How should Russia allocate its oil revenues, when it faces sanctions?

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Summary:

This thesis represents an attempt to provide a deeper knowledge of how a resource-rich country should manage its resources in the most efficient way. I model the Russian economy with the help of the Ramsey model. I specify the trade-off between consumption and investment in the Ramsey model and analyze it in Matlab. I use the runshooting algorithm to find the values of consumption and capital in the next 100 years.
There are two types of economy: open and closed. Two scenarios are possible for Russia in the next 100 years: it either overcomes geo-political crisis and remains open and integrated into the world markets or becomes isolated, without access to the financial markets. The results indicate that in the open case it is better for Russia to save oil revenues. In the closed case it is optimal for the country to consume more and not to save into welfare fund.

Acknowledgements:

First of all, I would like to thank my supervisor, Daniel Spiro, assistant professor at the Department of Economics at the University of Oslo, for his guiding, valuable comments and time.
I would like also to thank people, who were together with me, while I was writing the thesis: my husband Torstein, my grandparents Tatyana and Vladimir and my parents Natalia and Dmitry.
I decided to write the thesis on this subject, because I was interested how an oil nation can use its oil to something good. I took master in economics in Oslo, because wanted to learn how to manage economics in the most successful economy in the world – the Norwegian one. Both Norway and Russia are countries that are resource-driven. However their societies are inevitably different. One of the reasons can be different management of the resources. Thus, being armed with my new knowledge about how the perfect economy should function, I study the pillars and mechanisms of resource management in Russia and come up with the guidance on how the oil resources should be managed in this difficult for Russia time – occupation of foreign territory and economic sanctions that has followed.
Secondly, I am grateful for the knowledge of the Russian economy, which I acquired via my studies in St-Petersburg State University. I am highly grateful for the knowledge of economic theory and political relations and skills I gained during my studies in the University of Oslo.

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1. Introduction

My thesis is about the saving/investment trade-off of a country, which is very rich in the resources, but suffers from all resource curse side-effects. This country is Russia, the world's largest producer of oil, and it has substantial natural reserves, corruption, prohibiting sanctions, welfare fund and consumption appetite of the developing country and human and scientific capital of the developed country. The thesis addresses the savings rate decision problem of oil revenues management. How should Russia use its oil revenues to benefit from oil in the future?

The study is undertaken to answer the question: Given the sanctions of 2014 what would be the optimal consumption and saving for the country in the next 100 years in case the economy remains open or becomes closed?

This question is interesting because: 2/3 of export is natural resources; sanctions can vary years; oil is going to run off in 60-70 years.

There have been written the substantial amount of literature on consumption/saving trade-off, resource curse and it externalities, the Russian economy, fund management. But there are no studies, addressing these questions put together. There have been written several papers from the 1990s on effects of the saving and stabilizing funds on the economies. Udabir S. Das (2009) wrote a guide-line on the fund composition and management. The trade-off between consumption and saving of extra revenues has also been studied by the researchers, not theoretically, but empirically. Hassler et al (2014) investigated the implications of savings rule on the Ugandan economy. The research on institutions is abundant and was performed with respect to different countries, in particularly to Russia. Van der Ploeg (2011) made a substantial research on the factors, which decide whether the resource-rich country becomes a resource winner or resource loser. Auty R. M. (1993) wrote a book on sustainable development in the mineral economies through political, institutionalist and environmentalist approaches. Mehlum, H., K. Moene, and R. Torvik (2006) studied the effect of quality of institutions on the size of the resource curse. Ellman M. (2006) wrote a book "Russia's oil and natural gas: bonanza or curse?" where the author studies the long-terms effect of the Russian resource abundance on the structure of the economy and population welfare. There are a number of studies focused on the reasons of the Russian resource curse. They usually come to the same conclusion. I.e. they blame the soviet legacy of the structure of manufacturing sector. My paper addresses these issues in a different way.

In my master thesis I model the Russian economy with plenty of oil and inefficiencies, caused by the resource curse and structural peculiarities. The Russian economy extracts and sells oil

abroad and it is dependent on the oil price. The country also has a fund, where it accumulates part of the oil revenues. The purpose of my work is to evaluate the savings rule and fund management and find whether they are optimally applied. In such a way I will be able to find the conditions of resource management that lead to the highest welfare of the country in 100 years.

In order to analyze how the extra oil revenues can influence the Russian economic growth, I will build a growth model, based on Ramsey, to study the consumption/investment trade-off, which Russia has to face. Since the time horizon is 100 years, I will use different development scenarios for world oil price and oil extraction path. From the resource economics theory it is known that countries that are neither poor, nor rich, so-called "transition" countries with middle income should consume part of oil revenues and start saving the rest (Ploeg, 2011). Countries that have access to the world financial market have an extra tool of consumption smoothing besides oil revenues - borrowing abroad. However this tool might become unavailable for the Russian economy due to the recent geo-political events. The annexion of Crimea in 2014 triggered the mechanisms that prohibit the largest private and public Russian companies from borrowing abroad and introduce investment barriers for smaller private companies as well. Thus all oil and gas companies in Russia lost their access to international borrowing and lending. Moreover they are losing technology partnership contract. That can lead to banned access to extraction technologies in the future periods and thus the increasing extraction costs of oil extraction in the Arctic of off-shore. Sanctions 2014 might introduce complications to the consumption-saving decision and this question I also address in my paper. The political risks and corruption are the other side of the resource coin. How should Russia manage oil, given the thriving corruption and lack of transparency in investment decision-making? Part of my finding is that the construction of the fund is economically reasonable and helps to tackle many problems at the same time: smoothes consumption, stabilizes economy against oil price and other shocks.

The model cannot include everything, related to the questions and trade-offs stated above. So in the discussion section I will discuss how resource ownership, institutions, corruption and oil price volatility affect resource management and what can be done to manage resources and their revenues most effectively, by minimizing the negative externalities they can bring along. However there are a number of topics, which I didn't make the path of the paper. For example, the resource management often includes climate issues, which are not part of my model. In the fund management there are many questions that are interesting and important:

Where exactly should the country invest its fund? How currency composition affects stabilizing and saving roles of the fund? Who should have the decision-making power when it comes to asset spending from the fund? Since the fund can be used in political electoral promises or allocated on extensive public expenditure, the objects of fund investment must be defined strictly. I don't focus on the criteria and procedure of choosing the socially optimal investment projects and how to identify a possible "white elephant" (an investment project with negative social surplus according to J. Robinson and R. Torvik) – these issues can be a question of further research.

In section 2 the key economic facts on the Russian economy are presented. I draw assumptions on the oil price development path and extraction path in the next 100 years. In section 3 I build up a model and make calibrations to fit the model into Matlab code. Section 4 presents the result of the numerical exercises. In section 5 I lead discussion on the topics, related to the resource curse and savings rule. Section 6 concludes.

1.1 Purpose of work, background, relevance

The main question, which I answer in this work, is a consumption/investment trade-off faced by a resource-rich country, which finds itself in geo-political crisis.

The macroeconomic performance of countries rich with natural resources has been always an interesting part of macro- and policy analysis. The performances of countries who possessed a resource during a long time or has just discovered it make a rich field for empirical studies of how the additional revenue affect a country, institutions, poverty, development, corruption, taxation issues. I shall focus on Russia – the country with some indices of human capital and development that are among developed countries, and some macro and micro indices of developing countries. Russia has just foregone the period of transition from centralized economy to market economy. Despite a sharp and quite shaky period of transition with many negative externalities the country doesn't manage to sustain any of the conventional types of market economy. The country doesn't clearly belong to neither developed nor developing countries. It is considered to be one of the "newly advanced economic" states –BRIC due to its economic growth and potential, showed in 2001-2010 years. The country is not a member of OECD and had to leave G8 – these facts say more about geopolitics than economics, but they also show that Russia has a unique decision-making process in key economic questions that has a framework and goals different from common collaborative behavior of developed

western countries. When it comes to natural resources, it is trade that gives the most benefit of resource-owning. The trade revenues depend often on a country's negotiation ability which covers favorable resource price, supply and best response to rival's behavior. These parameters are mostly exogenous in neo-classical models. In my thesis, in order to reflect the Russian economy better, I will introduce different resource prices and extraction paths. In this way it will be easier to show the effect of recent geopolitical changes in status of a country with plenty of natural resources, but lack of value added production and big misbalances in economy, low productivity and high negative externalities. Thus a country with the largest reserves of many resources in the world can get severely affected by foreign trade and financial sanctions, which lead to isolation of the country from the world markets. Theory predicts that the more inefficiencies and bad institutions one country has, the less it will benefit from resource abundance (Michalopoulos and Papaioannou (2012)).

In my thesis I shall have a look at a country, Russia, with resource abundance and old technological legacy from the previous political regime, the Soviet Union. This country has been extracting oil from 1930, and in 1960 the main oil fields in Siberia was discovered and made ready for exploitation. Thus the extraction and refinery technology has a solid R&D base throughout 60 years. However today common extraction technological base is becoming very out-of-date. That coincides with the barriers to the western technological markets, introduced in 2014 for Russian oil companies. It is in this decade that Russia can experience substantial problems with extracting the "working horse" of its economy – oil. A decrease in oil extraction due to increasing marginal costs, limited access to new technologies, economical inefficiency, and harmed institutions can lead to recession in Russian economy not only in the short run, but in the long run as well. It is shown by many studies that oil reserves are not necessary a blessing for the economy. Russia before sanctions was more an example of resource curse, rather than blessing.

Firstly, in this chapter I will give a description of the Russian economy, its key strong and weak sides, a brief picture of the oil sector and its future challenges. Then I will form my assumptions on main oil and macro-economic variables to the model. Afterwards I will construct the Ramsey model suitable for finding how extra oil revenues can affect economy growth path. Then I will make some calibrations to the model and explain the use of Matlab in studying neo-classical models. In the discussion section of the thesis I shall discuss the role of the fund in smoothing of consumption, typical development pitfalls for countries with abundant reserves, role of the fund in stabilization of the fiscal sector, corruption and transparent investment evaluation procedures. In the end, I will formulate a guide on how to

achieve the highest welfare for the Russian economy: should they save all oil revenues in the fund, should they invest intensively, and what main characteristics should the fund require?

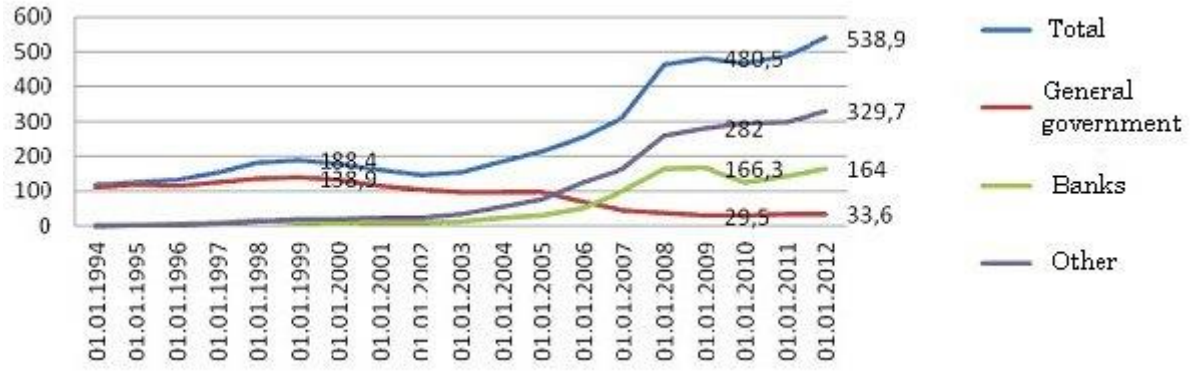
1.2. Main macro on resource-rich economy

Russia is a transition economy, with high reserves of mineral resources and ageing soviet legacy of technology. The GDP in 2013 is 2,096 billion $ (8th biggest in the world) in current prices. Population of the country is 140 million people and it experiences a continuous decline of 700 000 people a year due to low fertility and high mortality rates. Owing to a high immigration inflow the country manages to substitute this decline of population from natural reasons, by increase in number of immigrated workers. Due to gaps in fertility rate in 1990s there are at least two demographical shocks that are expected to happen by 2050.

In 2014 GDP per capita was 14,591$: the country is on 51th place in IMF ranking, next to Poland and the Baltic States. Compared to other oil-countries, Russian GDP per capita is higher than in Venezuela, but substantially lower than in Norway, Qatar and Saudi Arabia. It is difficult to find a country appropriate for comparison due to uncommon size of land, low population density and transition of the Russian economy.

Graph 1.1 GDP per capita. Source: World Bank

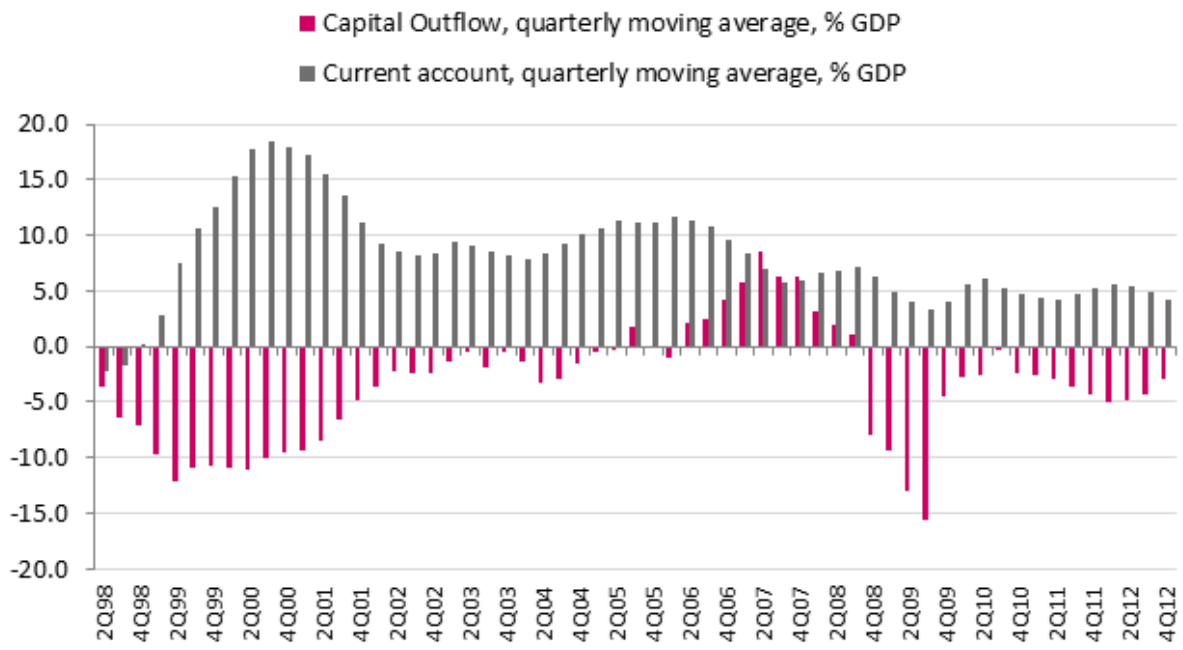
We can see that after the period of transition, Russia shows stable increase in GDP per capita. The overall macroeconomic performance in 2000-2009 is very successful: average growth of 4%, stable growth of consumption and industry output, controlled non-volatile inflation, increase of exported/imported goods.



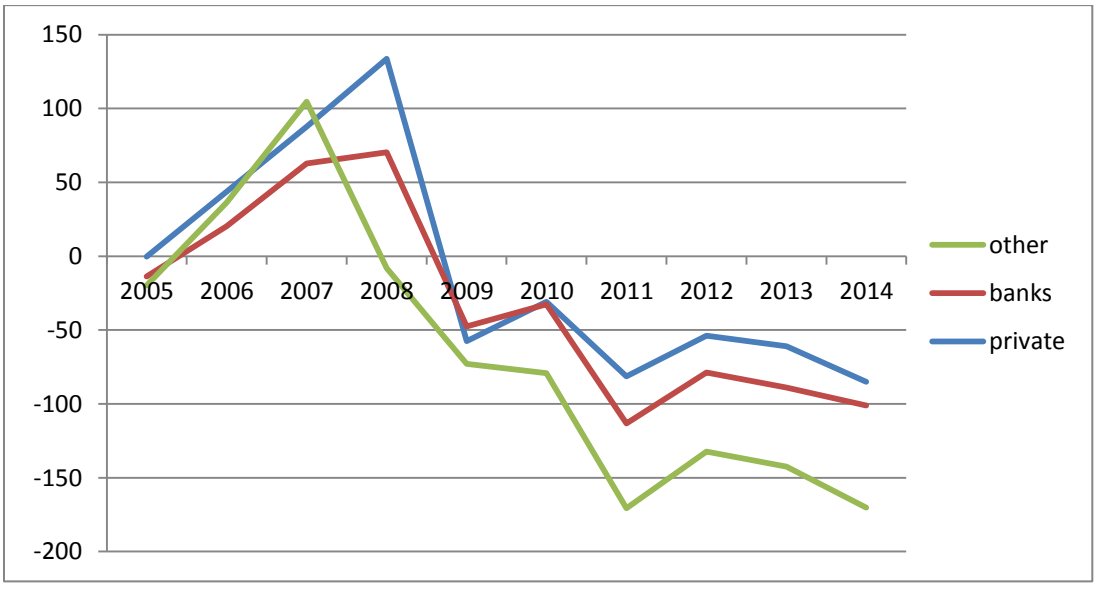
Graph 1.2 Russia's external debt ($ billion). Source: The Bank of Russia

Government debt is low compared to other developed countries, and equal to debt of former Soviet countries in Central Asia – 13% to GDP. Russia had high government debts, inherited from the Soviet Union. The country used actively oil revenues in 2001-2007 to repay most of the debt. While public debt isn't a burden for Russian economy even under the sanctions in 2014, the private debt and bank debt have increased in the recent years. Given the introduction of anti-Russian sanctions limited access of Russian companies to the world financial markets, slowdown of economy since 2012, private companies and banks may face problems with repayment of debts. Government deficit accounts for 10% of annual budget and is covered by oil revenues.

One of the most interesting trends in Russian economy, which is relevant to the model I will use in the next chapter, is capital outflow. It occurs when foreign and domestic investors sell off their assets in a particular country because they no longer perceive it as a safe investment. In theory, it is the difference between risks and returns that is available to investors in home country and abroad that makes capital flow. The notion of risks here consists of two parts: financial and political risk. Political risk reflects "stability of the ruling regime and the possibility of changes in economic policy by either the existing or a new government" (Alesina and Tabelini 1989). If we look at the graph of the capital movement, we can see that from 2006 to the last quarter of 2008 there was capital inflow in Russia, driven by overall positive situations in the world markets and good performances of the country: the growth rate that is higher than in developed countries; absence of volatility on the financial market; political stability; a number of taxation reforms. From 2009 the financial crisis deteriorated capital inflow to capital outflow. In the five previous consecutive years capital outflow has increased, driven by mostly political factors and increasing easiness of transactions towards off-shore banking zones.



Graph 3. Capital outflow. Source: Central Bank, Russia



Graph 4. Capital outflow. Source: Russian Central bank

1.2.1. Sources of growth rate according to Cobb-Douglas, used in the model

I will back out the historical sources of growth and then use them to predict the future sources of growth in the full model.

In the thesis I take the growth rate per capita and decompose it into contributions from the capital accumulation and productivity growth. After that I assume the balanced growth path

for the future periods. Then in chapter 3 I build a model, based on the assumption of the balanced growth path.

Here is a small historical note on the status of technology and technological growth in USSR/Russia. After this note I will have a closer look on the share of productivity growth in the GDP growth per capita.

First of all, the technological foundation of modern Russia was built in Soviet times; the main kick-start took place in middle Soviet era. Consequently after the collapse of the Union and during the transition period one part of technology became too old, the other part of technology lost its value, many scientists left their positions, R&D departments got closed (Yegorov, 2009). The years from 2000 and onwards face a gradually diminished scientific human capital and absence of well-established, regular R&D departments. The oil sector is increasingly sub-contracting its technology work to "international and domestic technology service companies" (Dyker D.A. 2001). The sanctions in 2014, among other targets, aim to: "shut down Western aid to Russian deep-water, Arctic offshore, and shale oil exploration" (COUNCIL REGULATION (EU) No 959/2014 of 8.08.2014). It is interesting to see an effect of sanctions on productivity growth. In the model I will construct productivity growth through GDP and capital accumulation effect in the Cobb-Douglas function:

$$y_t = z_t \; k_t^{\alpha} \; k_{g,t}^{\gamma} l_t^{1-\alpha-\gamma} ,$$

Where y_t is real GDP, k_t the private capital stock, $k_{g,t}$ the public capital stock, l_t the input of labour, measured in number of economically active labours in the economy at the time *t*.
The parameter α measures the importance of the private capital input in production function, γ does the same for the public capital, both are constants. z_t is total factor productivity. This output can be used for two purposes, for consumption and for investment. Given the data on output growth and knowing the law of motion for the capital stocks and labour in the future periods, one can calculate how much the output growth is accounted for with the growth parameters of factor inputs. Thus productivity growth can be found as difference between output growth and growth of variables of capitals and labour.
Later in the model (on page 28) I construct the law of motion for capitals (private - k ; and public -k_g):

$$k_{t+1} = (1 - \delta)k_t + (1 - \tau_t)i_t$$
$$k_{g,t+1} = (1 - \delta_g)k_{gt} + (1 - \tau_{gt})i_{gt}$$

δ and δ_g are the average rate of depreciation, it and $i_{gt}$is investment, and τ_t and $\tau_{gt}$are parameters, which have values of (0,1) and illustrate the assumption that a certain amount of investment spending is misused and don't get transformed into the productive capital. Here I assume that this amount disappears from the economy, for instance to foreign bank accounts. I will assume that growth rates of two capitals are equal. From the Cobb-Douglas function on the previous page I can find the growth rate of the total factor productivity z_t, which is denoted by g_{zt}.

I denote the growth rate of output, capitals, labour and technology by the letter g_t:

g_{yt} output growth, g_{lt} labour force growth.

For capital, g_{kt}= $g_{private_{capital},t}$ + $g_{public\_capital,t}$, since I assume that growth rates of two capitals are equal. When taking logarithm, τ , τ_g disappear since I assume they are constant.

$$g_{zt} = g_{yt} - \alpha\, g_{private_{capital},t} - \gamma g_{public_{capital},t} - (1-\alpha-\gamma)g_{lt}$$

Given that g_{kt}= $g_{private_{capital},t}$ + $g_{public\_capital,t}$, I can rewrite it and get:

$$g_{zt} = g_{yt} - (\alpha+\gamma)g_{kt} - g_{lt} - g_{lt}(\alpha+\gamma)$$

$$g_{zt} = g_{yt} - (\alpha+\gamma) * (g_{kt} - g_{lt})$$

Here I assume that$\alpha = 1/3$, $\gamma = 1/6$, typical values from macroeconomic theory in absence of any distortions.

Values of α and γ give

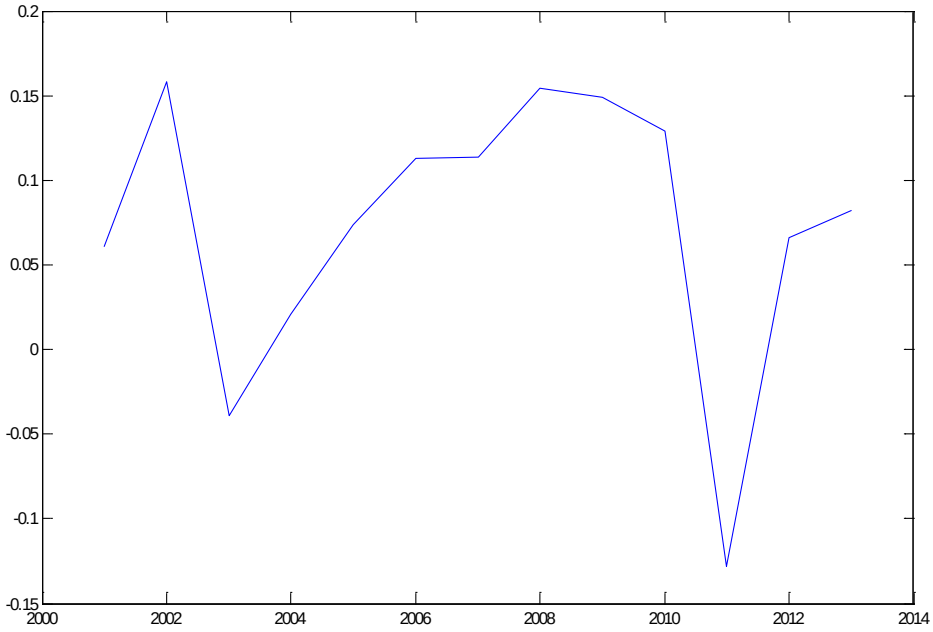
$$g_{zt} = g_{yt} - 0{,}5 * (g_{kt} - g_{lt})$$

Under the balanced growth I can use the notion that the growth rate of GDP per capita (per labour) equals the growth rate of both capitals per capita: $g_{yt} = (g_{kt} - g_{lt})$.

Taking this into consideration we see that

g_z = g_y (1 - α - γ)= $g_y(1-0{,}5)= g_y * 0{,}5$

That means that under the balanced growth path, GDP per capita growth is twice as high as the productivity growth.



Graph 5. Growth rate of GDP per capita, Russia. Penn World Table, 2013

Empirically, GDP per capita grew stable from 2003 till 2008(as it is seen on the graph 5), decreased during the world financial crisis and almost reached pre-crisis level in 2010, while TFP was slightly growing. However TFP grows at decreasing rate and predictions of GDP for 2015 show 0.5% growth instead of previously predicted 2%.[1] I can conclude that in the Russian economy, which has many imbalances, capital outflow and decreasing TFP, oil revenues, saved correctly, cannot help the economy to fight against the imbalances themselves, but can protect from external shocks.

1.2.2. Facts about the Russian oil

The Russian oil reserves are known to be 80,000 million barrels (data from US Energy Information Administration). There might be unproven oil reserves as well. Russian Ministry of Natural Resources and Environment estimates that the yearly findings of new oil fields to 2030 will be equal 530-535 mln tons. Such amount is equal to the oil extraction per one year – there was found 688,3 mln tons of oil and 523,2 mln tons was extracted in 2013. Such high findings rate is achieved only in the 2 last years and is explained more by cartographical reorganization of oil fields, rather than physical findings. Russia plans to find 490 mln. tons oil yearly up to 2015, 500mln. tons up to 2020 and by 2030 the amount of findings is planned to reach 530 mln. tons. The amount of findings is slightly higher than the amount of

[1] Cooper 2011

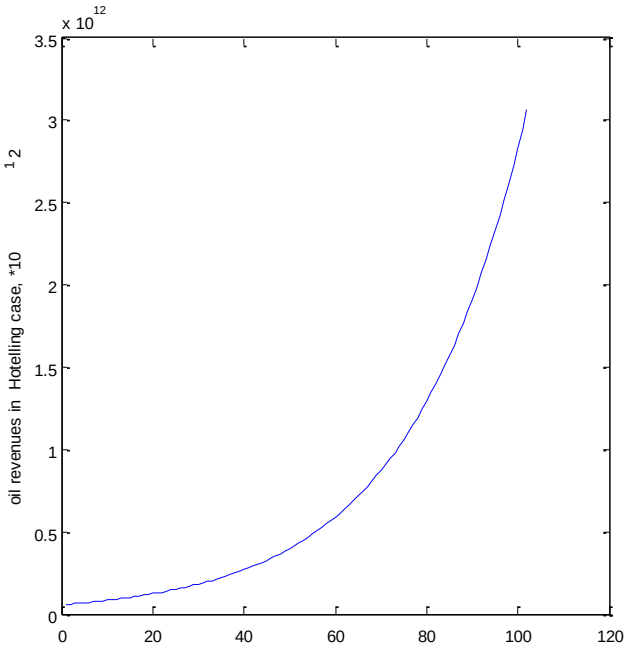
extraction per year – reserve replacement ration is about 102%, – which leaves the total estimated value of Russian reserves unchanged and stuck on the level of 80,000 million barrels over the long period of time (approximately two decades). I don't take probabilities and volume of oil discovery in the disputable Arctic territories into consideration while calculating Russian oil reserves.

Thus I assume that oil extraction path will follow the official prediction of the Ministry given that:

- the total oil reserves will remain relatively stable due to reserve replacement ratio of 102%;
- oil discoveries in the Arctic shelf demand investment and access to foreign high technology;
- Arctic oil discoveries are very costly and risky and need a horizon of 10 years to put any extraction activity into operation.

1.2.3. Hypothetical oil price scenarios

In order to calculate the possible values of revenue from oil selling I need to determine the price growth path for the next 100 years. In defining the price path I need to take consideration not only to the world price determinants, but also to the quality of oil found on the Russian territories. I assume that extraction path is completely flat and accounts for 530 million barrels a year.



Here is the summary of factors, which define oil price path in theory. I will analyze each of them and choose those that are most suitable for the Russian case.

a. Hotelling path
b. Hotelling + cost (increasing)
c. Hotelling + efficiency, increased marginal productivity per resource unit
d. Substitute. In the short run it won't provoke Russian oil companies to extract faster due to long reaction time of a state-owned company, limited investment possibilities, and limited access to frontier of western extraction technology.
e. Hotelling + improved extraction technology; is hardly the case for Russia

a. **In the first scenario I assume that world oil price follows the Hotelling rule** – marginal net revenue of exhaustible resource increases at the rate of interest. Thus a country maximizes value of the resource stock by extracting the resource when the price grows exactly at the rate of interest. From the economic theory if the interest rate grows faster than the resource price then it is optimal for the resource owner to extract more today and put revenues in the bank. That looks like the case of Russia – inner interest rate in the economy is 4-6%, which is typically high for middle-income economies. Although the Hotelling price path isn't approved by empirics I will assume this path to be part of the main case.

b. Imagine that the world price grows at the rate of interest plus the marginal cost of exploration. In this case marginal cost of exploration becomes one of the price determinants and the sign of the derivative of cost with respect to amount of the resource extracted will influence price growth rate.

   Change in marginal cost can be caused by improved extraction technology which eases extraction per unit of resource.

   Much of the world's easily-reachable sources of oil are already in work. Many of new oil findings tend to be in more challenging conditions and more remote areas and in less hospitable climate. That increases not only costs of extraction but also costs of exploration and shipment. Examples of the more difficult sources of oil are: deep-water areas, Russian Far East and in the Arctic and Antarctic. Oil extraction in difficult areas may suffer from shortage of skilled workers, something that can slow the pace of oil areas' exploration.

   Bearing this in mind I will assume that the marginal cost of oil extraction will increase, although it won't have a strong effect on price and oil price will growth insignificantly.

c. Improved technology in the future affects not only exploration costs, but production capacity of oil. Better technology increases marginal productivity per resource unit. More advanced technology will decrease the amount of input of oil needed to produce the final good – petroleum, plastic, etc. However R&D of such processes of the efficient conversion of fossil fuels is highly costly, especially when one takes care of environment and climate issues at the same time. Thus I conclude that improved technology of production of final goods won't lower the price significantly.

d. Substitute for oil. In the period up to 2114 there is a possibility that either the present R&D will succeed in inventing a fully-working oil substitute or there will be a non-anticipated breakthrough in energy-sources science. A substitute gives signals to the market, creates expectations, which can lower the price on the resource or motivate resource-owners to extract it faster. There is no evidence so far that Russia can provide such a substitute and escape oil-dependence and thus oil price-dependence. In the short run a substitute, invented in other countries, won't provoke Russian oil companies into extracting faster due to long reaction time of a state-owned company,

limited investment possibilities, limited access to frontier of western extraction technology. Thus I won't include a possibility of inventing a substitute as one of the factors, influencing the world price.

e. Since the possibility of improved self-made technology is hardly the case for Russia, such oil price path won't be analyzed.

World oil price can decline if new technology will decrease extraction costs. Together with the increased difficulty of exploration and extraction of oil in the long-run these two effects may offset each other. What effect will be stronger – the improved technology on marginal extraction cost or the challenging conditions of extraction on total costs, - is not possible to conclude. **I will assume the 2nd case of oil world price growth – the "flat" path.** Initial value of the world price is assumed to be the latest available data for the Urals crude oil - Russian oil is traded according to this type of oil. The initial value of world oil price is 110 $ per bbl. (As a matter of fact, 2013 - budget of Russian Federation was estimated to balance at an oil price of $110 per barrel and 2014-budget at some $115 a barrel.)

There can be the 3rd scenario – due to lower demand from China and other Asian countries and due to sanctions against Russian government the price in the short-run can fall to 80$ per bbl. In this case the price won't be high enough to balance the country budget; it will diminish investment in the oil sector and in related sectors; it will also cause further capital outflow. This scenario is particularly relevant, given the decrease in the market price in the late autumn 2014 to 64$ per barrel.

Costs of exploration and extraction are not that straightforward to count. Costs of extraction are based on technology efficiency and depth of digging. Extraction costs are generally assumed to be decreasing if one keeps in mind the technology improvement. Expected technology progress makes extraction easier. However, the more of the resource you extract, the deeper you have to dig. Furthermore, polar oil is highly risky investment.

Cost of extraction in West Siberia and in the Far East depends on the quality of oil. Russian oil isn't considered to be of a good quality. In 2000, Russia's oil balance consisted of 83 % light sweet crude oil, 15 % heavy oil, 2 % extra-heavy bitumen (a part of oil sand, considered to be costly to extract). By 2020 it is estimated that heavy oil will double its share to 30 % bitumen – to 20 %, the rest will consist of light and heavy oils. Costs include exploration, extraction, and transport. I build my calculations of costs on Sinyak and Kolpakov's (2014)

estimation of oil expenses, thus I assume **total costs equal 30$** per barrel. I will study three growth paths: the Hotelling path and the flat one. The oil quality has its own trademark "Urals". I use the dynamics of Urals price for the second oil growth path. In the first case the price grows at the Hotelling pace with 4 % interest rate. The profit from selling the resource will be $108\$*(1+0,04)^t - 30\$$. In the second case, where I assume the price will be flat $110\$*(1+0.02) - 30\$$. The 3rd case generates profit of 80$ - 30$ = 50$ per barrel in case the country will get into isolation and will have no access to international borrowing or technology.

Total oil revenues for the next 100 years for the country equal extraction per year, multiplied by number of years (100), and multiplied by price. At Hotelling price in the first case the revenue will be 406 696 140 000 $ (406 billion $), the profit will be 293,53 billion $; in the second case the revenue is 82 200 000 000$ and profit 52 billion $ respectively. In the third case revenues will be 26,5 billion $.

The first two cases give extra value of 2098 $ and 1006 $ per capita yearly, the 3rd one - 342$. Compared to the current GDP per capita of 4545 $ in 2013, the additional oil revenues might not be revolutionary for the economy. However, given the decreasing flow of FDI and increasing wear-off of infrastructure and equipment under 2014 sanctions, such extra revenue can have a positive effect on the stagnating economy.

To sum up, the oil resources will last about 25 years, if Russia won't make any findings. With their project plan of making oil discoveries up to 2030 and pace of extraction nowadays, oil in Russia may last to 60-70 years.

1.2.4. Why gas isn't assumed to be a source of eternal energy? Gas overview

Russia has big reserves of gas, but I didn't include them in the model. Here is the overview of the gas reserves and the reasons why they are not part of the analysis.

The proven gas reserves of Russia are the largest in the world and equal to 48,700 billion m^3. The country has been one of the biggest gas producers – it has been on the second place in gas production, after USA, until recently, with the 3rd place for Iran, who has much lower production volumes (660 billion m^3 against 180 billion m^3). These three countries are responsible for almost 50 % of the market supply.

The gas production has been relatively stable and had a growth from 550 billion m^3 in 2000 to 650 billion m^3 in 2013. This increase in production is primarily due to increasing demand and new fields having been brought on-stream.

Major gas reserves and exploration projects are situated in Western Siberia, while substantial areas of Eastern Siberia, the Far East and the Arctic remain underdeveloped due to a lack of infrastructure and severe weather conditions. Most of the country's natural gas reserves come from fields located in the Nadym-Pur-Taz region in Western Siberia, with the three largest ones sustaining the industry for 20 years. But unfortunately for Russia, these reserves have been in a declining state of production for some time now, forcing the country's companies to focus on acquisitions elsewhere.

There are several pipeline projects which were started in the recent years. However this development is driven, not only by the expectation that demand will increase, but also by past disputes with transit countries over gas supply and transit prices, as well as concerns expressed by Western European countries over the security of supply.

Russia gas industry faces its challenges as well as the oil industry does. At the present time the Russian gas industry is challenged be depleting reserves in traditional fields, with a subsequent rise in gas recovery costs, and by the necessity for significant investment to develop new gas provinces.

On the end markets, long-term contracts are linked to the price of crude oil, making them exceptionally profitable compared to the spot price of natural gas on the world market. Gazprom prices according to what the alternatives in the buying countries are. That may be called a strategy of a discriminating monopolist. However, it is possible to assume that price for gas is connected to the oil price.

Tarr and Thomson (2004) in their report for the World Bank estimated total marginal costs of gas extraction in the long-run 35 – 40$ per trillion m^3. Total marginal costs include development costs (are estimated in the range of $7 to $9/ trillion m^3), transmission costs and distribution costs ($5 to $10/ trillion m^3). The major gas fields are located over 2,000 kilometers away from major domestic markets. The long-run marginal cost associated with trunk transmission gas lines is estimated at about $1/ trillion m^3 per 100 kilometers. It is reasonable to assume gas marginal costs are equal 40$.

I don't make gas a part of my analysis of several reasons. Firstly, oil and gas market structure can't be compared. Gas industry is dominated by Gazprom, who has 75% of domestic gas market and who is price-setter. Secondly, Gazprom decides on market price both in Russia and on foreign contracts. The price-setting process is highly dependable on geo-politics. That makes it difficult to model gas price development path. Thirdly, gas reserves last for more than 100 years and won't be distortionary for my analysis.

2. Assumptions to the model

In the subsection 1.4. I motivated my assumptions on 3 price paths for the oil resource and yearly amount of oil extraction. Now I motivate my assumptions on other variables from the model in chapter 3.

Decreasing population:

In order to construct future values of population I must take into consideration the negative trend in Russian demography. The 2012 UN population projection for Russia plots 3 possible scenarios of Russian demography: the idealistic one – 146mln. in 2064, the median one – 120 mln, the pessimistic one – 88mln by 2064. In 1990, a one generation of perspective parents ago, total fertility rate was at 1,8 children per women. This rate which doesn't ensure a mere reproduction plunged to the 1,1 in 2000 and makes 1,5 in 2010. Only due to the sharp decrease in the number of children in 1990-2001 the long-term population loss accounts for 20 mln. people. Thus I choose to reject the optimistic scenario and will use the median projection to construct a series of population parameter. However median projections of population from UN are not different enough from reality to cause distortions in the results, so I set the labour input to 1.

Depreciation rate:

I will distinguish the private from the public capital stock. Kortelainen and Leppänen (2011) analyzed the productivity of public and private capital in Russia with parametric and non-parametric regression methods and found that public capital is less productive than private capital. Furthermore, private capital includes structures and equipment, while public stock consists mainly of infrastructure. Svejnar (2002) and Goldman (2003) wrote about large quantities of older assets inherited from communist times. They became a major obstacle in the way of new investment – a 'curse of old capital'. I distinguish the public from the private capital stock because of ageing physical infrastructure of oil sector, which bears the heavy imprint of Soviet legacy and have very high depreciation rate (from Izyumov and Vahaly (2008)). Depreciation rates for both capitals are considered to be constant.

2.1. Summing assumptions up and setting trade-offs

To sum up, I have 3 cases: open case (price at 110$, extraction at 530 million barrels annually for the next 100 years and access to technology), the closed economy case and the closed economy case with a fund with the Hoteling price. Open and closed cases will be presented and discussed in the outline of the model on page 21.

These 3 scenarios are going to represent the degree of integration of the country into the world capital and technology markets.

Effect of population growth on return from the capital depends on the amount of population in the country. A country with a small population growth has lower return on capital and doesn't need to invest. A country with a high population growth has increasing return on capital, which gives incentives to invest more. In case of Russia I assume that population is going to follow mild projection of UN, which predicts a little decrease in population from 140 mln. in 2014 and 120 mln. to 2064. Diminishing population creates incentive to invest less. The fact that there will be less people who can benefit from the sovereign wealth fund gives also less incentive to save for the future.

I will consider a time horizon of the next 100 years. Sovereign wealth fund accumulates revenues from oil export. Despite being one of the countries with the biggest coal reserves and production, coal revenues don't make a part of the fund. The time horizon is chosen so that I can trace the effects of oil shortage on the saving decision of the country. Having inexhaustible resource (such as copper of iron) as a source of wealth fund growth doesn't motivate a country to be cautious in consumption/investment decision-making, that is why it is more reasonable to look at the saving rule when the resource – oil - is going to be close to depletion.

In order to establish the point in time when Russian oil will face depletion, one should have a good overview of the oil reserves and production capacities. Despite being the largest oil producer, Russia doesn't run out of natural resources. Reserves-to-production ratio for oil for Russia is 23 years, however this ratio doesn't take into consideration the annual oil findings which are equal or some years slightly exceed annual oil extraction in Russia. That makes oil reserves undepletable for the several decades ahead. The time horizon of 100 year seems to be long enough to see the consequences of the resource depletion of the "working horse" of Russian economy and shows extra motivation to save for future generations who will be left without resource revenues cushion.

Given that Russia has such a long resource revenues horizon, it would have been reasonable for the country not to focus on future generations, but to consume more in the present. The necessity to save more for future generations appears when the resource bonanza comes to an end. In case of Russia it would be more natural if the country consumed revenues now and even borrowed in this period rather than to expect pessimistic scenario and save for the future with > 70 years resource cushion. That is why the time horizon of 100 years chosen. The trade-off between saving and consuming becomes even more interesting if one takes into consideration the latest sanctions imposed on Russian economy and its agents after the Crimea-crisis in April 2014.Given the size of Russian economy, its welfare and low governmental debt, the alteration of the saving rule for the oil fund doesn't have big consequences for the welfare level. But given the inefficiencies of the Russian economy, its long-term oil-sector management and sanctions which restraint Russian agents from borrowing abroad, the implications of the saving rule can be decisive for the Russian economy, if it wants to benefit from oil revenues as long as possible.

2.2. Consumption-investment decision with respect to future generations.

Demand in the goods market is given by consumption demand and investment demand of households, $c_t + i_t$. The solution of consumption/investment trade-off depends on the time horizon.

In the long-run there can be 2 setups: either to consume more today in order to catch up with developed countries, either to save more in order to have a more solid wealth fund against future negative forecast.

In the short-run: Does Russia need to consume more now to increase the demand, so it can increase production capacity? Or does it need to save more to get higher return to be able to have investment decisions in the future?

Consumption/investment trade - off is important when a country with resource bonanza wants to enjoy economic growth and smooth consumption at the same time. Extra resource revenues allow consumption smoothing. Countries with different income level can benefit from it differently:

- A developing country, which is in the process of growing and catching-up and has a growth rate, which is higher than in developed countries, consumes all of its income, including resource. It is optimal to consume everything and borrow

abroad to boost consumption today even more. Such countries suffer from underconsumption and usually borrow against future incomes.

Without the resource income a developing country would like to borrow but it can't, consequently it can't smooth consumption.

- A country with middle-level income consumes all of its income in the first periods, doesn't borrow and eventually starts saving. That can be the case for Russia: current economic policy absorbs oil revenues in the fund, however the country doesn't consume enough.
- A developed country, with high level of income, saves most of its resource revenues and in that way it prevents overheating of the economy this period and higher consumption in the future periods.

Russia is a paradox according to this classification: it has underconsumption, which is natural for developing countries, but it has access to international markets – something developing countries don't have. Moreover it saves oil revenues in a fund, which is not optimal for the economy, which needs boost in consumption, however it prevents overheating and income fluctuations. In the current situation it is optimal for Russia to save oil revenues only if it expects ban on borrowing and lending abroad.

I consider Russia to be a middle income country. Economic theory says that the poorer the country is, the more it needs to consume in the future. Household final consumption expenditure per capita equals 4545 $ in 2013, which places Russia along with Venezuela and its 3456$ deep behind OPEC-countries as well as developed countries. I shall model the growth path of Russia as the one of countries in transition – growth rate of 3-4%, tending to stagnate due to narrowed access to international credit and investment.

3. The model

3.1. Theoretical part

I take the classic Ramsey-Cass-Koopmans model from growth theory. The model predicts a certain growth path for the economy. A country produces an output, from which it shares between consumption and investment. The country chooses the certain level of saving which limits the contemporary consumption and allows investing in the next period. Due to the fact that the saving rate is endogenous, the model finds the best consumption/investment decision,

which leads to the highest level of welfare in the economy. An exhaustible resource – oil and revenues after selling it are part of the output through the resource constraint. I model no uncertainty and no removal of inefficiencies through time.

I present 2 types of economy: open and closed one. In the main case Russia is assumed to be the open economy, which can enjoy access to the world financial markets. It is reasonable to assume so because in the past decades the country functioned as a quite large economy and important member in most international organizations. However the recent events which took place in the last 5 years made it well-grounded to propose the second case – the case with closed economy. In this case Russia is viewed as an isolated economy, without any access to international borrowing/lending. The recent geopolitical actions, undertaken by Russia, make it plausible to suggest that the country may face a ban in financial, trade, technological, scientific cooperation. For the country it will lead to inability to borrow assets for inner consumption and investment projects. It will also reduce the ability of the country to manage its sovereign wealth fund effectively – the fund is party invested in low-yield securities abroad. De-jure investment abroad will not be prohibited, de-facto it faces barriers already today. Russia is not going to be completely closed, but I assume fully closed to differentiate from the open scenario.

The closed economy case has 2 subcases: with access to technology and with no technology. The importance of specifying the access to technology lies in the marginal cost of extraction of the engine of the Russian economy – the oil. The first case – closed economy with technology is derived from the assumption that the country can manage on its own if it will be isolated from the rest of the world. Given the highly technological background of the country, I assume that there is a chance that the country will develop the up-to-date extraction equipment on its own, or can make a breakthrough in oil sector. The second case: without western technology and cooperation with foreign oil-companies Russia will hardly be able to explore and put into operation new oil fields, which lay deeper and in areas more difficult for extraction. The costs of extraction with outdated equipment would be too high to produce and sell oil, which would lead to decrease of oil revenues to the country. That is the case for close economy with no access to technology – the future that wasn't plausible several years ago, but quite possible from today's perspective.

3.1.1. Outline of the model

The production technology is described by a stylized neoclassical Cobb-Douglas production function

$$y_t = z_t \; k_t^{\alpha} \; k_{g,t}^{\gamma} l_t^{1-\alpha-\gamma} \quad ,$$

where y_t is real GDP, k_t the private capital stock, k_{gt} the public capital stock. The labour input is omitted later. I set it to 1.

The parameter α measures the importance of the private capital input in production function, γ does the same for the public capital, both are constants. z_t is total factor productivity. This output can be used for two purposes, for consumption and for investment. The population factor is discussed on the page 23.

The non-market, 'planned' economic system from the Soviet times had its own specific mode of functioning, which over time had a profound impact on the structure of the economy – high pace of building of large and "strategic" state-owned industry, such as military-, oil-, aviation industries and few possibilities for citizens to build private houses or private business. I will distinguish the private capital stock from the public capital stock. Kortelainen and Leppänen (2011) analyzed the productivity of public and private capital in Russia with parametric and non-parametric regression methods and found that public capital is less productive than private capital. Furthermore, private capital includes structures and equipment, while public stock consists mainly of infrastructure. Svejnar (2002) and Goldman (2003) wrote about large quantities of older assets inherited from communist times became a major obstacle in the way of new investment – a 'curse of old capital'. I find it useful to distinguish the public from the private capital stock because of physical infrastructure of oil sector, which bears the heavy imprint of Soviet legacy and have very high depreciation rate (Izyumov and Vahaly (2008)).

In order to construct a series of capital stock I will introduce the law of motion for the capital.

$$k_{t+1} = (1 - \delta)k_t + (1 - \tau_t)i_t$$
$$k_{g,t+1} = (1 - \delta_g)k_{gt} + (1 - \tau_{gt})i_{gt}$$

This is the law of motion for the private capital, where i_t is private investment, τ_t is a parameter which reflects the level of inefficiency in the private sector. I assume that the Russian economy invests ineffectively and wastefully. The country is famous for its corruption, which distorts the common cost-benefit investment project analysis in favor to peer-and-relatives project evaluation. High levels of corruption in business and government sectors may harm total factor productivity in the long run, primarily through lowering the

level of production and slowing down the pace of its accumulation. My assumption here is that a certain amount of capital disappears from the economy, for example to foreign bank accounts. There are 2 definitions that helped me to find the appropriate inefficiency parameter: the rate of return and the "bribery" rate. The rate of return is typically measured as the sum of the profits, interest accruing to the reproducible capital stock, expressed as a fraction of the current value of that same reproducible capital stock. If the rate of return in one country is high enough, the country experiences the capital inflow. However, in the last decade there has been a steady outflow of private capital from Russia, which in 2012 reached its highest size – 10% of GDP.

Why do investors prefer to transfer assets abroad? It is because the higher return rates are not easy to be found in Russia, or if they are available, they carry too high levels of risk from the investor's point of view. Due to the high capital outflow I assume either very low rate of return or quite high risks.

The second parameter – the "bribery" rate is the rate which shows the share of one investment project, which goes on the bribery of an official to get the project done. Such data is very hard to collect, especially when there are no statistics hold on such type of crime and when the research on this matter is extremely weak. I shall use the results of the series of journalistic investigations, made by a group of professional lawyers in Moscow. The aim of investigations were all types of government projects – Sochi 2014, renovating of public transport system in one city, renovation of hospitals, building of a new research centre "Skolkovo", upgrade of horizontal boring equipment for state-owned oil-companies and etc. The principle of the research was to trace the contracts on the good/service delivery, find main beneficiaries, and traces the investment assets to the bank accounts and to calculate the final sum which was actually spent on the project. In 2004-2009 the "bribery rate" was considered to be at 15-30% level. These investigations show that when it comes to the purely government project, in 2012-2014 from 40% to 70% of initial investment sum may end in the suspicious bank accounts and not reach the project at all. Such numbers may provide one of multiple explanations on why the budget of Sochi 2014 has increased 4 times during its construction. In the model I assume that the parameter of inefficiency equals 0.25 for private capital and 0.5 for governmental capital. I assume that these inefficiencies won't disappear completely with the time. They may diminish slightly due to attempts of anti-corruption reforms. In the model these inefficiencies will decrease with 0.99 rate. A fraction δ of the capital wears down; it is considered to be constant and equals 0.2.

Law of motion for the governmental capital, where i_{gt} is government investment in infrastructure. From now on we will assume that investment of state-owned oil companies into exploration, extraction and oil infrastructure projects is government investment. There are 2 reasons to consider them to be a part of i_{gt}. Firstly, the oil industry is considered to be the "strategic" industry in the Russian economy, which means that all capital-intensive projects must go through state authorities' evaluation. State is actively involved in auction-making as well, something which contributes to the high level of investment inefficiency in the country. Many oil investment projects in Siberia and the Far East are infrastructural for the whole region around extraction site and get subsidies either from local or from the federal budget.

Depreciation rate δ_g is considered to be equal to 0.4. τ_{gt} equals 0.5.

Thus the investment in period *t* is equal the difference between capital in period *t* and *t+1*. Due to inefficiencies in the economy I represent the modern Russian economy with the help of 2 parameters, which reflect the low level of return from investment. Investment in period *t* is not equal to the difference between k_{t+1} and k_t. Investment is found by

$i_t = (k_{t+1} - (1-\delta)k_t) / (1- \tau_t)$

from the law of motion on page 28; that means that capital is corrected by extra parameters in order to represent the diminishing utility from investing.

Oil revenues are regarded as windfall; the model abstracts from export.

3.1.2. Open economy case

The resource constraint for the economy is given by

$$c_t + a_{t+1} + i_t + i_{gt} = y_t + p_t o_t + a_t * (1 + r)$$

That is the case where access to international credit markets for borrowing is open. c_t is consumption, a_t international lending, i_t is private investment, i_{gt} is government investment, y_t output from domestic production, $p_t o_t$ stands for price*oil, which means oil revenue (oil price multiplied by the amount of oil extracted). p_t is a net price (after oil costs have been deducted. Extraction costs are equal 30$ per barrel, motivation back it is on page 18). It is the net price p_t that is used in the model and Matlab-simulation. In the result section (chapter 4) cases with different prices have names after gross prices (costs included).

Utility function for household is given by

$\sum_{t=100} \beta^t u(c_t)$, where

$u(c_t) = \frac{c_t^{1-\theta}-1}{1-\theta}$ functional form for utility of household.

We choose this form so that economy converges to a balanced growth path. Here θ represents willingness of agent to shift consumption between different periods. When θ is low, marginal utility of consumption decreases more slowly as consumption rises, so the agent is more willing to allow its consumption to vary over time. β represents discounting, $\beta < 1$.

In order to find the optimal consumption path I maximize this utility function with respect to the restrictions imposed by the resource constraint and law of motion for the capital.

Max $\sum \beta^t \frac{c_t^{1-\theta}-1}{1-\theta}$

s.t.

$$c_t + a_{t+1} + i_t + i_{gt} = y_t + p_t o_t + a_t * (1 + r)$$

I assume that the economy cannot borrow without paying back. $\lim_{t\to\infty} a_t \geq 0$.

I set up Lagrange. First order conditions with respect to c_t, c_{t+1}, a_{t+1} give us 3 equations.

First order condition with respect to c_t:

$$-\frac{\partial L}{\partial c_t} = \beta^t c_t^{-\theta} - \lambda_t = 0$$

F.O.C. with respect to c_{t+1}: $\frac{\partial L}{\partial c_{t+1}} = \beta^{t+1} c_{t+1}^{-\theta} - \lambda_{t+1} = 0$

F.O.C. with respect to a_{t+1}: $\frac{\partial L}{\partial c_{t+1}} = -\lambda_t - \lambda_{t+1}(1 + r) = 0$

From these 3 equations we can find that

$$\left(\frac{c_{t+1}}{c_t}\right)^{-\theta} = \frac{\lambda}{\beta}$$

and $\lambda_t = \lambda_{t+1}(1 + r)$ $\lambda = 1/(1 + \mathrm{r})$

thus $\left(\frac{c_{t+1}}{c_t}\right)^{\theta} = \beta * (1 + r)$

This is the Euler equation, which says that intertemporal choice of consumption is determined by rate of return and not the portfolio choice. Euler equation gives us competitive equilibrium and solution to the social planner's problem. The social planner equates the marginal rate of substitution of the representative agent between consumption today and tomorrow. Letting the agent consume one unit of consumption less today allows for one more unit investment and thus one more unit of capital tomorrow.

If one inserts k_t and $k_{t,g}$ into resource constraint instead of i_t , i_{gt} through the law of motion for capitals and applies $y_t = z_t\ k_t^{\alpha}\ k_{g,t}^{\gamma} l_t^{1-\alpha-\gamma}$, where l_t is set to 1; one can get the portfolio equation that states that the return from private investment is equal to the return to the public investment and they both equal (1+r). That is understandable from the course of Finance Theory: for investors it is optimal to invest in 2 types of assets only if both of them give the same rate of return. Moreover, in the open economy where it is possible to borrow/lend at a certain rate, investors will choose to invest in *k* and k_g only until their net return rates are equal to *r*.

$$(1-\delta+(1-\tau_{t+1})\alpha k_{t+1}^{\alpha-1} k_{g,t+1}^{\gamma})\frac{1-\tau_t}{1-\tau_{t+1}} =$$
$$\left(1-\delta_g+\left(1-\tau_{g,t+1}\right)\gamma k_{t+1}^{\alpha} k_{g,t+1}^{\gamma-1}\right)\frac{1-\tau_{gt}}{1-\tau_{g,t+1}} = 1+r$$

This equation determines *k* and k_g independent from the rest of the model: amount borrowed *a*, oil extracted *o*, oil price *p* are absent in this equation.

3.1.3. Closed economy case

This case leaves us with the following maximization problem: given a time path of oil extraction and interest rates and initial capital *k0*, the social planner solves

Max $\sum\beta^t \frac{c_t^{1-\theta}-1}{1-\theta}$

s.t.

$$c_t + i_t + i_{gt} = y_t + F_{spent,t} \quad (1)$$
$$F_t = (F_{t-1}*(1+r) + o_t p_t) \quad (2)$$
$$F_{spent,t} = (F_{t-1} * (1+r) + o_t p_t) * spending\_rate\ , \quad (3)$$

Equation (1) is the resource constraint. F_{spent} means the amount of oil revenues allowed to be spent from the fund yearly, given the "golden rule" of spending from the fund r = 0.04.

Equation (2) is the structure of the fund: The value of the fund today is equal its value yesterday, increased by the interest rate, plus the oil sold in this period.

Equation (3) shows the part of the fund which can be spent each period, where *spending_rate* = 0.04.

The optimal path can be found by maximizing the above utility function subject to this resource constrained and law of motion for both capitals.

3.2. Matlab part

3.2.1. Parameters needed for Matlab

In the table below I gathered all parameters I will need to insert in Matlab. I divide them in 2 subgroups: exogenous and endogenous. Some of the parameters have values, based on assumptions. Some variables such as capital or consumption are time series variables, where it is only the initial value that is taken from the data, the rest of time line values are calculated with the help of initial value. In Matlab it is possible to calculate time series for investment, using formula on page 26. The source of data is given is either Penn World Table of 2013 or my assumptions, stated in chapter 2.

The variables, used in the model:

- *y*, real GDP: endogenous, depend on capital
- *g*, growth rate: has value of 1.025 in Matlab
- *k*, private capital stock (structure + equipment): endogenous. First I take its initial value from Penn World tables and the use law of motion to construct time series.
- *kg*, public capital stock (infrastructure): endogenous. First I take its initial value from Penn World tables and the use law of motion to construct time series.
- *z*, total factor productivity, endogenous.
- Labour input, set to 1.
- Alfa, set to 1/3, constant.
- Gamma, set to 1/, constant.
- *c*, consumption, endogenous.
- *i*, private investment, endogenous.
- i_g , government investment, endogenous.

- Oil price (gross price, before the costs are subtracted. Total costs equal 30$, from page 18), exogenous. It has 3 types of values from my assumptions: Hotelling growth for price; 110$; 80$.
- Oil extraction amount, exogenous. Set to 530 mln tonns yearly, based on the data from the oil sector.
- δ, Depreciation rate, private, equals 0.2
- $\delta_{g,}$ Depreciation rate, public, equals 0.5
- τ, Non-effectiveness rate, equals 0.25
- τ_g, Non-effectiveness rate, equals 0.5
- β, Discount rate for u(c), β (1 + r) = (1 + g) $^{\sigma}$
- θ, set to 1; implies log(consumption)
- r, World interest rate, 4%
- Fund, has an initial value of $87,32 billion, according to the World Bank

3.2.2. Motivation of using the numerical method and Matlab

I would like to find the theoretical growth path for the resource-rich economy. I take Russia as an example. I want to find how the development path will forego inefficiencies in the Russian economy. I shall use numerical method, because the model cannot be solved analytically. In this way I will get the quantitative result and not simply the qualitative. I will create assumptions, which suits the Russian economy and the controlling differential equation for the growth model. Since I am interested in the growth path, I will use law of motion for main variables to obtain the models behaviour over time. In order to get good results many iterative calculations may be required. Thus I will use the numerical model, since the precision can be seriously improved for a given time step by using a numerical procedure which is a bit more sophisticated than the Euler equation. The numerical method allows getting strong result, by using a little empirical information.

To get the result I will use Matlab. I will run a code in Matlab, where I specified equations for the law of motion of the main parameters, such as capital, consumption, output, growth path, oil price path, oil extraction path and conditions for different cases of open/closed economy.

The principle which lays in the foundation of the code is the shooting method. This method allows solving a system of differential equations given some preliminary conditions plus one guess on the initial value of the endogenous parameter. Given the initial value of one parameter – capital in this case- the code starts shooting possible guesses, so at the end all

conditions specified in the code will be satisfied. In order to shoot guesses I state the "shooting angle" in the code – the procedure that adjusts my initial guess (increases/decreases). Thus the program creates the loop of stating the guess and adjusting it to the right value that fits the system. The angle of shooting helps to iterate the initial guess so that after adjustment the loop will be closed.

4 Results

I will present the number of graphs which show the development path of the parameters most relevant for the analysis. They are going to cover 3 states of economy: the open economy with fund, the closed economy without fund and the closed economy with fund. All 3 cases seen under different price scenarios and extraction paths.

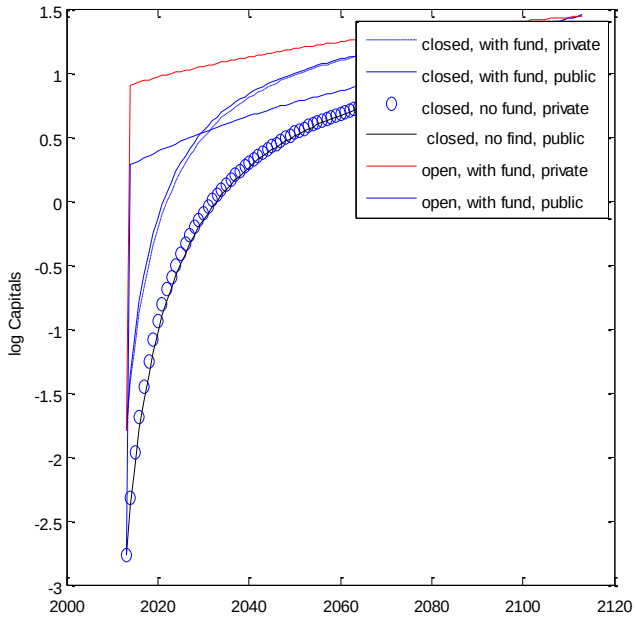
When we look at open or closed economy cases, we pay attention to the fact that our consumption/investment trade-off changes its focus. In a closed economy one must allocate extra revenues from oil between consumption and investment. That is not the case for the open economy, where the access to the international financial market gives the opportunity to borrow for unconstrained consumption regardless to investment decision. For now (2014) I can consider Russia to be an open economy land – it has been borrowing/lending on the world markets for several decades and has membership in many world-known financial institutions. However the access to international markets can become questionable if one takes into consideration the unconventional policies of contemporary Russian government towards Western countries and their response to them. If Russia is going to continue with political movements, which look unacceptable by most Western countries, the country will get more restrictive sanctions, whose aim is to limit the presence of Russian firms, agents, goods or capitals in the Western half-sphere. Russian companies in 2014 have already encountered barriers to invest their capitals abroad, and therefore, can't borrow in their turn. Given sharp decrease in trade of services and goods, and capital outflow as a result of events in 2014 it is possible to assume a scenario, where Russia will become a closed economy to 2018-2020. Thus, after open economy we will have a look on the growth path of the closed economy.

4.1. Open case

In the open economy consumption and investment are not in a trade-off, since the country can increase consumption by borrowing and not by decreasing investment.

In the open economy the consumption declines steeply with respect to the consumption in the closed economy without fund. In the first period consumption in the open case reacts a lot on

the introduction of oil revenues in the economy. In the graph 12 the private capital in open case has initial boost and since then has a higher level of utility than capital in the closed economy.



Graph 12 Capitals

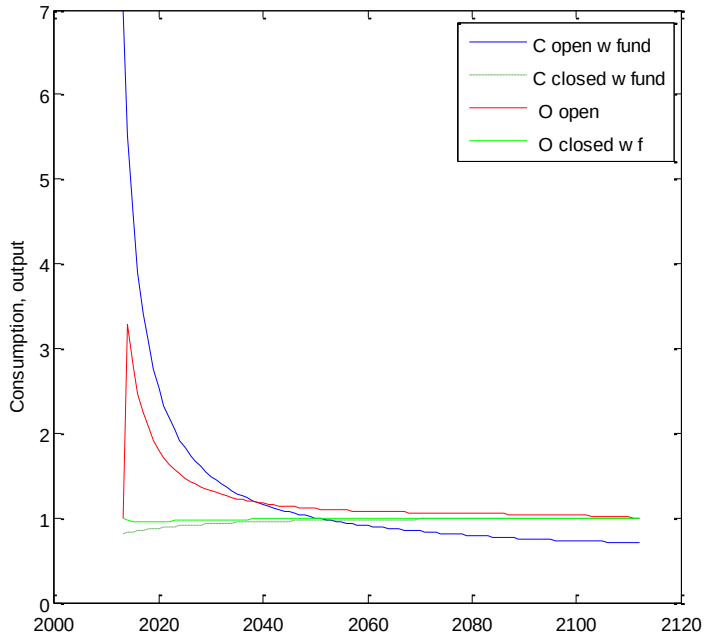
We can observe quite high lift to the consumption from oil revenues in the first period. The marginal utility of consumption is very high and decreases fast – it takes 30 years for the economy to get saturated with extra oil income and satisfy the need in extra consumption. Consumption in closed economy without fund reaches the same value as open consumption only to 2055.

Output in the open case experiences an initial boost as well – there is no need to sacrifice consumption in order to invest more, so opportunity costs for investment decrease. One can invest more without diminishing consumption, which leads to higher output and given the credited consumption, to the higher welfare level.

The case of the closed economy with fund relative to the closed economy without fund shows that consumption, reduced by transfers to the fund has negative values. Marginal utility of consumption in fund case is lower than marginal utility of consumption without transfers to the fund. That means that economy has lower consumption than in the optimal state. Output in fund case is slightly lower that output in no-fund case. Output benefits from the different levels of consumption and investment, which party can be sent to the fund. The graph shows that utility of consumption not being sent to the fund is higher than utility of extra revenues

sent to the fund. Output in no-fund case benefits from unreduced consumption more, than it could benefit from fund withdrawals.

On the graph 8 one can see how consumption and output evolve in 3 cases: consumption and output in open economy relative to its variables in closed economy without fund and consumption and output in closed economy with fund against variables from the case with no fund.



Graph 8 Consumption, output relative to cons, out closed

4.2. Fund case

The fund is constructed by the following equation:

$$F_t = (F_{t-1}*(1+r) + o_t p_t)$$

Oil revenues from extraction are collected into the fund.

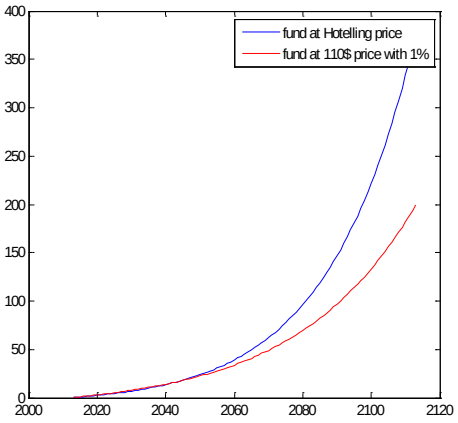
The part of the fund that can be spent in each period:

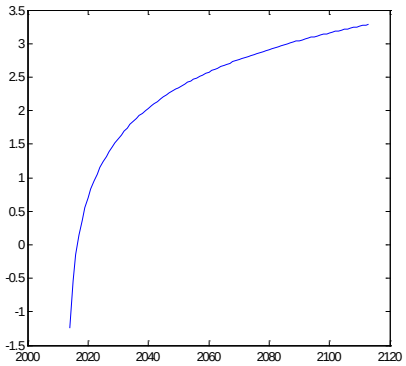
$$F_{spent,t} = (F_{t-1} * (1 + r) + o_t p_t) * r$$

Each year it is possible to withdraw 4% of the fund for consumption/investment purposes. The rest of the fund from each period is invested in the world markets at 4% interest rate.

The fund can be accumulated with oil sold at a different price: at Hotelling price, which grows at the interest rate of 4% a year or at flat price of 110$. Moreover one can come up with different saving rate. In the graph 9 one can see absolute values of fund accumulation under Hotelling price and 4% saving rate and under price of 110$ and 1% saving rate for the

economy, whose marginal value of consumption is very high. The graph 10 shows the process of fund accumulation at the rates of growth and withdrawal that are equal each other.





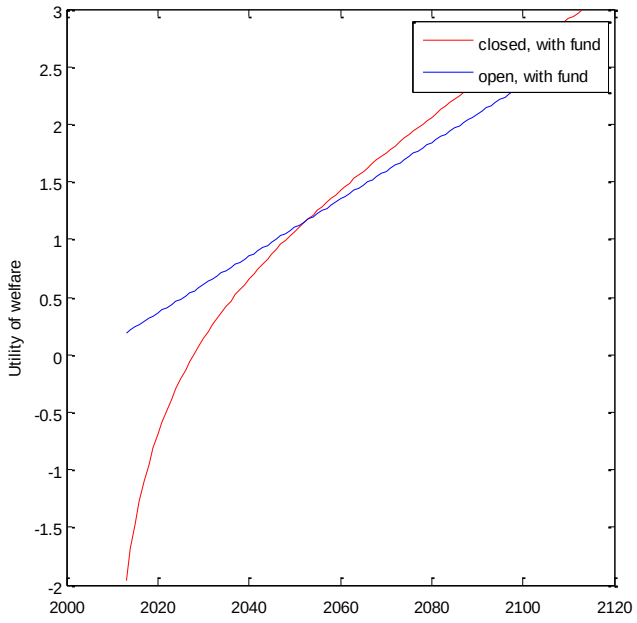
Graph 9 Absolute values of fund Graph 10 Log values of fund

Variable	Growth rate 1.025	Growth rate 1.50; 110$ oil price	Grate 1.025; Hotelling price	1.025; savingrate 1.1; Hotelling	1.025; savingrate 1.01; Hotelling
Welfare	115.47	142.73	122.59	122.59	122.59
W_fund	113.94	141.86	119.34	120.93	115.47
W_open	125.1908	143.99	130	130	130
Fund	7.55	31.72	98.18	37.67	259

Table 1. Welfare and Fund absolute values

In the table 1 one can see values of welfare levels and fund size under different cases and with different oil price and saving rates.

Welfare rate is the highest in the open economy, however for the Russian case, the closed economy without fund is more preferable than with fund. It shows that Russia has underconsumption up to the year 2050 (graph 8). In table 1 welfare is higher in the open economy, which coincides with the growth theory for developing countries.



Graph 11 Change in Welfare level

Graph of welfare represents levels of utility in closed and open economies. In the open economy utility path is smooth and grows at the equal rate. In the closed economy welfare is increased most in the first decades of oil revenues.

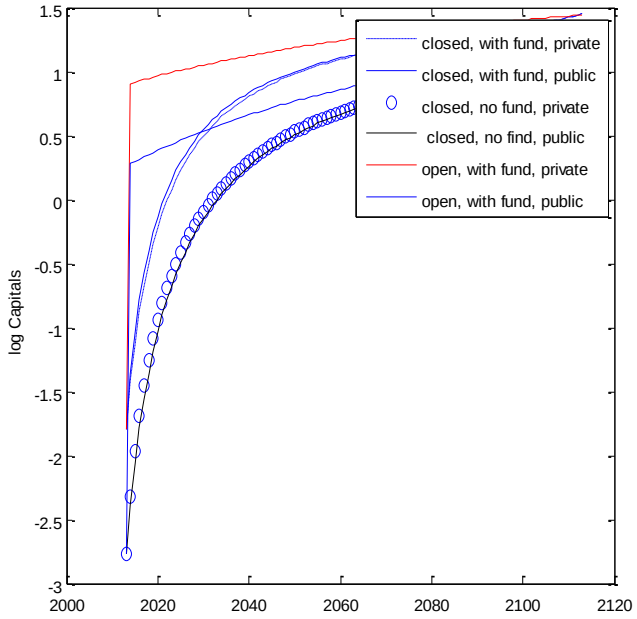
4.3. Closed economy without fund

We will look at the case of the closed economy, which doesn't send oil revenues to the fund. In this case oil revenues either go to consumption, either make up federal budget. The case of Russia is interesting in this scenario, because Russia constructs its budget on a particular oil price each year. Thus Russian budget becomes highly volatile with respect to world oil price in the short run or to its own extraction path in the long run.

The framework is that oil revenues are shared between consumption and investment. I implement different price paths and extraction paths, will show graphs for 1 price/extraction set and draw general conclusions.

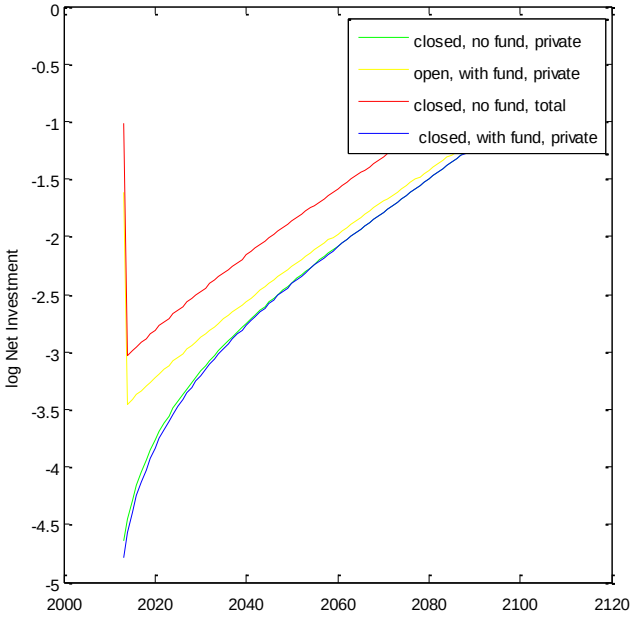
As it is seen in graph 12, capitals, both private and public, are lower than capitals in other 2 cases. That confirms the theory, where consumption in open economy has higher values than consumption in closed. However fund leads to higher consumption accumulation. It would be more logical to assume that extra revenues in the economy, not absorbed in the fund, would lead to higher consumption and investment. The capital begins to grow from the first period of oil income and shows an increase in several times. The graph 13 describes investment path under several cases. In the closed economy with no fund investment drops immediately after

first oil revenues. Together with consumption path, I can conclude that the country has a strong need for capital accumulation and doesn't consume or doesn't invest.



Graph 12 Capitals

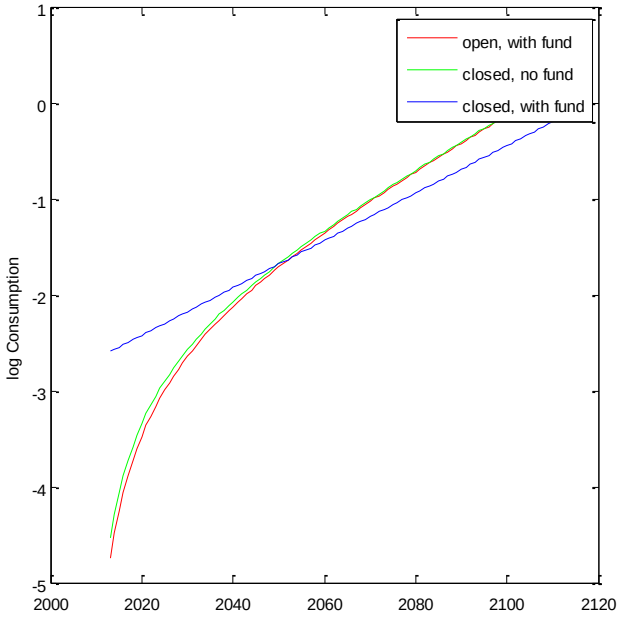
Private and public capital stocks have the same growth rate, because they are constructed with the same inefficiency, which is affected by the same productivity growth rate. Both capital stocks show smoothness and monotonicity.



Graph 13 Investment

On the graph 13, one can see paths of investment. Investment is highest in the case without the fund. Since the country acquires oil revenues, it wants to invest a lot. Investment path for private sector looks smoothly increasing. Private investment accumulation is increasing and is higher for no fund case, than with fund case.

Consumption is represented by the graph 14. Consumption under open economy is slightly higher than under closed economy without fund. Consumption with fund is completely smoothed. In the first 40 years it is the smoothed fund-constrained consumption that has higher values than consumption in other cases. After 40 years –period, economies without fund has higher allocation. Here open and closed consumptions are almost equal, which means that the country doesn't have a need in excessive borrowing. It is also seen that once the country receives oil income, it increases consumption and decreases investment.

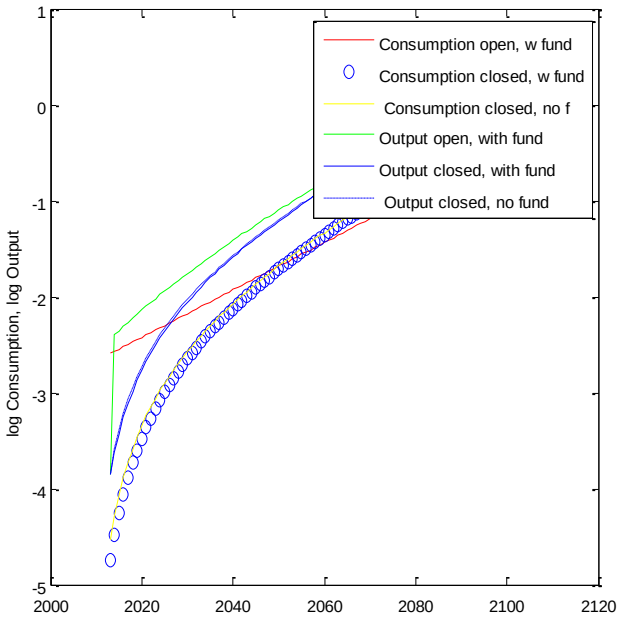


Graph 14 . Consumption under open/closed with fund

Output without fund is slightly higher than with fund. That can happen due to the need in extra assets, and not in conserving them in the fund. The highest output is still achieved in the open economy.

Extraction path I chose for these cases is flat and starts from the first period. Thus, government receives oil income from the beginning and doesn't need to wait for future incomes, there is no uncertainty. One can see an immense boost in consumption and a drop in investment in all cases. Extra revenues from oil contribute to the consumption possibilities and lead to the strong initial consumption response. It is strong in open and closed economies.

The fact that the open economy can borrow against future incomes, increases consumption and output.



Graph: 15 Consumption and Output under open/closed with fund / closed no fund

On the graph 15 consumption and output are displayed together. In the long-run all outputs converge to one path. However open output is higher than closed output, but the gap between them is decreasing. The same we can observe when it comes to consumption. Marginal utility of consumption in the open economy is very high, it almost reaches output. Since I constructed law of motion of inefficiencies in such a way that they just slightly diminish with time, it becomes optimal to borrow now to increase consumption. In the open case the growth path of consumption is not that steep as under the closed case: first, when marginal utility is high, it is optimal to borrow, and then one needs to repay debts. And that is the point where 3 consumptions cross each other.

Mathematical observations from coding in Matlab:

In order to get the results from the Ramsey model, I use MATLAB, where the model can be written with equations and the input parameters can be set. Matlab code consists of number of input orders and number of equations – first order conditions, steady state conditions, which give results according to the given input. Here I want to make notions on how some variables behave in Matlab equations:

1. Capitals don't react on any change in oil input, i.e. oil extraction path.
2. Fund's initial value doesn't have any impact on the development path of capital, consumption or output.
3. Fund reacts on changes in extraction path and oil price dramatically and on saving rate.
4. Changes in oil price path or extraction path doesn't affect capital, cons, and output. However oil price affects value of oil, which is discounted, given the growth rate. Thus if I use a flat price path, it decreases oil value through the next 100 years. That is why Hotelling price is a suitable price scenario, despite it gives extremely high values of price in 100 years.
5. Changes in economy growth or in inefficiencies' adjustment path changes capital path severely.
6. Welfare levels don't depend on the extraction part or saving rate, but react on the sufficient price change and most of all on growth rate.

4.4. Conclusions from the model simulation:

I was aiming to find how resource revenues influence country's growth path; how welfare and inefficiencies develop with resource income. Here are the findings from the simulation of my version of Ramsey model in Matlab.

1. I find that the country needs to smoothen the consumption. On the graph 8 one can see that marginal utility of consumption in the open case is very high. Since inefficiencies diminish with time and output increases in the future periods, it is not optimal to make any restrictions on consumption, as for example, in the cases with closed economy with or without fund.
2. Russia experiences initial boost in the consumption, but consumption has a lower growth afterwards. $\frac{F_{t+1}+R}{F_t+R} < \frac{F_1+R}{F_0}$, where R is resource revenue and F is output function. Effect of extra resource incomes is enormous in the first periods, and the economy growth is high in the first periods.
3. Utility level is the highest in the open case. In the closed economies it is the case without fund that has the highest utility level, rather than the case with fund. It shows that marginal utility of consumption is high and thus extra revenues from resources are vital for consumption enlarging and consumption smoothing. The most optimal variant is to borrow more for consumption in the open case from the international

markets. This variant suits more developing countries, than developed. Developed countries don't have underconsumption and prefer to collect all revenues in the sovereign wealth fund. The Russian government should maintain one starting conditions in its oil – sector policies: measures should have either developing-country feature – with catching-up growth and consumption smoothing, or they should target developed countries' aims – saving, economy stabilizing.

4. The second advantage of open economy for the Russian case is that consumption smoothing due to borrowing abroad won't hinder output from growing. Thus it is reasonable to manage oil revenues, because extra income helps to smooth consumption and borrow against future incomes. Borrowing on the international level is based on the international interest rate, not the domestic one. In the transition countries like Russia the inner interest rate is much higher than the international one. Thus borrowing abroad doesn't lead to decrease in the output.
5. I find that the saving rule in the fund has a big effect on consumption and, consequently, on welfare. If the percent of saving in the fund is changed, the amount of revenues, which can be used in consumption, is changed as well. The Russian economy gets the highest welfare when the saving rate is decreasing, allowing more money to be consumed. That means that it is optimal for Russia to choose the fund management that is consumption-oriented, not saving-oriented. The question "to save or to consume" has other factors to take into consideration. We can compare gains and losses of implementing one of the cases, but these cases bear positive and negative externalities, which can't be installed in the model. The case with closed economy with the fund has its pros and cons. It can restrain consumption in the first period and prevent consumption smoothing, but it can also lead to future gains. The gains in the future can include a welfare fund, which has stabilizing function, anti-rent grabbing political regime, good institutions, absence of Dutch disease and small government debt.

5. Discussion

Since not everything can be included in the model, I will leave some topics connected to the Resource Economics and Development Economics for the less formal discussion, presented in this chapter.

5.1. What are possible scenarios of consumption/investment for differently developed countries?

Spiro (lecture notes 2014) shows that resource income expands budget constraint. Before the resource income is received the budget looks like F (k_t, h_t), after the income is received - F (k_t, h_t) $+R_t$.

Russia experiences initial boost in the consumption, but consumption has a lower growth afterwards. $\frac{F_{t+1}+R}{F_t+R} < \frac{F_1+R}{F_0}$, where R is resource revenue and F is output function. Effect of extra resource incomes is enormous in the first periods, and the economy growth is high in the first periods.

The next question is the source of economic growth. Resource sector usually drives technological improvement (S. Managi, J. Opaluch, 2005). What can be the growth source: capital sector or oil technology that has spillovers to the other sectors? The Russian economy shows little capital productivity growth; oil technology is mostly imported. One of the sources of growth can be labour productivity – Russia has highly-skilled workforce, however that is not the most secure growth source. Without reasonable capital productivity, labour productivity can decrease in one generation's time.

World Bank (Where is the wealth of nations, 2006) provides its method of calculation a country's wealth. Their rapport consists of figures for "nearly 120 countries on the per capita values of agricultural land, minerals, forests, produced assets, and an aggregate term intangible capital". Intangible capital is labour, human capital, social capital and other factors such as quality of institutions.

TABLE 1
TOTAL, NATURAL, PRODUCED AND INTANGIBLE CAPITAL, 2000
(*$ per Capita and Percentage Shares*)

Income group	Natural capital	Produced capital	Intangible capital	Total wealth	Natural capital share	Produced capital share	Intangible capital share
Low-income countries	1,925	1,174	4,434	7,532	26%	16%	59%
Middle-income countries	3,496	5,347	18,773	27,616	13%	19%	68%
High-income OECD countries	9,531	76,193	353,339	439,063	2%	17%	80%
World	4,011	16,850	74,998	95,860	4%	18%	78%

Note: All dollars at nominal exchange rates. Oil states excluded.
Source: World Bank 2006, table 2.1.

Table 2, vd Ploeg, 2011

When one looks at the produced capital share, one notices that it has the same value regardless to the income level of the country. It is the share of natural capital, which has the most spread distribution: it is relatively low for high-income countries, but much higher for the poor countries. One should also notice that despite the share of natural capital is the lowest for rich countries, it has the absolute value per capita that is higher than in the poor countries. Ploeg (2011) states that: "The results confirm what we know from the literature on economic growth that intangible capital is the main engine of growth and wealth." Richer countries tend to focus more on dynamic sectors, for example services and manufacturing, while poor countries prefer to specialize in the more static resource- extracting sector.

Intangible Capital and the Composition of

Wealth in Highly Resource-Dependent Countries

		Percentage share of total wealth		
Country	Intangible Capital per capita ($)	Natural capital	Produced capital	Intangible capital
Russian Federation	6,029	44	40	16
Guyana	2,176	65	21	14
Moldova	1,173	37	49	13
Venezuela	4,360	60	30	10
Gabon	-3,215	66	41	-7
Syrian Arab Rep.	-1,598	84	32	-15
Algeria	-3,418	71	47	-18

Nigeria	-1,959	147	24	-71
Congo	-12,158	265	180	-346

Table 3, vd Ploeg, 2011

In Table 3 there is a pool of countries, which are chosen due to their high share of natural capital. Russia, Venezuela and Nigeria are oil producers. The method of calculation of intangible capital in the World Bank report implies that total wealth is the present value of sustainable consumption.

If it has negative values that mean that the present level of gross national income is too low in these countries. Gross national income is too low, meaning that the rates of return on all kinds of capital in the economy: produced capital, human and institutional. Auty (2001) and Gylfason (2001) found that such distribution of capital is an evidence of the resource curse. Gylfason (2001) found that resource-rich countries are overconfident in their natural capital in a way that resource bonanza causes misbehavior of the political elite, corruption, political instability and civil war.

Russia performs not well when it comes to the share of intangible capital. When is has been found that it is the intangible capital that is the source of sustainable growth, Russian deep dependence on natural resources is a sign of inner inefficiencies in its economy.

When a country owns high level of resource reserves, it is possible to follow 2 development paths: to turn oil into resource blessing or into resource curse.

It also shows that Russia in post-transformation time is following the second path. Auty and Gelb (2001) show that the natural resource wealth partially determines the development paths of countries, while increasing the likelihood of political failure. The resource-rich countries tend to rely on the primary sector and not on the manufacturing. At the same time countries with poor resource base tend to focus on labor-intensive manufacturing. As a result they gain diversification and accumulation of industrial and human capital. In order to sustain this scenario it is the special political state that is required: the state with sufficient autonomy "to sustain a coherent economic policy and the objective of raising economic welfare"[2].

Is it possible for Russia to escape the resource curse?

Atkinson and Hamilton (2003) found that countries, which managed to escape the resource curse, used resource rents as a source of investment in industry, not the source of consumption. These counties avoided negative externalities, connected to the resource curse,

[2] Auty and Gelb (2001)

by transforming natural capital into produced capital. The Hartwick rule states: a country should invest all the rents from the exploitation of natural resources.[3] This rule is especially valuable when it comes to the management of rents from non-renewable resources, and this is the case of Russia. The special feature of nonrenewable resources is that they don't have a growth function – after discovery they can only be depleted. Thus the resource management policy must invest rent effectively and its main goal should be to maintain fiscal stability. There are several pitfalls that a country with resources can fall in if it mismanages resource rent. In the Russian case I found that the country underconsumes. Thus the future oil revenues can be collateral for borrowing today. The typical mistake here is to borrow that much, that foreign debt grows dangerously. Moreover oil revenues enlarge public expenditure and it becomes harder for governments to introduce budget cuts. Weinthal and Luong (2006) propose their variant of best rent investment management: investment in fiscal and monetary policies; economic diversification; natural resource funds; transparency, accountability and public involvement; and direct distribution to the population.

Fiscal policy is driven by the government. Thus it is necessary that the Russian government applies principles of transparency and accountability when it implements the measures stated above. The common externality such as corruption makes it necessary to impose more strictly control on the politicians, because fiscal policy, calculated by economists, is fulfilled by politicians. Thus, the advice is to control politicians, by upper unrelated agencies, international revisers or by local institutions.

5.2. Oil price volatility and federal budget

The fund establishment can help to prevent volatility of oil prices from damaging the economy.

The volatile oil price has two main implications: it creates volatile income stream and it becomes difficult to manage the not yet extracted resources. Oil rent is the main source of the Russian budget. The Russian budget is made 1 year in advance and based on oil price prediction. Oil extraction due to the technological factors and investment business-plans can't be adjusted in the short-run. Such strong dependency of the state budget on oil price isn't good for economy in the long-run. In the short-run consequences of the oil price volatilities can be smoothed by borrowing on the world market. However the possibility for Russia to borrow on world markets is not doubtless. The oil price plunge in the autumn 2014 is claimed to be triggered by geo-political reasons. By the same reasons the country loses access to

[3] Hartwick (1977)

public and private borrowing abroad. Thus it would be optimal for the country to save more in the fund in case it will not be possible to smoothen oil price volatility by borrowing abroad.

The second point – resource evaluation under volatile price- is very important when it comes to resource management and macroeconomic forecasts. Robert S. Pindyck (1999) suggests that oil prices are mean-reverting; however there are authors who believe that price fluctuations don't average in the long-run. This question, of course, leads to uncertainty in resource value assessment. However in the long-run it is not going to affect extraction path dramatically. Russia has plenty other resources, prices on which are either non-volatile (aluminium, copper) or are contractual and defined by the country itself. Thus it is reasonable to advise Russia to save more and not to borrow, but from the Russian managers' perspective that seems to be too cautious. The country has gas reserves for the next 100 years and iron ore, nickel, copper altogether will last 50-60 years. Since something will be left for sure to the "future generations", it is not of big concern for Russians to choose the most optimal extraction path or to save preventively.

To sum up, it is highly reasonable for Russia to save oil rent in the fund. The resource curse, bad institutions, non-optimistic forecasts and sanctions are good reasons to focus entirely on fund management. The fund has been split in two funds in 2008. Each of the funds has its own goals and merits. The Reserve fund is invested abroad in low-yield securities and used in case oil and gas incomes fall. The National Welfare fund is invested in riskier securities and covers budget expenditures. These funds accumulate revenues from oil export and tax, which is paid by extracting companies, only when the price for the Urals brand exceeds the set cut-off price[4]. The National Wealth fund has lost 10% of its reserves during the first 6 months after the sanctions were imposed. Given the inefficiencies of the Russian economy and the self- isolation process it is highly reasonable to accumulate more in these funds.

5.3. Weaknesses in oil industry after sanctions 2014

The Russian refining sector, despite being third largest in global capacity (behind the United States and China), has only recently begun to be modernized. Russian refineries currently produce a disproportionately large share of dirty, carbon-heavy fuel oils, which has nearly tripled in volume since 2000. A reason for this, beyond older infrastructure, is that Russia taxes its unprofitable refined heavy oil at a lower rate than light oil.

Due to the fact that most of the oil extraction takes place in West Siberia – a region where 75 % of the oil fields are already in operation and their stock goes empty by 50 % of the resource

[4] http://www.minfin.ru/ru/nationalwealthfund/accumulation/

– if the country wants to keep producing oil at the non-diminishing rate, it will need to *reinvest* a lot into the industry.

Adoption of new production techniques as well as new refining processes will demand other fiscal and foreign investment policies than those which are applied now.

Without adequate reinvestment, efficiency gains in the sector will stall, responsible practices will not be established, production declines will set in, and the sector will be forced to rely on more damaging, low-quality oils.

Nowadays the oil sector in Russia is underinvested. Due to the sanctions in 2014 the possibility to receive investment from foreign oil companies has been substantially narrowed. The future projects in oil sector are concentrated on the continental shelf (Arctic shelf). However these projects have extremely low investment interest. The main reasons are: small geological knowledge of the shelf and the resources there, high risks of investment; unfortunate geographical location of mining fields which have too high costs of exploration and extraction; no infrastructure concerning extraction and transportation of resources; instable fiscal regime; too much bureaucracy of authorities which issue property rights on the continental shelf; absence of law framework for any type of extraction works.

When I model the Russian oil sector, I need to take into consideration key features: state control of the key sectors of the economy, weak market institutions, all trunk pipelines are 100 % state-owned, giving the state control over access to oil export markets. These features motivate inefficiencies in the economy and the importance of investment-saving decision. The structure of oil sector doesn't allow adjusting extraction or reacting adequately on oil price shocks, outer economic shocks and sanctions.

5.4. Recommendations from discussion

The recommendations stated below are not part of my research. However, after taking the courses in Development Economics and Resource Economics, I find it important to look at the Russian oil revenues from the perspectives of good/bad institutions, corruption, negative environmental effects. Given the long-varying negative trends the Russian economy, I feel obliged to come with recommendations on how to manage the oil revenues bonanza.

1. Transparency, accountability and other institutional principles – all these existing solutions have largely failed because making the state a better "manager" of its mineral wealth requires institutions that promote transparency, accountability, and oversight—that is, institutions that are widely absent in developing countries.

2. Despite the big oil reserves and high reserves-to-production ratio, oil itself cannot be a pure blessing for the economy. Effective resource management includes preventive measures against negative externalities such as rent-grabbing, corruption, increasing inequality. The country has already shown these symptoms. Unfortunately, history shows that Russia joins the club of resource-losers. If it wants to benefit from oil reserves in the future, it should be ready to initiate reforms and invest only in socially-optimal and profitable projects.
3. The rest of oil revenues should be accumulated in the fund. Russia has already experience with funds. Nowadays 2/3 of the fund has been accumulated from oil export revenues. The share of oil rent, which should be collected into the fund, is to be decided by politicians. However in order to benefit from oil politicians should have clear goals and commitment. They should commit to fight corruption and thus save more, spend less. It is also highly advisable to establish clear rules of fund usage. The rules for evaluation and picking-up an investment project or a fiscal task should be made transparent. Information about where the fund is invested should be also made public: what share of the fund is invested abroad and its risk tolerance.

   Since one Russian fund has been split into two funds – reserve and national welfare – they should set defined investment horizons according to their tasks and avoid spending on other purposes. The funds should not invest in the currency to which rouble is pegged (Das, Lu, 2009). However the funds' current composition is 45% in US dollars, 45% in euro, 10% in pounds[5]. Such composition is extremely unlucky, when the national currency gets depreciated.
4. Following the discussion on the investment policy, the entire approach to the project assessment must be changed and made transparent. Blooming corruption and investment in white elephants became part of everyday life in Russia. In order to promote economic development without resource curse side-effects, one should create monitoring agencies, so that they can ensure that the standard principles of cost-benefit analyses are applied. Moreover the control mechanism should be redesigned as well. The public investment projects must be monitored by unaffiliated social institutions and independent foreign agencies, which don't have incentive to allow misallocation of resources on a particular project.

[5] http://www.minfin.ru/en/reservefund/management/

5. The main function of the two Russian funds is claimed to be a stabilising tool, however they have different objectives: pension and fiscal stabilisation. The Reserve fund is set up to maintain federal budget balance, reduce inflationary pressure, and stabilize the Russian economy against volatile oil prices. There are two points that need to be mentioned. Firstly, oil price represents a volatile income source. Secondly, saving assets abroad assists on mitigating the resource curse. In general, the decision to divide the stabilisation fund into two saving parts is approved by world practice. One of the funds is directly targeted at smoothing boom/bust cycles to overcome Russia's main income source volatility.

6. Conclusion

2014 is a year when the future development of the Russian economy has been on the crossroad. Sanctions 2014 and geo-political crisis can push the country into 2 different directions: open, fully-integrated into the world, economy or isolated, self-sufficient economy. The question of this work is to find out the decision of consumption/investment question given open / closed economy path.

The open case is possible if the country will continue its democracy-oriented reforms and remain integrated into the world markets. It is in this case it will have the highest benefit from the oil it possesses. The optimal consumption will be higher than that in closed economy. The optimal saving is higher than under the closed economy to prevent overheating. In the closed case the country faces isolation. There it is optimal for the country not to establish the fund in order to achieve optimal consumption level.

1. Utility level is the highest in the open case. In the closed economies it is the case without fund that has the highest utility level, rather than the case with fund.
2. The country experiences underconsumption and it is not optimal for it to absorb all oil revenues into the fund. However it might be optimal to save now, if the future looks pessimistic. If the country expects that the future is negative due to world markets crisis or due to the diminishing access to world capital or due to trade- and financial sanctions imposed on the country, then it may find it optimal to save all immediately.
3. When it comes to consumption/saving trade-off, Russia should consume part of oil rent, but consume cautiously. Not ubiquitous consumption should help in limiting corruption of decision-makers in the oil sector and politicians. Moreover by

consuming prudently the country will support the industrial sector and will have assets to smoothen consumption in the future periods when the access to borrowing abroad will be limited. It is advised to cut public expenditure as well to prevent budget deficit, which can be easily caused by changes in volatile oil price.

To sum up, the country with plenty of mineral resources should consume prudently and save more in the funds. The resource curse creates many disturbances in the economy and together with geo-political status of the country makes its future more pessimistic. The overall design and functioning of two stabilising funds don't receive much critique. It is the investment mechanism that should be reformed, so that the country could become the resource winner and not the resource loser.

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Appendix A:

Sanctions

The sanctions, introduced by the USA and the EU, have important consequence for the Russian economy. Here is the summary of the sanctions, announced from March 2014 to December 2014, so that the reader of this work could understand better the motivation behind the open / closed economy cases in the model. The sanctions, introduced in 2014, aim at oil and gas sectors in Russia. It is quite early to say what effects they will have in the long-run. However it is useful to get to know the essence of the sanctions for my analysis:

> "On 31 July, the European Union (EU) adopted certain sanctions that affect new contracts related to Russia's oil sector, in response to perceived Russian destabilizing actions in Ukraine as well as Russian connections to rebels who are alleged to have shot down a civilian airliner. The oil sanctions, explicitly not retroactive, affect new exports and investments by EU-based entities in deep water, arctic, and nonconventional (shale) exploration and development. However, the conventional oil sector, as well as the natural gas sector, is unaffected. US sanctions, published on 6 August, appear to be more comprehensive than EU sanctions, affecting a broader scope of investment, with both the natural gas and oil sectors targeted. Existing agreements, however, are also exempted. The omission of the natural gas sector from sanction by the EU will likely mean that technological transfer and investment on shale plays will not be as greatly impeded as would otherwise be the case. This is because much of the technology overlaps and also because it can be difficult for regulators to draw a distinction. In any event, given the exemption of existing contracts and investments, the implications for Russian production are more in the medium-term, which would also necessitate the sanctions staying in place for some time. EU sanctions are set to expire in one year, unless an explicit decision is taken to renew them by the European Council. In the short term, a perception of higher risk could make some Russian companies more conservative in terms of their capital spending. Rosneft could also find that its acquisition (currently in process) of Morgan Stanley's energy trading practice is less valuable, as the company's ability to function as an oil trading company in the West is limited in some ways.", from International Energy Agency, Oil Market Report from 12 August 2014.

"The Western sanctions, combined with uncertainty about their possible escalation in the future, have negatively affected business confidence in Russia, constrained the ability of corporates and banks to access international debt markets, and contributed to capital flight. Capital outflows from Russia continued in the second quarter of 2014, although at a significantly slower pace than in the first quarter. Cumulative net private capital outflow reached US$ 75 billion in the first six months of the year."[6] This extract is taken from European Bank of Reconstruction and Development, report from September 2014.

"US and EU sanctions on the Russian oil sector are not providing oil markets with much support either. The consensus in the industry seems to be that neither set of sanctions will have any tangible near-term impact on supplies. Even for the medium term, their impact appears questionable. EU sanctions are highly selective, exclude agreed contracts, and can only be extended past one year by consensus. Their 'perimeter' seems loosely defined, potentially leaving room for finding ways around the most constraining measures." from International Energy Agency, Oil Market Report from 12 August 2014.

[6] http://www.ebrd.com/downloads/research/REP/rep-2014.pdf