sign of $\mathrm{d}p/\mathrm{d}t$. An increase in oil prices makes the extraction path steeper while a decrease in the oil price makes the extraction path flatter. The only difference with the slope of the no-tax extraction path (equation (7)) is the last three terms of the right-hand side of the equation. The effect of the third term on slope of the extraction path is the same as described in Section 4.2.2. Similar to Section 4.2.2, even if $(\mathrm{d}p/\mathrm{d}t - rp) = 0$, the oil price increases at the same rate as the interest, and the tax rate does not vary with the oil price; however it does not mean that the above equation takes the same form as in the case of no-tax. The extraction path with export tax differs from the no-tax extraction path. This is because the following equation, which is the solution of the first order conditions (equations (28)–(30)) of the Hamiltonian function, requires:

$$\frac{\partial\pi}{\partial q}e^{-rT} - C'(R) = \frac{p\tau}{x}e^{-rT}. \tag{33}$$

So a different extraction path satisfying equation (33) is used. Thus, when the oil price rises at the same rate or below the rate of interest and when the tax rate increases over time, the extraction path is lower than the no-tax extraction path. The reason for that is the same as described in Section 4.2.2: if tax increases at T, it cannot at the same time raise the reserve R (assuming rising marginal exploration cost). Oil production will be reduced and fewer reserves will be discovered, although the degree of the negative effect depends on the tax rate. An increase in the oil price also has some negative effect on oil production and oil exploration because the tax rate increases with oil price. The effect is lower if the tax rate increases at a lower rate than the oil price. The size of the effect of the tax on the slope of extraction path depends now also on the portion of oil exports in total production. If the portion of oil exports equals zero, all produced oil is consumed domestically, so the export tax has no effect on oil extraction and oil exploration. If the portion of oil exports equals one, all produced oil is exported, and the effect of tax is the same as the effect of a royalties tax (assuming royalties are set at a price-dependent rate).

4.2.4. *The effect of quantity-dependent ad valorem taxes with variable oil prices*

In Kazakhstan, the royalties tax is set at a rate that varies with the amount of oil produced: a higher tax rate is set for a greater amount of oil produced. When an oil producer is eligible to pay a quantity-dependent ad valorem tax, which rates vary with the amount of oil produced, and oil prices vary over time, it faces the profit maximizing problem same as in equation (9).

It is assumed that an oil company is required to pay a quantity-dependent ad valorem tax and with oil prices variable over time, thus the profit of an oil producer after tax as following:

$$\pi^{\tau}(q(t), p) = \pi(q(t), p(t)) - q(t)p(t)\tau(q(t)), \tag{34}$$

where $\tau(q(t))$ is a rate of a quantity-dependent ad valorem tax. This problem can be solved by constructing the present-value Hamiltonian function for a profit maximizing oil-producing company:

$$H = e^{-rt}[\pi(q(t), p(t)) - \tau(q(t))p(t)q(t)] - C(R) + \lambda(t)(-q(t)) \tag{35}$$

subject to transition equation $dR(t)/dt = -q(t)$, initial oil reserves equation $R(0) = R$ and transversality condition $R(T) = 0$.

The necessary conditions for an optimum can be expressed as follows:

$$\left[\frac{\partial\pi}{\partial q} - \frac{\partial\tau}{\partial q}pq - \tau p\right]e^{-rt} = \lambda(t), \tag{36}$$

$$C'(R) = \frac{\partial\lambda(t)}{\partial t}, \tag{37}$$

and

$$\lambda(T)R(T) = 0. \tag{38}$$

If H is concave in R, then the conditions above are sufficient for a maximum. The solution of necessary conditions (36)–(38) implies that:

$$\frac{\partial^2\pi}{\partial q^2}\frac{dq}{dt} = r\frac{\partial\pi}{\partial q} - \frac{\partial^2\pi}{\partial q\partial t} + \left(\frac{dp}{dt} - rp\right)\tau + \frac{d\tau}{dq}\frac{dq}{dt}p - \frac{\partial^2\pi}{\partial q\partial p}\frac{dp}{dt}, \tag{39}$$

where dq/dt is a slope of the extraction path and equals to:

$$\frac{dq}{dt} = r\frac{\partial\pi/\partial q}{\partial^2\pi/\partial q^2} - \frac{\partial^2\pi/(\partial q\partial t)}{\partial^2\pi/\partial q^2} + \left(\frac{dp}{dt} - rp\right)\tau\frac{1}{\partial^2\pi/\partial q^2} + \frac{\frac{d\tau}{dq}\frac{dq}{dt}}{\partial^2\pi/\partial q^2}p - \frac{[\partial^2\pi/(\partial q\partial p)](dp/dt)}{\partial^2\pi/\partial q^2} \tag{40}$$

As in Section 4.1, it is assumed that the profit function is concave in q, so that $\partial^2\pi/\partial q^2 < 0$. As explained in Section 4.1, $\partial^2\pi/\partial q\partial t$ can be small or large. If $\partial^2\pi/\partial q\partial t$ is small, the slope of the extraction path is negative. If $\partial^2\pi/\partial q\partial t$ is large enough, the slope of the extraction path is positive. The main difference between the slope of the extraction path with a quantity-dependent ad valorem tax (equation (40)) and the extraction path with an ad valorem tax (equation (24)) is the fourth term of the right-hand side. A quantity-dependent ad valorem tax is set at a higher rate for a greater amount of oil produced; thus, the amount of oil produced has a positive effect on tax rate, or $d\tau/dq > 0$. Thus, the sign of the third term depends on the sign of dq/dt. An increase in oil production makes the extraction path steeper and a decrease in oil production makes the extraction path flatter. The only difference with the slope of the no-tax extraction path (equation (7)) is the last three terms of the right-hand side of the equation. The effect of the third term on the slope of the extraction path is the same as described in Section 4.2.2. Similar to Section 4.2.2, even if $(dp/dt - rp) = 0$, the oil price increases at the same rate as interest, and tax rate does not vary with quantity, it does not mean that the above equation takes the same form as in the case of no tax and the extraction path with tax differs from the no-tax extraction path. This is because the following equation, which is the solution of the first order conditions (equations (36)–(38)) of the Hamiltonian function, requires:

$$\frac{\partial\pi}{\partial q}e^{-rT} - C'(R) = \left[\frac{\partial\tau}{\partial q}pq + p\tau\right]e^{-rT}. \tag{41}$$

So a different extraction path satisfying equation (41) will be used. Thus, when oil prices raise at the same rate or below the rate of interest, and when the tax rate increases over time, the extraction path is lower than the no-tax extraction path. The reason for that is the same as described in Section 4.2.2; if the tax increases at T, it cannot at the same time raise reserves (R) (assuming rising marginal exploration cost). Oil production will be reduced and fewer reserves will be discovered, although the degree of the negative effect depends on the tax rate. The negative effect of tax is lower if the tax rate increases at a lower rate than the amount of oil produced.

Table 1
Data.

Data and units	Period	Source
CPI, index (December 1993 = 100)	Jan. 1994–Jul. 2013	National Bank of Kazakhstan (www.nationalbank.kz)
GIR, US dollars	Jan. 1994–Jul. 2013	National Bank of Kazakhstan (www.nationalbank.kz)
REER, index (December 2000 = 100)	Jan. 1995–Jun. 2013	National Bank of Kazakhstan (www.nationalbank.kz)
Exchange rate, tenge/US dollar	Jan. 2005–Jul. 2013	National Bank of Kazakhstan (www.nationalbank.kz)
Fund's assets, US dollars	Jan. 2001–Jul. 2013	National Bank of Kazakhstan (www.nationalbank.kz)
Fund's revenue, tenge	Jan. 2005–Jul. 2013	Ministry of Finance of Kazakhstan, Statement of receipts and application of the National fund of the Republic of Kazakhstan (www.minfin.gov.kz)
Fund's withdrawals, tenge	Jan. 2005–Jul. 2013	Ministry of Finance of Kazakhstan, Statement of receipts and application of the National fund of the Republic of Kazakhstan (www.minfin.gov.kz)
Government expenditure, tenge	Jan. 1999–Jun. 2013	Ministry of Finance of Kazakhstan, Statistical bulletin (www.minfin.gov.kz)
Oil production, thousand barrels/day	Jan. 1994–Apr. 2013	US EIA, IES (www.eia.gov)
CPI of USA, index (December 2005 = 100)	Jan. 1994–Jun. 2013	IMF, IFS (www.imf.org)
World oil price, US dollars/barrel	Jan. 1994–Jul. 2013	IMF, IFS (www.imf.org)

Table 2
Summary statistics.

Variable	Number of observations	Mean	Standard	Minimum	Maximum
Oil production, thousand barrels/day	232	1010	419	407	1621
Real world oil price, US dollars/barrel	234	47	27	12	119
Real government expenditure, mln. tenge	174	219,975	173,004	16,430	83,916
Fund's revenue, mln. US dollars	235	358	515	−109	2563
Real GIR, mln. US dollars	224	10,844	9730	1252	32,363
REER, index December 2000 = 100	222	102	10	86	135
VAT, %	235	15	2	12	20
Export tax, %	235	12	14	0	33

5. Empirical work

The current section tests the effect of fiscal policy on oil production, the National fund's revenue, gross international reserves and the effectiveness of the National fund. Effectiveness in this context means whether the National fund helps to stabilize government expenditure and REER.

5.1. Data

Data sources are provided in Table 1. All data are monthly. The summary statistics are provided in Table 2.

Since oil export is available only from January 2001, we used oil production data instead. The monthly real value of oil production was calculated by multiplying real world oil price in US dollars per barrel on oil production in thousand barrels per day. We used world oil prices as approximate price for oil which was produced in Kazakhstan. Real oil prices were computed by dividing the nominal price in a given month by the ratio of the CPI of USA in that month to the CPI of USA in the "base" period, December 2005. The real government expenditure was computed by dividing the government expenditure in a given month by the ratio of the CPI of Kazakhstan in that month to the CPI of Kazakhstan in the "base" period, December 2005. The similar way were calculated real gross international reserves. It is necessary to drop CPI of Kazakhstan data before November 1994 (Fig. 12), from November 1994 price liberalization in Kazakhstan was complete according to Hoen (2010).

In the same month a part of oil revenue can be deposited in the National fund and a part of the National fund's assets withdrawn to the budget for government expenditure. That is why we have to take into account not only the revenue of the National fund but also withdrawals. This can be done by calculating net revenue of the National fund as a difference between revenue and withdrawals to the budget. Revenue of the National fund is not only oil revenue received from oil producers, but also investment earnings. It is necessary to deduct investment earnings from total revenue of the National fund. Withdrawals from the National fund are allowed to cover budget deficit, transfers to the budget and to cover the cost on external auditing of the National fund. It is important to deduct the expenditure of external auditing from total withdrawals as it is not government expenditure. Data on deposits and withdrawals of the National fund are provided by the Ministry of Finance of the Republic of Kazakhstan only from 2005 (five years after the fund was established). However the central bank of the Republic of Kazakhstan provides the value of accumulated assets of the National fund at the end of every month starting from 2001. The revenue of the National fund for the period over 2001–2004 was calculated approximately as the difference in the value of financial assets of the National fund at the end of every month. The difference between differences of the value of assets of the National fund and actual accumulation of the National fund are cost of external auditing and investment earnings of the National fund. Cost of external auditing of the National fund is approximately 0.2 percent per year of the annual difference of the value of assets, while annual investment earnings are approximately ten percent of the annual difference in the value of assets of the National fund (using data of 2011).

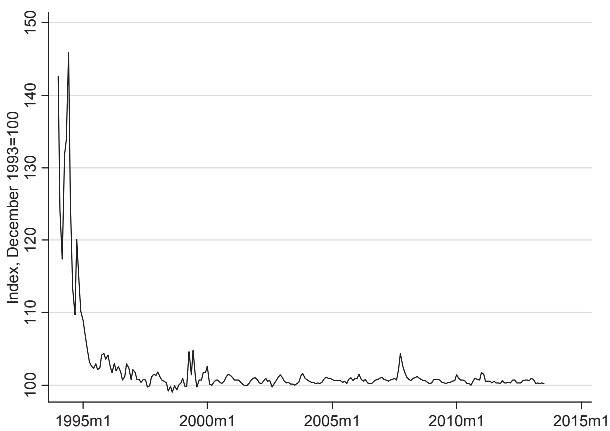

Fig. 12. Consumer price index. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz.

Table 3
Dummy variables.

Dummy variable	Period
Fund exists	From January 2001
Fund 2001	January 2001–June 2006
Fund 2006	July 2006–December 2008
Fund 2009	From January 2009
Taxes 2004	January 2004–December 2008
Taxes 2009	From January 2009

Fund's deposits and withdrawals are provided by the Ministry of Finance in tenge, while the value of assets in the National fund is provided by the central bank in US dollars. Fund's deposits and withdrawals were converted into US dollars using the official exchange rate of the central bank of Kazakhstan. Net revenue of the National fund was calculated as the difference between fund's deposits and fund's withdrawals to the budget. The real net revenue of the National fund was computed by dividing the net revenue of the National fund in a given month by the ratio of CPI of USA in that month to the CPI of USA in the "base" period, December 2005.

Interestingly that the monthly data of the value of assets in the National fund provided by the Ministry of Finance and the central bank do not match. Looks like the Ministry of Finance uses exchange rate different from the official exchange rate provided by the central bank. Also the Ministry of Finance have few months delay in providing data of investment earnings by the National fund and provides quarterly investment earnings in monthly reports. This makes the monthly value of assets provided by the Ministry of Finance not as accurate as annual.

Dummy variables indicate periods over which significant changes in fiscal policy were made, either in oil taxation or in rules of the National fund. Table 3 indicates periods over which dummy variables equal one.

5.2. Unit root test

The time series causes a set of problems; therefore, it is important to study the characteristics of the data available. In particular, the time series are often nonstationary. It is important to know whether or not time series variables have a unit root (Davidson & MacKinnon, 2004) because the distribution of estimators and test statistics associated with a nonstationary regressor may be very different from those associated with a stationary regressor. The problem with a regression of a highly persistent time series (with a unit root process) is that it can lead to misleading results if the Ordinary Least Squares (OLS) assumptions are violated. A solution to this problem is to use the error correction model (ECM) with the first differences of the variables instead of OLS regression. Therefore we started by testing characteristics of the data available before regression.

Table 5
The results of Engle–Granger cointegration test.

Variables	p Lags	Breusch–Godfrey test, chi-sq	DF/ADF test	Result
The value of oil production and oil price	2	0.001	−2.809***	CI
GIR and the value of oil production	0	1.086	−3.081***	CI
REER and the value of oil production	2	0.167	−3.070***	CI

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.
CI – cointegration.

To test for unit root (nonstationarity), the Dickey–Fuller (DF) test (Dickey & Fuller, 1979) was applied – the simplest and most widely used test for unit root. The DF test can include drift and a trend:

$$\Delta y_t = \mu + \gamma^* y_{t-1} + \varepsilon_t \tag{42}$$

and

$$\Delta y_t = \mu + \beta t + \gamma^* y_{t-1} + \varepsilon_t, \tag{43}$$

where the null hypothesis $H0 : \gamma^* = 0$ (y_t is nonstationary) is tested against the alternative hypothesis $H1 : \gamma^* < 0$ (y_t is stationary). Time trend was included where necessary according to visual presence of a time trend. If the series tend to increase or decrease over time, DF/ADF test with drift and time trend was applied. In the presence of autocorrelation the DF test is not valid. On the subject of autocorrelation, several tests have been suggested for its detection: the Breusch–Godfrey Lagrange multiplier (LM) test (Breusch & Godfrey, 1981), Box and Pierce's test (Box & Pierce, 1970), Ljung–Box test (Ljung & Box, 1978) and the Durbin–Watson test (Durbin & Watson, 1950, 1951, 1971). Until recently, the most commonly used test was the Durbin–Watson test for the first order autocorrelation. Nowadays, the Breusch–Godfrey Lagrange

Table 4
The results of unit root test.

Variable	Trend	Breusch–Godfrey test, chi-sq	Lags	DF/ADF test	Result
Real world oil price	Yes	1.398	2	−3.333*	I(1)
Oil production	Yes	1.032	0	−1.728	I(1)
Real GIR	Yes	2.330	0	−1.385	I(1)
Fund's real net revenue	Yes	0.029	0	−6.511***	I(0)
REER	No	0.085	2	−2.387	I(1)
Real government expenditure	Yes	1.816	0	−14.480***	I(0)
Real value of oil produced	Yes	0.467	2	−2.627	I(1)

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.
I(0) – stationary and I(1) – nonstationary.

Table 6
The results of Johansen cointegration test.

Variables	AIC	HQIC	SBIC	Rank	Result
The value of oil production and oil price	4	2	0	1	CI
GIR and the value of oil production	1	0	0	1	CI
REER and the value of oil production	2	2	2	1	CI

CI – cointegration.

multiplier (LM) test (Breusch & Godfrey, 1981) is more popular because it can be applied in a wider set of circumstances and can test for higher order serial correlation (Wooldridge, 2009). The null for the Breusch–Godfrey LM test $H0$: no serial correlation in ε_t is tested against alternative hypotheses $H1 : \varepsilon_t$ is AR(p) or MA(p). The test statistics is calculated by estimating the following regression:

$$e_t = x_t'\gamma + \varrho_1 e_{t-1} + \cdots + \varrho_p e_{t-p} + u_t, \quad (44)$$

where e_t is residual from equation (42) or (43). The test statistics is TR^2. Under $H0$ we have $T \to \infty$,

$$\text{LM} = TR^2 \sim \chi_p^2.$$

There is an evidence of autocorrelation in variables real world oil price, REER and value of oil produced. In order to remove serial correlation from the residuals, we added enough lags using the augmented Dickey–Fuller (ADF) test. ADF test can include a drift and a trend:

$$\Delta y_t = \mu + \gamma^* y_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad (45)$$

and

$$\Delta y_t = \mu + \beta t + \gamma^* y_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta y_{t-i} + \varepsilon_t. \quad (46)$$

The test of the hypothesis in ADF test is the same as in DF test. In deciding whether to reject or accept the null hypothesis, we used a non-standard Dickey–Fuller distribution. In order to reject the null hypothesis, the DF test statistics must be significantly negative. The appropriate amount of lags was determined using the Schwatrz's Bayesian information criterion (SBIC) by Schwarz (1978), the Akaike's information criterion (AIC) by Akaike (1974) and the Hannan and Quinn information criterion (HQIC) by Hannan and Quinn (1979). Using the number of lags suggested by information criterions, the serial correlation in the residuals from equations (45) and (46) was tested using Breusch–Godfrey LM test. In variables real world oil price, REER and the value of oil produced serial correlation was removed using 2 lags. The results of DF/ADF unit root test shows that all variables are nonstationary except accumulation of the National fund and government expenditure (Table 4).

5.3. Cointegration test

The results of unit root tests show that most of variables are nonstationary. There is a possibility of cointegration between oil production and oil price, gross international reserves and value of oil production, REER and value of oil production. Cointegration between two series means that there is a long-run relationship between them. There are two cointegration tests Johansen's (Johansen, 1991) and Engle–Granger (Engle & Granger, 1987). If both series are cointegrated a linear combination of them must be stationary. To apply Engle–Granger test we estimated residuals and then applied DF or ADF test without drift and trend on predicted residuals. DF test was applied if there is no serial correlation while ADF test was applied if there is serial correlation. Serial correlation was tested using Breusch–Godfrey LM test and the appropriate amount of lags was determined using information criterions SBIC, AIC and HQIC. If predicted residuals are nonstationary there is no cointegration, if predicted residuals are stationary there is cointegration. The results of Engle–Granger test showed the presence of cointegration between oil production and oil price, gross international reserves and value of oil production, REER and value of oil production (Table 5).

Johansen's test determines the number of cointegrating relationships among variables or cointegration rank. For this test we need to rewrite VAR model as follows:

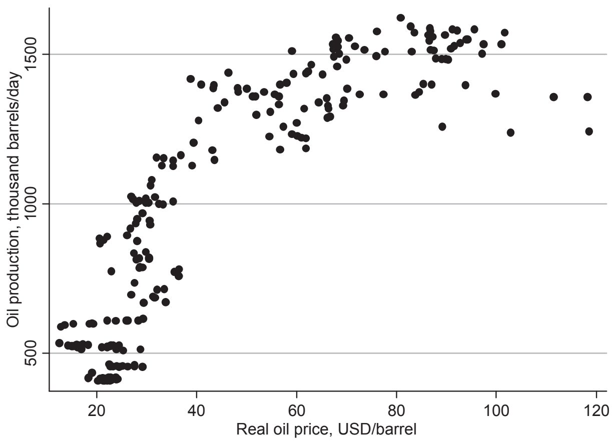

Fig. 13. Correlation between Kazakhstan's oil production and oil price. Data source: The Energy Information Administration, available at www.eia.doe.gov.

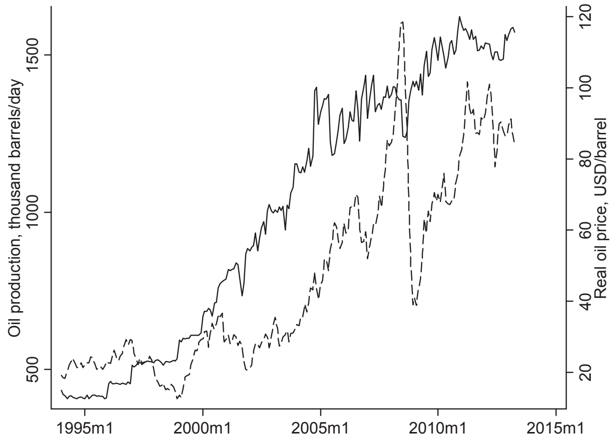

Fig. 14. Kazakhstan's oil production and oil price. Data source: The Energy Information Administration, available at www.eia.doe.gov.

$$y_t = Bx_t + \sum_{i=1}^{p+1} \Phi_i y_{t-i} + \varepsilon_t \quad (47)$$

in the vector error correction model (VECM) form:

$$\Delta y_t = Bx_t + \Pi y_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta y_{t-i} + \varepsilon_t. \quad (48)$$

If rank of $\Pi = 0$ there is no cointegration, if rank of $\Pi = 1$ there is one cointegrating vector and if rank of $\Pi = 2$ there is full rank. The number of lags (p) was determined using information criterions HQIC, SBIC and AIC. According to Schwert (1989) the maximum lag length should be at least equal to $12(T/1000)^{1/4}$, where T denotes the number of periods for which data is available. The number of lags suggested by information criterions is different, but they all provide the same result about presence of cointegration (Table 6).

Johansen's test confirms cointegration between oil production and oil price, gross international reserves and the real value of oil production, REER and the real value of oil production. This means that there is a long-run relationship between oil production and oil price; gross international reserves and the value of oil production; and REER and the value of oil production.

5.4. Econometric specification

This section provides an empirical model to test the theoretical model developed in the previous section. The theoretical model suggests that taxes reduce the oil exploration and reduce the extraction of oil. From equations (24), (32) and (40), the oil production function is specified as a function of oil price, taxes, cost of production and the cost of oil exploration.

$$Q_{it} = S_i\left(p(t)_{it}, \tau(t)_{it}, x_{t,}, C(q)_{it}, C(R)_{it}\right). \quad (49)$$

In this section only data from Kazakhstan was used; other countries' data was not included. Due to data limitations, the cost of oil extraction and the cost of oil exploration in Kazakhstan were not included. Therefore, equation (49) was simplified to a log linear specification in which oil production is a positive function of the oil price and tax rates of value-added tax and tax on oil export. Unfortunately, it

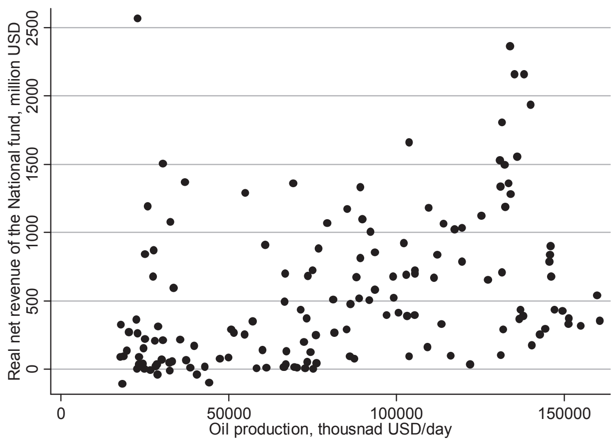

Fig. 15. Correlation between the National fund's revenue and oil production of Kazakhstan. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz; and the Energy Information Administration, available at www.eia.doe.gov.

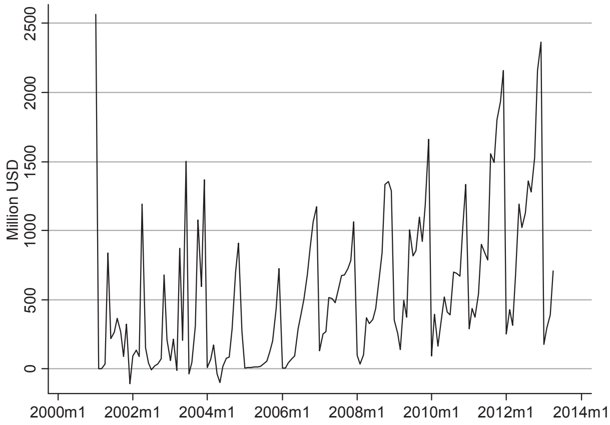

Fig. 16. The National fund's real net revenue. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz.

was impossible to include royalties tax in the model as its rates vary according to the quantity of oil produced by each oil producer, so oil producers pay tax at different rates. Other taxes were impossible to include as most of them were changed simultaneously in 2004 and were valid until the end of 2008. Thus, in the model, a dummy variable 2004 was included, which indicates the period 2004–2008 when tax rates were changed significantly. Many tax rates were changed recently in January 2009. That is why dummy variable 2009 indicates the period from 2009.

Figs. 13 and 14 show a positive relationship between oil production and oil prices. Equation (49) shows a relationship between oil prices and oil production.

To show the effect of fiscal policy on oil production we estimate the effect of real world oil price, oil export tax, VAT and changes in oil taxation in 2004 and 2009 on oil production in Kazakhstan. This model is based on the findings of the theoretical model in Section 4. Oil production and oil price are nonstationary and cointegrated according to unit root and cointegration tests, which means that they have long-run relationship. In order to estimate models involving nonstationary variables we use first differences of those variables to correct for nonstationarity. Since there is a long-run relationship between cointegrated variables we applied error correction model (ECM) which captures long-run and short-run relationships:

$$\Delta q_t = \lambda e_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta q_{t-i} + \sum_{i=0}^{p} \delta_i \Delta x_{t-i} + \varepsilon_t, \qquad (50)$$

where Δ is a first difference, q is a log of a monthly production of oil in Kazakhstan, x are explanatory variables which are a log of the world oil price, a rate of a value-added tax in Kazakhstan, a rate of tax on oil exports in Kazakhstan (according to current world oil price), dummy variables indication periods when significant changes were applied in the taxation of oil in 2004 (equals one if the period 2004–2008 and equals zero otherwise), and when significant changes were applied in the taxation of oil in 2009 (equals one if the period from 2009 and equals zero otherwise).

Oil revenue is all taxes paid by oil producers. The first part of oil revenue was deposited in oil revenue fund of Kazakhstan (the National fund) in January 2001. The amount of oil revenue which must be deposited in the National fund and which can be withdrawn to the budget defined according to accumulation and withdrawal rules of the National fund. Thus, the National fund's revenue dependence on rules of the National fund, taxes on oil, oil prices and oil

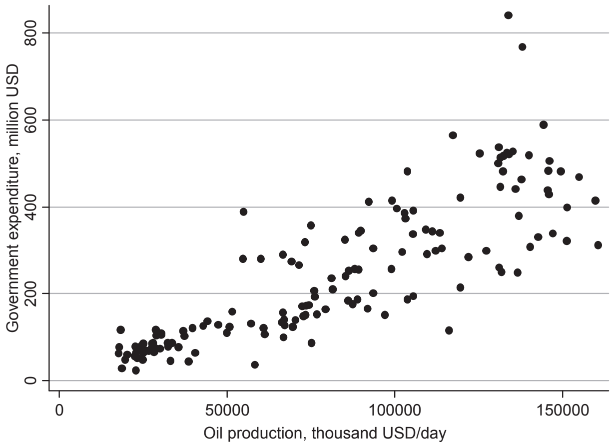

Fig. 17. Real government expenditure and the real value of oil production. Data sources: The Ministry of Finance of the Republic of Kazakhstan, available at www.minfin.kz; and the Energy Information Administration, available at www.eia.doe.gov.

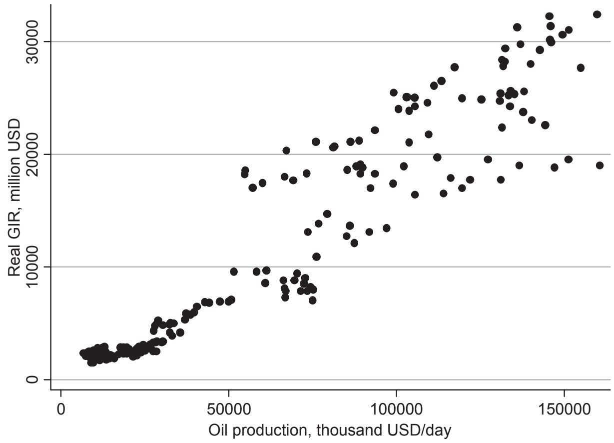

Fig. 18. Kazakhstan's GIR and oil production. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz; and the Energy Information Administration, available at www.eia.doe.gov.

production. Fig. 15 shows relationship between the National fund's net revenue and the value of oil production. Fig. 16 shows real net revenue of the National fund.

The real net revenue of the National fund is a stationary variable, while the value of oil production is a nonstationary variable. We used first differences of nonstationary variables to correct for nonstationarity:

$$r_t = \alpha + \sum_{i=0}^{q}\sum_{j=0}^{k}\beta_{ij}FUND_j\Delta pq_{t-i} + \sum_{i=0}^{q}\sum_{j=0}^{n}\gamma_{ij}TAX_j\Delta pq_{t-i}, \quad (51)$$

where r is the log of the real net revenue of the National fund, pq is the log of the real value of oil produced, $FUND_j$ are dummy variables indicating periods over which rules were significantly changed in July 2006 (equals one if the period July 2006–December 2008 and equals zero otherwise) and 2009 (equals one if the period from 2009 and equals one otherwise) and TAX_j are variables indicating changes in oil taxation such as a rate of oil export tax, VAT, dummy variables indicating periods over which taxes on oil were changed 2004 (equals one if the period 2004–2008 and equals zero otherwise) and 2009 (equals one if the period from 2009 and equals zero otherwise).

The National fund's accumulation and withdrawal rules put constraints on the government expenditure. Fig. 17 shows a relationship between the real government expenditure and the real value of oil produced.

To show the effect of the National fund on government expenditure we test real value of oil production and its interaction terms with the existence of the National fund and changes in rules of the National fund on the real government expenditure. Since the real government expenditure is stationary variable, while the real value of oil production is nonstationary data, we use first differences of nonstationary variables to correct for nonstationarity:

$$g_t = \alpha + \sum_{i=0}^{q}\sum_{j=0}^{k}\delta_{ij}\text{FUND}_j\Delta pq_{t-i} + \sum_{i=0}^{q}\sum_{j=0}^{n}\gamma_{ij}\text{TAX}_j\Delta pq_{t-i}, \quad (52)$$

where g is the log of the real government expenditure.

The National fund invests its revenue in foreign assets. About 90 percent of foreign assets in the National fund are

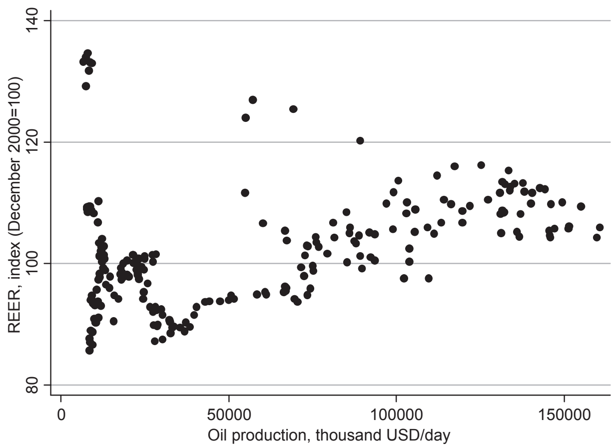

Fig. 19. REER and oil production. Data sources: The National Bank of the Republic of Kazakhstan, available at www.nationalbank.kz; and the Energy Information Administration, available at www.eia.doe.gov.

gross international reserves. Gross international reserves and the value of oil production are nonstationary and cointegrated variables. Fig. 18 shows relationship between the real GIR and the value of oil produced. In order to estimate models involving nonstationary variables we use first differences of those variables to correct for nonstationarity. Since there is a long-run relationship between cointegrated variables we applied ECM:

$$\Delta \text{gir}_t = \lambda e_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \text{gir}_{t-i} + \sum_{i=0}^{q} \delta_i \Delta x_{t-i} + \varepsilon, \quad (53)$$

where gir is a log of real gross international reserves of the National fund and x are explanatory variables which are a rate of a value-added tax in Kazakhstan, a rate of tax on oil exports in Kazakhstan (according to world oil price), dummy variables indication periods when significant changes were applied in the taxation of oil in 2004 (equals one if the period 2004–2008 and equals zero otherwise), and when significant changes were applied in the taxation of oil in 2009 (equals one if the period from 2009 and equals zero otherwise), a log of the real value of oil production, its interaction terms with dummy variables indicating periods over which fund exists (equals one if the period from 2001 and equals zero otherwise) and rules were significantly changed in July 2006 (equals one if the period July 2006–December 2008 and equals zero otherwise) and 2009 (equals one if the period from 2009 and equals zero otherwise).

One of the objectives of the National fund is to protect exchange rate of local currency, tenge, from windfalls of foreign currency which Kazakhstan receives as oil revenue. The National fund invests a part of oil revenue in foreign assets to take foreign currency abroad. For this reason domestic investment by the National fund is not allowed. To show the effect of the National fund on REER we test the effect of the value of oil production, the existence of the National fund and changes in rules in July 2006 and in January 2009 on REER.

Fig. 19 shows relationship between REER and the real value of oil produced. REER and the real value of oil production are nonstationary and cointegrated variables. In order to estimate models involving nonstationary variables we use first differences of those variables to correct for nonstationarity. Since there is a long-run relationship between cointegrated variables we applied error correction model (ECM):

$$\Delta \text{reer}_t = \lambda e_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta \text{reer}_{t-i} + \sum_{i=0}^{q} \delta_i \Delta x_{t-i} + \varepsilon_t, \quad (54)$$

where reer_t is a log of the real effective exchange rate and x are explanatory variables which are a rate of a value-added tax in Kazakhstan, a rate of tax on oil exports in Kazakhstan (according to current world oil price), dummy variables indication periods when significant changes were applied in the taxation of oil in 2004 (equals one if the period 2004–2008 and equals zero otherwise), and when significant changes were applied in the taxation of oil in 2009 (equals one if the period from 2009 equals zero otherwise), a log of the real value of oil production, its interaction terms with dummy variables indicating periods over which fund

Table 7
The results of Breusch–Godfrey LM post estimation test.

Model	Chi-sq with no lags	Lags	Chi-sq with lags
Real government expenditure	128***	13	1.891
Fund's real net revenue	68***	1	0.032

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.

Table 8
The results of Breusch–Pagan heteroskedasticity test.

Model	Chi-sq	Result
Real government expenditure	6.80***	Heteroskedasticity
Fund's real net revenue	2.84***	Homoskedastisity

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.

Table 9
Empirical results of oil production.

Oil production in log (first difference)	Lags	ECM1	ECM2	ECM3
Oil production in log (first difference)	1	−0.154**	−0.137*	−0.116
	2	−0.277***	−0.288***	−0.246***
	3	−0.205**	−0.187***	−0.136*
	4	0.063	0.067	0.105
	5	−0.146**	−0.140**	−0.115
Real oil price in log (first difference)	1	−0.027	−0.030	−0.047
	2	−0.034	−0.032	−0.035
	3	0.033	0.027	0.008
	4	0.021	0.028	0.046
	5	−0.013	−0.005	−0.034
Export tax	1		−0.001	0.002
	2		0.000	0.000
	3		−0.001	−0.002
	4		0.000	−0.006**
	5		−0.001	−0.001
VAT	1		−0.003	−0.007
	2		0.002	0.000
	3		−0.002	−0.003
	4		0.006	0.005
	5		−0.012*	−0.007
Taxes 2004	1			−0.100
	2			−0.016
	3			0.018
	4			0.001
	5			0.023
Taxes 2009	1			−0.055
	2			−0.035
	3			−0.017
	4			−0.102
	5			0.043
Error correction term	1	0.018**	0.011**	−0.000
Constant	0	0.009***	0.010***	0.009***
Number of observations		226	226	226
Chi-squared		44***	51***	55***
R-squared		0.171	0.202	0.223

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.

Table 10
Empirical results of GIR.

Gross international reserves in log (first difference)	Lags	ECM1	ECM2	ECM3	ECM4
Gross international reserves in log (first difference)	1	0.124*	0.105	0.103	0.120
	2	−0.033	0.034	−0.043	0.040
	3	0.073	0.003	0.070	0.051
	4	−0.015	−0.077	0.020	0.034
	5	−0.143**	−0.169**	−0.126*	−0.150**
	6	0.133**	0.076	0.138**	0.144**
The value of oil produced in log (first difference)	1	0.077	0.015	0.083	0.036
	2	0.014	−0.001	0.023	0.015
	3	−0.034	−0.049	−0.018	0.006
	4	−0.039	−0.042	−0.020	0.017
	5	0.017	−0.002	0.020	0.003
	6	−0.051	−0.104*	−0.055	−0.052
Export tax	1		0.000		
	2		0.007		
	3		0.004		
	4		0.002		
	5		−0.005		
	6		0.007		
VAT	1		−0.004		
	2		0.003		
	3		−0.014		
	4		−0.017		
	5		−0.005		
	6		−0.004		
Taxes 2004	1		−0.044		
	2		−0.192		
	3		−0.093		
	4		−0.078		
	5		0.062		
	6		−0.208		
Taxes 2009	1		−0.058		
	2		−0.154		
	3		−0.047		
	4		−0.109		
	5		−0.237**		
	6		0.004		
Interaction with the first difference of the value of oil produced					
Fund exists	1		0.003	−0.001	
	2		−0.001	−0.003	
	3		0.002	0.000	
	4		−0.010	−0.013**	
	5		−0.006	−0.008	
	6		0.002	−0.003	
Fund 2001	1				−0.000
	2				−0.002
	3				0.001
	4				−0.013**
	5				−0.007
	6				−0.001
Fund 2006	1				−0.004
	2				−0.004
	3				0.007
	4				−0.011
	5				0.014
	6				0.005
Fund 2009	1				0.004
	2				−0.007
	3				0.011
	4				−0.009
	5				0.003
	6				0.012
Error correction term	1	−0.049***	−0.027*	−0.066***	−0.063***
	1		0.067***	0.052**	0.045**
	1			0.002	0.002
	1				0.002
Constant	0	0.009*	−0.003	−0.002	−0.004
Number of observations		225	215	225	215
R-squared		0.186	0.251	0.241	0.294
Chi-squared		48***	57	62***	75***

exists (equals one if the period from 2001 and equals zero otherwise) and rules were significantly changed in July 2006 (equals one if the period July 2006–December 2008 and equals zero otherwise) and 2009 (equals one if the period from 2009 and equals zero otherwise).

The lag length (p) selection is very important in ECM. We can use the lag length as suggested for Johansen's cointegration test (Nielsen, 2006). However to determine the lag length for Johansen cointegration test we used variables in levels, but for ECM we need to use first differences of variables. Thus we can use lag length as suggested for Johansen's cointegration test less one lag. Information criterions HQIC, SBIC and AIC suggest different amount of lags (Table 6). We used the amount of lags which is suggested by AIC. According to Ivanov and Kilian (2005) AIC tends to be more accurate with monthly data.

Usually we estimate OLS by assuming that the classical assumptions hold, and then attempt to test whether those assumptions appear to be satisfied by the estimated model. According to the Gauss-Markov theorem, the OLS estimators are the best linear unbiased estimators (BLUE) if the following conditions are satisfied: exogeneity of independent variables, homoskedasticity and non autocorrelation in the errors. There is a need to test for heteroskedasticity and autocorrelation in models with dependent variables government expenditure and fund's revenue.

Breusch–Godfrey LM test for autocorrelation was applied after estimation of models with dependent variable government expenditure and fund's revenue. The results of Breusch–Godfrey LM test for autocorrelation showed presence of autocorrelation in both models (Table 6). The optimal amount of lags of dependent variable to correct for serial correlation was chosen using information criterions HQIC, SBIC and AIC. The Breusch–Godfrey LM test was applied again with suggested amount of lags to make sure that there are enough lags to correct for serial correlation. The results show no presence of serial correlation in both models if lagged dependent variables added (Table 7).

The autocorrelation in models can be corrected by including lagged dependent variables:

$$r_t = \alpha + \sum_{i=1}^{p} \delta_i r_{t-i} + \sum_{i=0}^{q} \sum_{j=0}^{k} \beta_{ij} \mathrm{FUND}_j \Delta pq_{t-i} + \sum_{i=0}^{q} \sum_{j=0}^{n} \gamma_{ij} \mathrm{TAX}_j \Delta pq_{t-i} + \varepsilon_t \tag{55}$$

and

$$g_t = \alpha + \sum_{i=1}^{p} \delta_i q_{t-i} + \sum_{i=0}^{q} \sum_{j=0}^{k} \beta_{ij} \mathrm{FUND}_j \Delta pq_{t-i} + \sum_{i=0}^{q} \sum_{j=0}^{n} \gamma_{ij} \mathrm{TAX}_j \Delta pq_{t-i} \varepsilon_t. \tag{56}$$

Several tests have been suggested for the detection of heteroskedasticity: the Goldfeld–Quandt test (Goldfeld & Quandt, 1965), the Breusch–Pagan test (Breusch & Pagan, 1979) and White's test (White, 1980). The method employed to test for heteroskedasticity in this chapter is the Breusch–Pagan with the null hypothesis of constant variance in errors. The results of Breusch–Pagan heteroskedasticity test showed absence of heteroskedasticity in the model with dependent variable the real net revenue of the National fund. The null hypothesis of homoskedasticity cannot be rejected at five percent level of significance (Table 8). However their results showed presence of heteroskedasticity in the model with dependent variable government expenditure. The null hypothesis of homoskedasticity can be rejected at five percent level of significance (Table 8). In this case regressions can be corrected for heteroskedasticity using robust standard errors.

Table 11
Empirical results of fund's revenue.

Fund's revenue in log	Lags	DM1	DM2	DM3	DM4
Fund's revenue in log	1	0.627***	0.562***	0.530***	0.630***
The value of oil produced in log (first difference)	0	−0.271	−0.480	1.041	−0.253
	1	0.646	1.155	0.297	0.477
Export tax	0		−0.077**	−0.179**	
	1		0.067**	0.205**	
VAT	0		0.421	−0.735*	
	1		−0.560**	0.368	
Taxes 2004	0			−2.817	
	1			1.097	
Taxes 2009	0			−9.093***	
	1			7.564***	
Interaction terms with the first difference of the value of oil produced					
Fund 2006	0				0.022
	1				0.018
Fund 2009	0				−0.041
	1				−0.011
Constant	0	2.188***	4.669***	8.621***	2.180***
Number of observations		133	133	133	133
F-statistics		30***	17***	14***	13***
Adjusted *R*-squared		0.405	0.464	0.531	0.389

*Significant at 10 percent level.
**Significant at 5 percent level.
***Significant at 1 percent level.

Table 12
Government expenditure

Government expenditure in log	Lag	DM1 robust	DM2 robust	DM3 robust
Government expenditure in log	1	0.273***	0.252***	0.197
	2	0.099**	0.135**	0.111*
	3	0.091	0.089	0.057
	4	0.039	0.048	0.038
	5	−0.004	−0.023	0.007
	6	0.086	0.083	0.106
	7	0.031	0.029	0.066
	8	−0.028	−0.019	−0.021
	9	0.002	0.016	0.009
	10	−0.050	−0.044	−0.913
	11	−0.097	−0.100	−0.108
	12	0.770***	0.741***	0.764***
	13	−0.225**	−0.222**	−0.148
The value of oil produced in log (first difference)	0	−0.079	−0.049	−0.054
	1	0.561***	0.515***	0.574**
	2	0.060	0.110	−0.022
	3	0.013	0.041	−0.289
	4	−0.212	−0.222	−0.313
	5	−0.047	−0.009	0.026
	6	0.088	−0.005	0.008
	7	0.201	0.191	0.338
	8	−0.176	−0.157	0.092
	9	0.532	0.537***	0.607**
	10	0.075	0.002	0.056
	11	−0.287*	−0.251	−0.171
	12	0.247	0.268	0.256
	13	0.095	0.068	−0.073
Interaction terms with the first difference of the value of oil produced				
Fund exists	0		−0.008	
	1		−0.006	
	2		0.027**	
	3		−0.009	
	4		0.023**	
	5		−0.001	
	6		0.011	
	7		−0.004	
	8		−0.003	
	9		0.009	
	10		0.011	
	11		0.011	
	12		−0.028***	
	13		−0.035***	
Fund 2001	0			−0.010
	1			−0.006
	2			0.019
	3			−0.015
	4			0.015
	5			−0.001
	6			0.015
	7			0.007
	8			−0.002
	9			0.008
	10			0.006
	11			−0.000
	12			−0.039**
	13			−0.031**
Fund 2006	0			−0.022
	1			−0.016
	2			0.005
	3			−0.013
	4			−0.026
	5			−0.049**
	6			0.007
	7			0.032*
	8			−0.004
	9			−0.002
	10			0.018
	11			−0.008
	12			−0.032
	13			−0.013

(*continued on next page*)

Table 12 (*continued*)

Government expenditure in log	Lag	DM1 robust	DM2 robust	DM3 robust
Fund 2009	0			−0.051*
	1			−0.051*
	2			−0.004
	3			−0.005
	4			−0.016
	5			−0.16
	6			0.019
	7			0.050**
	8			0.012
	9			0.002
	10			−0.005
	11			−0.014
	12			−0.050
	13			−0.014
Constant	0	0.157*	0.157*	0.189
F-statistics		211***	5855***	23,830***
Adjusted *R*-squared		0.964	0.967	0.974
Number of observations		159	159	159

5.5. *Empirical results*

Oil production and real world oil price have long-run relationship according to the results of cointegration test. The results of effect of fiscal policy on oil production in Kazakhstan are presented in Table 9. The long-run relationship between oil production and oil price is captured by the error correction term. The short-run effects on oil production are captured by coefficients of other explanatory variables. The results show that in short-run there is no statistically significant effect of real world oil price on oil production in Kazakhstan. The results show that tax on oil exports and VAT have statistically significant negative effect on oil production. The negative effect of oil export tax has four months lag on oil production. The negative effect of VAT has five months lag on oil production. The results show that changes in oil taxation in 2004 and in 2009 did not have statistically significant effect on oil production.

GIR and the value of oil production have long-run relationship according to the results of cointegration test. The results of effect of fiscal policy on GIR are presented in Table 10. The long-run relationship between GIR and the real value of oil production is captured by the error correction term. The short-run effect on GIR is captured by coefficients of other explanatory variables. The results show no positive effect of the real value of oil production on GIR. There is no statistically significant effect of taxes on GIR. The existence of the National fund is not associated with greater GIR. Changes of rules of the National fund from July 2006 and January 2009 had no statistically significant effect on GIR.

The results of the effect of fiscal policy on the real net revenue of the National fund are presented in Table 11. The results show positive but statistically not significant effect of the real value of oil produced on the real net revenue of the National fund. Changes in taxes on oil have negative effect on the real net revenue of the National fund. An increase/decrease of a tax rate on oil export by one percentage point causes a decrease/increase in the real net revenue of the National fund by 0.01 percent. An increase/decrease of a rate of VAT by one percentage point causes a decrease/increase in the real net revenue of the National fund by 0.139 percent. Changes in oil taxation in 2004 did not have statistically significant effect on the real net revenue of the National fund. Changes in oil taxation in 2009 have statistically significant negative effect on the real net revenue of the National fund. From 2009 the real net revenue of the National fund decreased by 1.529 percent. The results show no statistically significant effect of changes in rules of the National fund on the real net revenue of the National fund from July 2006 and 2009.

The results of the effect of the National fund on government expenditure are presented in Table 12. The results show that the real value of oil produced has statistically significant positive effect on real government expenditure. This means that in Kazakhstan government expenditure is correlated with the value of oil produced. If the first difference in the value of oil produced increases/decreases by one percent, the estimated government expenditure increases/decreases by 0.274 percent. In order to stabilize economy the National fund was established. The results show that the National fund is effective in stabilizing government expenditure. After the establishment of the National fund in 2001 the effect of the first difference of the value of oil production on the government expenditure is reduced by 0.013 percent. This means that after the establishment of the National fund the increase/decrease of the first difference of the value of oil production causes increase/decreases of the government expenditure by 0.261 percent. After the establishment of the National fund in 2001 the accumulation and withdrawal rules were significantly changed from July 2006 and January 2009. We tested which rules made the National fund effective. The results show that all rules, which were set in 2001, July 2006 and 2009, made fund effective. The results show that the National fund was mostly effective over the period 2001–June 2006. The National fund was most effective over the period 2001–June 2006, less effective over the period from 2009 and the least effective over the period July 2006–2009. This does not necessary mean that rules which were set in 2001 were most successful. Over period 2001–

Table 13
Empirical results of REER.

REER in log (first difference)	Lags	ECM1	ECM2	ECM7
REER in log (first difference)	1	0.200***	0.201***	0.193***
	2	0.017	0.023	−0.006
	3	0.044	0.048	0.052
	4	−0.020	−0.019	0.010
	5	0.047	0.056	0.076
	6	0.036	0.040	0.062
	7	−0.253***	−0.252***	−0.287***
The value of oil produced in log (first difference)	1	−0.057***	−0.066***	−0.055**
	2	0.017	0.010	−0.006
	3	−0.001	−0.004	−0.033
	4	−0.010	−0.017	−0.032
	5	0.002	0.008	−0.015
	6	0.021	0.018	0.001
	7	−0.005	−0.012	−0.017
Interaction terms with the first difference of the value of oil produced				
Fund exists	1		0.002	
	2		0.002	
	3		0.001	
	4		0.001	
	5		0.002	
	6		−0.000	
	7		−0.002	
Fund 2001	1			0.002
	2			0.001
	3			0.001
	4			0.000
	5			0.001
	6			−0.001
	7			−0.002
Fund 2006	1			−0.002
	2			−0.000
	3			0.000
	4			−0.001
	5			−0.001
	6			0.002
	7			−0.003
Fund 2009	1			−0.016***
	2			−0.003
	3			0.000
	4			−0.001
	5			−0.000
	6			0.005
	7			−0.001
Error correction term	1	−0.057**	−0.079***	−0.074**
	1		0.009**	0.012*
	1			−0.002*
	1			−0.001
Constant	0	−0.006*	−0.009**	−0.013**
Number of observations		212	212	212
R-squared		0.204	0.227	0.372
Chi-squared		50***	55***	102***

June 2006 oil price mostly increased. In 2008 oil price sharply decreased, probably that is a reason why over the period July 2006–2008 the National fund was least successful.

REER and the real value of oil production have long-run relationship according to the results of cointegration test. The results of the effect of fiscal policy on REER are presented in Table 13. The long-run relationship between REER and the real value of oil production is captured by the error correction term. The short-run effects on REER are captured by coefficients of other explanatory variables. The results show that the real value of oil production has positive but statistically not significant effect on REER. Surprisingly the results even show statistically significant negative effect of the real value of oil production on REER if taxes on oil as explanatory variables are added. This is probably because the rate of tax on oil export positively depends on oil price. Changes in oil taxation in 2004 had negative but statistically not significant effect on REER. Changes in oil taxation in 2009 associated with reduction in the first difference of REER by 0.109 percent. The National fund is effective in stabilizing REER. However when we control for changes in rules of the National fund, the results show that the changes in rules of the National fund in 2009 are effective in stabilizing REER due to the real value of oil production.

The results of the effect of dummy variables indicating periods over which significant changes in oil taxation or rules of the National fund were made are limited. It is not necessary that only those changes in oil taxation or rules of the National fund had effect on dependent variables. There is a possibility that other changes which took place during those periods affected dependent variables. Also the above results are limited with the sample size. Kazakhstan is a young country, so the period of coverage is not very large, especially for the regressions on the National fund as it was only established in 2001. Also, results are limited because in the regressions only data from Kazakhstan was used. Regression of panel data, including other oil-producing countries, would allow us to estimate the effect of other variables such as transparency of the fund, withdrawal rules, accumulation rules, management of the fund and so on. Another limitation is that oil price during the sample period mostly increased, and the period when oil prices decreased is very short (Fig. 20).

6. Conclusion

This paper provides theoretical and empirical evidence of the effect of taxes on oil production. Also this paper provides empirical evidence of the effect of fiscal policy on the National fund's revenue, gross international reserves, REER and government expenditure in Kazakhstan.

The National fund's revenue is accumulated from fiscal oil revenue from selected companies and other non-fiscal revenues. Thus, fiscal policy must have a significant effect on the National fund and its effectiveness. Although there is some literature showing the effect of a fund on the economy, in this chapter it is shown that not only the existence of National fund but rules are important. In this chapter, the term fiscal policy is narrowed down to include only taxation of oil, the existence of the National fund and its accumulation and withdrawal rules.

Fiscal policy affects oil revenue funds directly since the fund is accumulated from fiscal oil revenue from selected companies, and indirectly affects extraction and exploration of resources. Taxation of resources is a combination of per unit, per revenue and lump sum taxes. An appropriate design of fiscal policy is significant in avoiding high volatility of oil revenue: an ad valorem tax allows for higher revenue when resource price is high; a per unit tax allows a country to receive resource revenue even when the resource price is low; and a lump sum tax allows a country to receive revenue even when the level of oil production is

Fig. 20. World oil prices. Data source: The Energy Information Administration, available at www.eia.doe.gov.

low. In Kazakhstan oil producers are mostly taxed by ad valorem taxes (royalties, tax on oil exports, value-added tax). This allows the country to receive higher revenue when resource price is high. Also, oil producers pay lump sum taxes. This allows the country to receive revenue even when the level of oil production is low. However, there is no per unit tax on oil in Kazakhstan, which would allow the country to secure itself by receiving oil revenue even when oil price is low.

It is straightforward to calculate the effect of fiscal policy on an oil revenue fund for a given level of production. That is why in this chapter a developed theoretical model and an empirical model show the effect of the taxation of resources (value-added tax, tax on oil exports and significant changes in oil taxation in 2004 and 2009) on its production. The theoretical results show that taxes on oil have a negative effect on exploration and extraction. The effect of value-added tax depends on the share of oil sold in the domestic market to the total oil production. Since, in Kazakhstan, the portion of exported oil is very large, the theoretical model predicts that value-added tax have a small effect on oil production in Kazakhstan. The empirical results show a statistically not significant effect of value-added tax on oil production in Kazakhstan. The effect of tax on oil exports also depends on the share of exported oil in total production. Since, in Kazakhstan, the portion of oil exports is very large, the theoretical model predicts a significant effect of this tax on oil exports. The tax on oil exports in Kazakhstan is a price-dependent ad valorem tax. The theoretical model shows that not only does the rate itself have a negative effect on oil exploration and extraction, but also the rate at which the tax increases compared to oil price growth. When oil prices grow at a rate greater than the tax rate on oil exports, the negative effect of this tax is smaller. The rate of tax on oil exports in Kazakhstan from 2004 to 2008 grew at a greater rate than oil prices, and the difference is larger for smaller prices and smaller for larger prices. Thus, the theoretical model predicts a negative effect of tax on oil exports and oil production and this negative effect is greater at lower oil prices and lower at greater oil prices. The royalties tax rates in Kazakhstan are set at an increasing scale depending on the amount of oil extracted. The theoretical model shows that the royalties tax has a negative effect on oil exploration and extraction. The negative effect of the royalties tax is stronger when the tax rate of royalties grows at a greater rate than oil production. Such is the case in Kazakhstan from 2004 to 2008 during which the royalties tax rate grew at a greater rate for larger amount of oil production and at a smaller growth rate for smaller amounts of oil produced. Thus, the theoretical model predicts that the royalties tax has a negative effect on oil production and this effect is less negative for a smaller amount of oil production and greater for a larger amount of oil production.

In order to support theoretical model, the effects of fiscal policy on oil production, the National Fund's revenue and gross international reserves in Kazakhstan were estimated. These regressions used data from Kazakhstan over the period January 1994–July 2013. The results from the theoretical model on the effect of oil taxation are supported by empirical results, which provide a statistically significant negative effect of VAT and oil export tax on oil production. The problem with the regression of changes in taxation is that often these changes take place simultaneously from 1st January; thus, it is difficult to estimate the effect of each tax independently. The effect of the royalties tax on oil production was impossible to test empirically because the rate of the royalties tax vary with the amount of oil extracted, so tax rates differ with oil producers. According to cointegration test oil production and oil price have long-run relationship, but empirical results showed no statistically significant short-run effect of oil price on oil production. The empirical regression shows no effect of the value of oil produced on the real GIR. The existence of the National fund and changes in their rules are not associated with greater GIR. The regression on the National fund's revenue shows that the value of oil produced has no effect on the real net revenue of the National fund. Empirical results show that the real government expenditure and the real value of oil produced are correlated. The National fund reduced correlation between the real government expenditure and the real value of oil produced. Empirical results show that the real value of oil produced has no positive effect on REER. The National fund has no effect on REER.

To show how other policies affect the National fund and its effectiveness, such as transparency, withdraw rules, accumulation rules and other taxes, further studies with panel data regression including other oil-producing countries are needed.

References

Akaike, H. (1974). A new look at the statistical model identification. *IEEE Transactions on Automatic Control, 19*, 716–723.

Boadway, R. W., & Flatters, F. (1993). *The taxation of natural resources: Principles and policy issues*. The World Bank policy research working paper, 1210.

Box, G. E. P., & Pierce, D. A. (1970). Distribution of residual autocorrelations in autoregressive-integrated moving average time series models. *Journal of the American Statistical Association, 65*(332), 1509–1526.

Breusch, T. S., & Godfrey, L. G. (1981). A review of recent work on testing for autocorrelation in dynamic linear models. In R. Nobay, D. A. Currie, & D. Peel (Eds.), *Macroeconomic analysis: Essays in macroeconomics and macroeconometrics*. London: Croom Helm.

Breusch, T. S., & Pagan, A. R. (1979). A simple test for heteroscedasticity and random coefficient variation. *Econometrica, 47*(5), 1287–1294.

Burness, H. S. (1976). On the taxation of nonreplenishable natural resources. *Journal of Environmental Economics and Management, 3*(4), 289–311.

Conrad, R. F., & Hool, R. B. (1984). Intertemporal extraction of mineral resources under variable rate taxes. *Land Economics, 60*(4), 319–327.

Davidson, R., & MacKinnon, J. (2004). *Econometric theory and methods*. Oxford University Press.

Davis, J. M., Ossowski, R., Daniel, J., & Barnett, S. (2001). *Stabilization and savings funds for nonrenewable resources: Experience and fiscal policy implications*. International Monetary Fund occasional paper, 205.

Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*(366a), 427–431.

Durbin, J., & Watson, G. S. (1950). Testing for serial correlation in least squares regression: I. *Biometrika, 37*(3/4), 409–428.

Durbin, J., & Watson, G. S. (1951). Testing for serial correlation in least squares regression: II. *Biometrika, 38*, 159–177.

Durbin, J., & Watson, G. S. (1971). Testing for serial correlation in least squares regression: III. *Biometrika, 58*(1), 1–19.

Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica, 55*(2), 251–276.

Goldfeld, S. M., & Quandt, R. E. (1965). Some tests for homoscedasticity. *Journal of the American Statistical Association, 60*(310), 539–547.

Government of the Republic of Kazakhstan. (March 19, 2001). Regulation number 369a.

Government of the Republic of Kazakhstan. (July 5, 2006). Regulation number 159-III.

Hannan, E., & Quinn, B. (1979). The determination of the order of an autoregression. *Journal of the Royal Statistical Society*, 190–195.

Heaps, T., & Helliwell, J. F. (1985). *The taxation of natural resources*. In A. J. Auerbach, & M. Feldstein (Eds.), *Handbook of public economics* (Vol. 1); (pp. 421–472). Elsevier.

Hoen, W. H. (2010). Transition strategies in central Asia: is there such a thing as "shock-versus-gradualism?". *Economic and Environmental Studies, 10*(2), 229–245.

Hotelling, H. (1931). The economics of exhaustible resources. *The Journal of Political Economy, 39*(2), 137–175.

Ivanov, V., & Kilian, L. (2005). A practitioner's guide to lag order selection for VAR impulse response analysis. *Studies in Nonlinear Dynamics & Econometrics, 9*(1).

Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. *Econometrica, 59*(6), 1551–1580.

Liuksila, C., Garcia, A., & Bassett, S. (1994). *Fiscal policy sustainability in oil-producing countries*. International Monetary Fund working paper, 94/137.

Ljung, G. M., & Box, G. E. P. (1978). On a measure of lack of fit in time series models. *Biometrika, 65*(2), 297–303.

Manzano, O. (2000). *Tax effects upon oil field development in Venezuela*. MIT Center for Energy and Environmental Policy research working paper, 00-006.

Nielsen, B. (2006). Order determination in general vector autoregressions. *Lecture Notes-Monograph Series, 52*, 93–112.

Pontryagin, L. S. (1934). On dynamical systems close to Hamiltonian systems. *Journal of Experimental and Theoretical Physics, 4*, 234–238.

President of the Republic of Kazakhstan. (August 23, 2000). Decree number 402.

President of the Republic of Kazakhstan. (January 29, 2001). Decree number 543.

President of the Republic of Kazakhstan. (September 1, 2005). Decree number 1641.

President of the Republic of Kazakhstan. (April 2, 2010). Decree number 962.

The Ministry of Finance of the Republic of Kazakhstan. (2001). The state budget of the Republic of Kazakhstan Accessed 25.11.12 http://www.minfin.kz.

The Ministry of Finance of the Republic of Kazakhstan. (2004). The code of the Republic of Kazakhstan about taxes and other mandatory payments to the budget of the Republic of Kazakhstan Accessed 25.11.12 http://www.minfin.kz.

The Ministry of Finance of the Republic of Kazakhstan. (2009). The code of the Republic of Kazakhstan about taxes and other mandatory payments to the budget of the Republic of Kazakhstan Accessed 25.11.12 http://www.minfin.kz.

The Ministry of State Income of the Republic of Kazakhstan. (1991). The law about taxes and other mandatory payments to the budget of the Republic of Kazakhstan Accessed 25.11.12 http://www.minfin.kz.

The Ministry of State Income of the Republic of Kazakhstan. (1995). The law about taxes and other mandatory payments to the budget of the Republic of Kazakhstan Accessed 25.11.12 http://www.minfin.kz.

The National Bank of the Republic of Kazakhstan. (2008). International reserves and assets of the National fund of the Republic of Kazakhstan Accessed 25.11.12 http://www.nationalbank.kz.

The Republic of Kazakhstan. (April 24, 2004). Code number 548-II.

The Republic of Kazakhstan. (July 5, 2006). Law number 165-III.

The Republic of Kazakhstan. (December 4, 2008). Budget code number 95-IV.

Schwarz, G. (1978). Estimating the dimension of a model, The Annals of Statistics. *Institute of Mathematical Statistics, 6*, 461–464.

Schwert, G. W. (1989). Tests for unit root: a Monte Carlo investigation. *Journal of Business and Economics Statistics, 7*, 147–159.

Shabsigh, G., & Ilahi, N. (2007). *Looking beyond the fiscal: Do oil funds bring macroeconomic stability?*. International Monetary Fund working papers, 07/96 (pp. 1–18).

White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica, 48*(4), 817–838.

Wooldridge, J. M. (2009). *Introductory econometrics: A modern approach*. South-Western Publishing.