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ESTIMATING THE INCOME COUNTERFACTUAL FOR OIL PRODUCING COUNTRIES OF THE MENA REGION

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Abstract

How much richer would oil producing countries in the Middle East be if they invested all their natural resource rents? This study tries to answer this question by calculating the counterfactuals of capital stock and income under two major scenarios. Combining several data sets, including a unique set on sovereign wealth funds, it finds that oil-producing MENA economies could have had, on average, around a 0.55 percentage point higher growth rate if they had used their natural resource rents efficiently. This difference in growth rate translates to around 25% higher income over a 40 year period. These numbers are separately calculated for each country and their important policy implications are discussed.

JEL Classification: Q32, Q43, Q48

Keywords: Resource Rent, Economic growth, Middle East and North Africa

ملخص

الى أي مدى ستكون الدول المنتجة للنفط أكثر ثراء إذا استثمرت كل ريع الموارد الطبيعية الخاصة بهم؟ تحاول هذه الدراسة الإجابة على هذا السؤال من خلال حساب الريع من أسهم رأس المال والدخل تحت سيناريوهين رئيسيين. الجمع بين عدة مجموعات البيانات، بما في ذلك مجموعة فريدة على صناديق الثروة السيادية، فإنه يرى أن اقتصادات منطقة الشرق الأوسط المنتجة للنفط قد كان، في المتوسط، حول معدل النمو 0.55 نقطة مئوية أعلى إذا كانت قد استخدمت الإيجارات الموارد الطبيعية بكفاءة. هذا الاختلاف في معدل النمو يترجم إلى ارتفاع الدخل بحوالي 25٪ على مدى فترة 40 سنة. وتحسب هذه الأرقام بشكل منفصل لكل بلد وتناقش انعكاساتها الهامة على السياسة.

1. Introduction

Many have argued about the positive and negative consequences of having natural resources. Regardless, the fact is some countries are endowed with these resources and their policy question is how to make the best use of them. This is especially important for the oil and gas producing countries in the Middle East and North Africa (MENA) region that have very large resource endowments. Hartwick (1977) argued that if resource-rich countries want to make the best use of their resource and maintain high income levels, even after the resources are depleted, they need to invest all profits derived from natural resources instead of consuming them (*Hartwick rule*). This study tries to estimate how much richer and wealthier MENA oil producing countries would be if they followed Hartwick's simple, but highly beneficial, rule.

To illustrate the purpose of this paper, consider the fact that oil and gas rent – the difference between the market prices of oil and gas and the economic costs of producing them – is high. For instance, in some oil producing countries, such as Saudi Arabia, Kuwait, Iraq, and Iran, it costs less than US$10 (in 2005 prices) to produce a barrel of oil, while the market price is sometimes several times larger. This stark difference between price and cost, multiplied by large production volumes, generates sizable profits (rents) that are volatile over time (and usually unknown to the public). As a result, oil and gas rents may have numerous positive and potentially negative consequences on the structure of the economy, politics and even culture, as some argue.

The potential effects of natural resource rents on an economy have been extensively discussed in the economic literature[1]. Although there is no consensus on the impact of natural resource rents, many countries are endowed with them regardless and have to deal with the (potential) consequences. In this context, one of the major policy questions is how can the performance of resource-rich economies be improved? In other words, is there an optimal policy to deal with natural resource rents? And how will incomes increase if resource-rich countries adopt such a policy?

Another closely related issue is that some natural resources, such as oil and gas, will run out at some point in time, leading to the question of how an economy can sustain growth when the revenues from such resources dry up. Trying to answer this question, Hartwick (1977) finds that under certain conditions, investing all rents provides the maximum per capita consumption after resources are depleted over time. Under his premise, when the resources are still available, the country's capital stock should increase with the size of rents every year. This means that the net investment (investment minus depreciation) should be equal to rents. The country does not consume the rents, but it can consume the returns from investments. The capital stock grows over time due to the investments. As a result, the returns increase, which, in turn, translates into more consumption (or income) over time. By the time the resources are depleted, the capital stock will be at its highest and will provide the same returns as it did before the resources were exhausted. This return stays constant afterwards since the size of capital stock does not change (net investment = rents = zero).This is called 'zero net saving' or the 'Hartwick rule.' A country may be even able to do better than this if it invests more than natural resources profits (i.e. more than the zero net saving rule).Under certain conditions, the consumption levels grow over time even after the resource is depleted.(Net-)Investing more than the rents is called the 'genuine savings' rule.

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[1]The evidence on some of these consequences, however, is not strong. For a literature review, please see van der Ploeg (2011). For quasi-experimental evidence on the economic impacts of natural resources, see Caselli and Guy (2013). For the social impacts, see Postali and Nishijima (2012). Moreover, see Ross (2012) for more discussion of social, political, and economic impacts of oil and gas. Recent literature argues that the potential negative impact of natural resources may materialize only under bad governance (Collier 2010; Collier and Goderis 2007; Elbadawi and Soto 2012).

This study estimates the hypothetical income when oil producing countries of the MENA region use their oil and gas rents according to these two rules. These hypothetical incomes are called the 'counterfactual incomes,' because they show what could have been possible under a different policy. Hamilton et al. (2006) have calculated the counterfactual capital stocks according to these two rules for 66 countries, but only Algeria and Egypt from the MENA region are in their sample. They also do not try to find estimates of the counterfactual of income (only capital). This study differs from Hamilton et al. (2006) in three dimensions: First, it specifically looks at countries that were not included in Hamilton et al. (2006) (i.e. oil producing countries in MENA). Second, in calculating counterfactuals, it accounts for investments in offshore accounts (Sovereign Wealth Funds) and education, which are substantial in these countries. Third, it tries to estimate the counterfactuals of income, in addition to capital. Fourth, following the critique of Asheim et al. (2003) on the Hartwick rule[2], this paper tries to find the counterfactuals of capital and income if there are deviations from the Hartwick and genuine savings rules (i.e. if portions of rents are consumed rather than invested). The elasticity of these calculations with respect to the amount consumed is estimated.

Calculating the counterfactual income has important implications. First, it gives policy makers an idea of how valuable it is to adopt the right policies. For example, if it turns out that the counterfactual income is substantially larger than the actual income, it may warn policy makers of the consequences of current policies. Second, it provides more insight into one of the primary questions in natural resource literature: that of whether natural resources are a curse or a blessing.

The rest of this paper is organized as follows. First, the methodology through which the counterfactuals of income are estimated is explained. Then the data and some calculations are discussed. A description of the results using three major counterfactuals of capital is then presented. Finally, the policy implications are explained.

2. Methodology

Hartwick (1977) showed that if one invests all (net) returns from resource extraction, all generations will consume the same level. Based on this, Hartwick (1977), in what is known as the *Hartwick rule*, suggested that countries with natural resources should have net investments equal to their natural resource rents so that future generations enjoy a maximized sustainable stream of consumption levels when natural resources are depleted. Of course, if the economy invests more than the Hartwick rule, consumption grows over time. A country's investing even more than what is stipulated under Hartwick's rule is referred to as the *genuine savings rule*.

This study first calculates the actual and three hypothetical (or counterfactual) capital stocks (based on investment equal to and more than the rate suggested by the Hartwick rule) in the natural resource rich economies of MENA region, and then estimates counterfactuals of incomes using these counterfactual capital stocks.

The actual capital stock is estimated using a Perpetual Inventory Model (PIM) approach. That is

[2]Asheim et al. (2003) shed doubt on whether the Hartwick rule can be realistically applied in practice. One reason is that even if the current policy makers commit themselves to invest resource rents, they cannot commit future policy makers to do the same. The rents from natural resources are substantial and there is always temptation for consumption rather than investment. In addition, various interest groups may demand consumption of the resource and it may thus be politically impossible to invest all rents. Therefore, it may be too idealistic for governments to follow the Hartwick or genuine savings rules.

$$K_t = \sum_{j=0}^{19} (1-\delta)^j I_{t-j} \tag{1}$$

in which I_{t-j} is the gross investment at time $t-j$, δ is the annual depreciation rate and the assumption is that it is 5%. One needs at least 20 years of data in order to start calculating capital stocks. As a result, for the countries in the sample the first year for which we can calculate capital stock is in the 70s and 80s. The three counterfactuals of capital stock are (1) a capital stock derived from the standard Hartwick rule, (2) a capital stock derived from the constant net or genuine investment rule, and (3) a capital stock derived from the maximum of observed net investment and the investment required under the constant genuine investment rule. These counterfactuals of capital are the values for the capital stock under the best policies.

Capital stock based on the Hartwick rule is calculated using

$$K_{2008}^{H} = K_{19xx} + \sum_{t=19xx}^{2008} R_t \tag{2}$$

in which K_{2008}^{H} is the capital stock in 2008 if the country had been following the Hartwick rule, K_{19xx} is the initial capital stock which for most countries in the sample is the capital stock in a year in the 1970s and 80s, and R_t is the oil and gas rent in year t.This study uses the actual rent (profit) rather than only revenues from producing natural resources. In other words, it considers costs of production as well[3]. The last year for which we can calculate these counterfactuals is 2008, as it is the last year for which data on oil and gas rents were available.

The two other counterfactuals for capital stock are calculated using

$$K_{2008}^{G} = K_{19xx} + \sum_{t=19xx}^{2008} (I^G + R_t) \tag{3}$$

$$K_{2008}^{M} = K_{19xx} + \sum_{t=19xx}^{2008} max(NI_t, I^G + R_t) \tag{4}$$

in which $K_{2008}^{G}$is the counterfactual capital stock in 2008 with constant 'genuine saving,' and I^G is the genuine saving and is equal to 5% of GDP in 1990 (the middle year in the period). Five percent is roughly the average investment rate of low income countries between 1970 and 2000. This rate is also proposed by Hamilton et al. (2006) for calculating the genuine savings counterfactual capital stock. One can choose any other year instead of 1990 to estimate I^G, but 1990 was chosen since it is roughly in the middle of the sample for many countries and the world economy was relatively stable then. NI_t is the actual net investment in year t. K_{2008}^{M} is calculated using the maximum of constant genuine saving and the actual net investment.

Some of the oil exporting countries of the MENA region invest part of their oil and gas rents in sovereign wealth funds (SWFs) abroad[4] and some, like Kuwait, even donate part of it in

[3]Until recently, data on cost of production were not available. Now,the World Bank data set, the "changing wealth of nations," provides data on rents accounting for the cost of production.

[4]Interestingly, according to the World Development Indicators, net outflow of FDI out of Saudi Arabia is negligible (between -0.11% of GDP in 2005 and 0.62% of GDP in 2012), while for Kuwait it was roughly about 6% of GDP between 2005 and 2012.

development aid to other countries. Therefore, the portion of rent invested in SWFs or donated in aid is not available to be invested (in physical capital) according to the Hartwick rule. To account for this fact in calculating counterfactual capital stocks, one can subtract the investments in the SWFs, as well as donations for development aid, from rents every year to come up with the amount of rent available to be invested (according to the Hartwick or genuine savings rules), and use this in place of R_t in Equations (2), (3), and (4). In other words, $R_t = Rent_t - SSWF_t - Aid_t$, in which $Rent_t$ is the total rent (profits) produced in year t, $SSWF_t$ is the savings in the SWFs in year t and Aid_t is the development aid donated in year t. One can argue that a part of rents in the oil and gas producing countries of MENA is invested in education and should be accounted for in the same was that investments in SWFs or development aid are accounted for. Similarly, we can subtract the expenditure on education from the total rent to get a better measure of available rent, R_t. This will be discussed further in Section 4.

One can then use the calculated counterfactual capital stocks to estimate counterfactuals of income. There are two ways to estimate the income counterfactuals. One is to argue that all rent is invested domestically in physical capital and creates income through a constant return to scale Cobb-Douglas production function. The second is to argue that all the rent is invested abroad, as the country has reached its investment capacity and cannot invest domestically more in physical capital.

Consider the first method and assume that income is generated using a constant return to scale Cobb-Douglas production function, $y_t = A_t L_t^{1-\alpha} K_t^{\alpha}$, in which A_t is the technology and L_t is the human capital, both at time t. For every capital counterfactual, an income counterfactual exists. These income counterfactuals for the year 2008 can be written as $y_{j,2008} = A_{j,2008} L_{j,2008}^{1-\alpha} K_{j,2008}^{\alpha}$, in which j stands for H, G, and M (the counterfactuals discussed above). The actual income can also be written as $y_{a,2008} = A_{a,2008} L_{a,2008}^{1-\alpha} K_{a,2008}^{\alpha}$, in which a stands for actual. If one assumes that the technology and human capital change the same way over time, whether one follows the Hartwick rule or not, then $A_{j,2008} = A_{a,2008}$ and $L_{j,2008} = L_{a,2008}$ for $j = H, G, M$. This is not an unrealistic assumption if the rate of change in these factors is driven by global forces, such as innovation in other countries. Using this assumption, one can find the ratio of the counterfactual income to actual income as: $\frac{y_{j,2008}}{y_{a,2008}} = \frac{A_{j,2008} L_{j,2008}^{1-\alpha} K_{j,2008}^{\alpha}}{A_{a,2008} L_{a,2008}^{1-\alpha} K_{a,2008}^{\alpha}} = \left(\frac{K_{j,2008}}{K_{a,2008}}\right)^{\alpha}$. This ratio does not depend on labor, technology, or any input other than capital. Therefore, no matter how human capital and technology evolve over time, as long as we assume that under the counterfactual investment in capital (i.e. the Hartwick or genuine savings rules) they will change in the same way as they actually did, we will get the same result. Using these ratios it is easy to find the counterfactual output as $y_{j,2008} = \left(\frac{K_{j,2008}}{K_{a,2008}}\right)^{\alpha} y_{a,2008}$. One can easily calculate the average growth rate of the actual and counterfactual GDP between the initial year and 2008.[5]

The main parameter of the Cobb-Douglass production function, α, is necessary to calculate the above equations. Using a VARX model, Esfahani, Mohaddes, and Pesaran (2012) estimated an empirical growth model for major oil exporters including, Iran, Kuwait, Libya, and Saudi Arabia and in the process estimated the share of capital, α. I used their estimates for these countries. Since

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[5]The average growth rate of the actual GDP is simply, $\left(\frac{y_{a,2008}}{y_{19xx}}\right)^{\frac{1}{2008-19xx}} - 1$, in which a stands for actual and y_{19xx} is the income in the initial year. One can find the average growth rate in counterfactual GDP similarly by replacing $y_{j,2008}$ instead of $y_{a,2008}$, in which j stands for H, G, and M.

these estimates are close to each other (0.13 for Iran, 0.14 for Kuwait, 0.07 for Libya, and 0.25 for Saudi Arabia), I use their average for the other oil exporters in the Middle East.

Some argue that small countries like Kuwait have reached their investment capacity and it is difficult to invest more domestically. They can, however, invest in sovereign wealth funds abroad. This leads us to a second way to estimate the counterfactual of income. If the counterfactual capital stock is larger than the actual capital stock, the difference between the two, $K_{j,2008} - K_{a,2008}$, cannot be invested as physical capital and enter into the production function, because we have already reached the investment capacity. This difference should be invested abroad. Considering the average annual return to capital globally, one can estimate the income generated by this difference ($K_{j,2008} - K_{a,2008}$,) that is invested abroad in, for instance, year 2008. There are different ways to get the average annual return to capital. For example, Dow Jones Industrial Average real annual return (considering the inflation) from World War II to 2008 has been about 3.7percentage points per year.[6] In his recent book, *Capital in the Twenty-First Century*, Thomas Piketty meticulously calculates the after-tax rate of return for capital over a long period and finds it to be about 3.3% per year between 1950 and 2012. Based on these, I use 3.3% as the annual return on capital to calculate income counterfactuals using the second method. I also estimate the elasticity of these calculations with respect to this assumed annual return on capital to find how sensitive the results are to this assumption.

3. Data

The annual gross physical investment data in 2005 domestic currency comes from the Penn World Tables. They were multiplied by the exchange rate in 2005 to be converted to US dollars. Using annual investment data, one can find the actual capital stock as described in Section 2. Population was collected from Penn World Tables, and GDP in current US dollars was obtained from World Development Indicators and deflated using US GDP deflators to 2005 US dollars.

Per capita oil and gas rent data comes from the recently released World Bank data set, "The Changing Wealth of Nations," that has oil and gas rents for 208 countries until 2008.[7] These rents are the difference between the revenues from natural resources and the costs of extraction in current prices.

As discussed in Section 2, to calculate available rent to be invested in capital in year t, one needs to subtract the savings in SWFs as well as the development aid from the total rent produced (all in year t). Therefore, annual data on savings in SWFs as well as development aid for oil and gas producing countries of MENA are necessary. Data on the Sovereign Wealth Funds (SWFs) are coming from the Sovereign Wealth Funds Institute[8] and data on development aid are obtained from the Open Data for International Development.[9] Development aid data are annual and over time. However, only the total size of each SWF at the end of 2013 and the year in which the SWFs were established were available for the study, and not annual savings in the SWFs. Therefore, to obtain annual savings on SWFs, we make three assumptions. First, we assume that a fixed share of oil and gas rents is saved annually in SWFs (in other words, this share is constant over time). Second, no withdrawal from the SWFs is made. Third, annual returns on savings are the same as the annual returns on Dow Jones Industrial Average (DJIA). The annual returns on DJIA are obtained from

[6] Authors' calculations using data on DJIA and inflation, both from the Federal Reserve of St. Louise.

[7] http://data.worldbank.org/sites/default/files/subsoil_and_forest_rents.xls

[8] http://www.swfinstitute.org/

[9] http://aiddata.org/

the Federal Reserve of St. Louise.[10] Therefore, the fixed share that is saved annually, S, can be calculated as $S = \frac{SWF_{2008}}{\sum_{j=y_0}^{2008}\left[\prod_{i=j+1}^{2008}(1+r_i)\right]\cdot Rent_j}$,[11] in which$SWF_{2008}$ is the size of fund in 2008, y_0 is the year the SWF was established, r_i is the annual return on DJIA[12], and $Rent_t$ is the total rent in year t. All are in current prices. Using S, one can calculate the savings in SWFs every year, $SSWF_t$, as follows: $SSWF_t = S \cdot Rent_t$.

There are, however, three empirical issues with the calculations. First, to calculate the counterfactual capital stocks, one needs available rent in 2005 dollars, since the actual capital stock and investments are in 2005 dollars. Therefore, after calculating the available rent ($R_t = Rent_t - SSWF_t - Aid_t$), it is deflated to get the number in constant 2005 dollars. Second, note that in the numerator of the equation for S, we have SWF_{2008} instead of SWF in any other year, like 2013. This is because we only have rents data (the denominator) available until 2008.[13] Third, some countries, like the United Arab Emirates, have several sovereign wealth funds that began in different years. S was calculated for each fund separately and then were added to each other when those funds overlap in a year. Fourth, the data on total rents are available only since 1970, but the SWF for Kuwait and potentially Saudi Arabia were established before 1970. If one assumes that these funds were established in 1970, the amount of savings each year is overestimated. Therefore, the counterfactuals of capital and income will be underestimated. One should take this into account when looking at the results for Kuwait and Saudi Arabia. Table A.1 in the Appendix reports the SWFs for various countries, their year of inception, and the calculated S for each.

Finally, data on public expenditures on education are obtained from the World Bank Development Indicators.

4. Results

Table 1 provides the results for the actual capital stock as well as counterfactual capital stocks based on net zero saving (the Hartwick rule), constant genuine saving, and maximum of constant genuine saving and the actual net investment. As discussed, for the actual capital stock to be calculated, 20 years of prior data are necessary. The second column reports the first year for which it is possible to calculate capital stock. For most oil producing countries in MENA, the first year is 1989, although there are a few exceptions, such as for Egypt and Iran. In the third column, the 2008 actual physical capital stock, calculated based on PIM (Equation 1), is reported.

In the next columns, the ratios of various counterfactual capital stocks in 2008 relative to actual capital stock were estimated. H stands for counterfactual based on the Hartwick rule, G for constant genuine saving, and M for maximum of genuine saving and actual net investment. One can see that the three ratios (H, G, and M) for all countries are larger than one, meaning that these countries could have had a larger capital stock in 2008 if they had followed the counterfactual investment

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[10]https://research.stlouisfed.org/fred2/series/DJIA/downloaddata

[11]Here is how this equation is found: the savings in SWF in year $t$is $SSWF_t = S \cdot Rent_t$. These savings accrue interest over time. Suppose savings happen at the end of the year when all revenues from oil and gas are materialized. This means that savings in year t start to accrue interest from the following year. Hence, savings that took place in year t will increase in size to $\prod_{i=t+1}^{2008}(1+r_i)\cdot SSWF_t$in year 2008. Therefore, the size of the fund in 2008, which is the sum of all savings and their accrued interest, is $SWF_{2008} = \sum_{j=y_0}^{2008}\left[\prod_{i=j+1}^{2008}(1+r_i)\right]\cdot SSWF_j = \sum_{j=y_0}^{2008}\left[\prod_{i=j+1}^{2008}(1+r_i)\right]\cdot S \cdot Rent_j$. Using this equation, one can find S as shown in the text.

[12]It is the percentage change in DJIA from the beginning to the end of a year.

[13]But another problem that arises is that only SWF in 2013 (not 2008) is in the data. Therefore, one has to find SWF in 2008 based on the available data (SWF in 2013). Since we assumed that SWF changes over time based on how DJIA changed, we can calculate SWF in 2008 by dividing SWF in 2013 by the return on DJIA from 2008 to 2013 (i.e. 1.889).

rules. For instance, for Qatar and United Arab Emirates, which have the lowest ratios, the capital stock in 2008 would have been 1.4 times larger if they had followed the Hartwick rule. For Libya, which has the largest ratios, the Hartwick capital stock is 8.4 larger than the actual in 2008. These ratios were also calculated for non-oil producing countries,[14] such as Morocco, and not surprisingly, a smaller than one ratio was obtained.

Not surprisingly, the counterfactual capital stock using the constant genuine savings rule is larger than the one for the Hartwick rule. Interestingly, ratios in columns G and M are the same for each country. This shows that net investment was never larger than the genuine savings. Therefore, the counterfactual capitals using equations (3) and (4) are identical for these countries. Hence, the rest of the table only reports the counterfactuals using the Harwick rule (H), and the genuine savings (G).

It is not fair to compare these ratios (H, G, or M) across countries. Consider Algeria and Egypt. For both, the ratio for Hartwick rule is two (2.0). That means in 2008, they could have had twice as much capital stock if they had followed the Hartwick rule. It implies that these two countries have similar outcomes. But a closer look reveals that the initial years between these countries are different. The ratio (2.0) is calculated for Algeria based on 30 years of investment (1979 to 2008), but for Egypt it is based on 39 years (1970 to 2008). Algeria achieved this ratio faster than Egypt. This means that if these two countries are given the same amount of time, the ratio for Algeria will be larger than for Egypt. In other words, Egypt is doing better than Algeria, but this is not clear from the Hartwick ratios that are shown in these columns. Hence, to get comparable numbers for the performance of these countries it is better to look at other measures, such as the growth rate of capital formation. The rest of the table shows such measures.

The next columns depict how fast these countries should have increased their capital stock. Consider Algeria and Egypt again, for which the Hartwick ratios were the same (2.0). Looking at growth rates, one finds that the difference between the growth rates of counterfactual capital stock and actual capital stock in Egypt (9.3–7.4 = 1.9) is smaller than Algeria's (5.1 - 2.5 = 2.6). This means that Egypt is closer to the Hartwick growth rates and hence performed better than Algeria since the lower this difference, the better. The growth rates show that Libya is the only country for which capital stock decreased from 1989 to 2008 (-2.2% capital stock growth). It also has the largest difference between the actual and counterfactual capital stock growth rates (10.1 – (-2.2) = 12.3%). It is followed by Iraq (8.7%), Kuwait (7.6%), and Saudi Arabia (7.5%). United Arab Emirates, Egypt, and Qatar have the lowest difference (1.8%, 1.9%, and 2.1% respectively.)

To understand, for instance, how much a 7.6% and an 8.7% growth rate differ from each other, one can look at the size of the capital stock that these two growth rates create after, say, 40 years. The last two columns of this table show the size of the counterfactual capital relative to the actual capital stock 40 from the initial year based on the growth rates reported in the Table. The results show that over a 40 period, these growth rates translate into two to 114.7 times larger capital stocks.[15] Qatar and the United Arab Emirates have the best record, while Libya has the worst. For example, Libya should have around 115 times more capital than it now has if it invests according to the zero savings rule. Even though Qatar and the United Arab Emirates enjoy very large natural

[14] Not reported in the table.

[15]One can predict the ratio of counterfactual to actual GDP 40 years after the initial year by $\left(\frac{1+g_j}{1+g_a}\right)^{40}$ in which j stands for H, G, and M and a stands for actual.

resource rents and have more incentives to consume large sums of the rents, they manage to invest a bigger portion than other resource rich countries such as Libya and Saudi Arabia.

But these numbers on counterfactuals of capital stock do not give a clear sense of how much the country would be richer, in terms of income. As explained in Section 2, one can assume that all available rent is invested domestically and contributes to income through a constant return to scale Cobb-Douglas production function (first method), or it is invested abroad and therefore the return on these investments will increase income (second method).Tables 2 and 3, which are similar in organization to Table 1, report the results for the first and second methods respectively.

Consider the columns in Table 2 that depict the growth rates for counterfactual and actual capital stocks. They show that the counterfactual growth rates using the Hartwick rule are between 0.2 (for Egypt, Iran, Qatar, and UAE) to 1.9(for Saudi Arabia) percentage points larger relative to the actual growth rate. Over a 40 year period, these growth rates translate to 11% to100% more income. Using constant genuine savings, the growth rate is 0.4 (again for Egypt, Iran, Qatar, and UAE) to 2.0(again for Saudi Arabia) percentage points larger, relative to the actual growth rate. In 40 years, this translates to around 15% to 108% more income. The best performing economies are in Egypt, Iran, Qatar, and the UAE, while the worst are in Saudi Arabia and Iraq. Having been through 14 years of war and civil war in the last three decades, it is not surprising to see that Iraq has not done well.

In Table 3, consider the columns showing the counterfactual income relative to actual income after 40 years. Comparing the results with those in Table 2, one finds that all income counterfactuals are smaller in Table 3, although for most countries, these estimates are not that different from Table 2. But for Saudi Arabia and Kuwait, for example, the difference is quite pronounced. For Saudi Arabia, Table 2 shows that the income counterfactual is almost twice as large as actual income forty years later. But, Table 3 reports the income counterfactual to be only 1.27 times larger. One may argue that for countries which seem to have reached their physical capital stock capacity, such as Saudi Arabia and Kuwait, the first method (using a Cobb-Douglas production function) overestimates the counterfactual income, while the second method (investing abroad and receiving 3.3% in returns) gives a more feasible income counterfactual.

It would be interesting to see how much the results in Table 3 are sensitive to the assumption of 3.3% return on investments abroad. The last two columns of Table 3 report the elasticity of the ratio of income counterfactuals to actual income after 40 years from the initial year, with respect to the return on assets abroad (the 3.3% return). Consider the elasticity for Syria, which is 0.10 (for counterfactual based on the Hartwick rule): if the return on investments abroad increases by 1% (not percentage point; i.e. 0.033 percentage points increase over 3.3%), Syria's ratio of income counterfactual relative to actual after 40 years from the initial year increases by 0.10% (or $0.0010 \times 1.10 = 0.0011$ percentage points). For example, when the return on investments abroad increases to 4% (from 3.3%), it is roughly a 21% change and that means the counterfactual income increases by $21 \times 0.10 = 2.1\%$ (or $0.021 \times 1.10 = 0.0231$ percentage points). The largest elasticity belongs to Libya (0.24) and Saudi Arabia (0.23), meaning that the results for these countries is more sensitive to the assumed returns than others. But even for them the sensitivity is tiny.

Asheim et al. (2003) shed doubts on whether the Hartwick rule can be really applied in practice. One reason, among others, is that even if the current policy makers commit themselves to invest resource rents, they cannot commit future policy makers to do the same. It is, in essence, politically very difficult to implement such policies over a long time. There are different interest groups and constituencies that require consumption of rents. One way to address this criticism is to calculate income counterfactuals allowing for part of rents to be consumed rather than invested. Here, we find the counterfactuals of capital and income if there are deviations from the idealistic Hartwick and genuine savings rules. In other words, if a part of rents is spent on consumption categories, such as providing subsidies on basic food or anti-poverty programs, how much do the results change? Figures 1(a)-1(b) show the Hartwick counterfactuals of income after 40 years from the initial year (using the second method) over the dollar amount of oil and gas rent spent on consumption per person. For example, Figure 1(a) for Algeria shows that if nothing from the oil and gas rent is spent on consumption, the counterfactual of income is around 1.12 times the actual income. As more dollars from rent are spent on consumption this ratio decreases. The ratio becomes equal to one if US$450 per person from the rent is spent on consumption. Figure 1(a) covers countries in the MENA region with high oil and gas rent per capita. Therefore, the horizontal axis covers a large range from zero to $8000. Figure 1(b), however, depicts countries with low oil and gas rent per capita. Hence, the horizontal axis only needs to cover a smaller range (i.e. from zero to $1000.)

The ratio of counterfactual income to actual income 40 years from the initial year becomes equal to one for countries in Figures 1(a) and 1(b): Bahrain at US$2,600, Kuwait at US$8,000, Libya at US$3,300, Oman at US$3,150, Qatar at US$4,050, Saudi Arabia at US$4,000, UAE at US$2,550, Egypt at US$100, Iran at US$500, Iraq at US$700 and Syria at US$250. One can also calculate the elasticity of the counterfactual income relative to oil and gas rent dollars spent on consumption. For instance, the elasticity for Algeria is -0.10, which means that a one percent increase in consumption of oil and gas rents reduces the ratio of counterfactual to actual income in 40 years by 0.10%. The other elasticities are-0.12 for Bahrain, -0.16 for Kuwait, -0.27 for Libya, -0.18 for Oman, -0.03 for Qatar, -0.26 for Saudi Arabia,-0.04 for UAE, -0.04 for Egypt, -0.12 for Iran, -0.18 for Iraq, and -0.11 for Syria.

One may say that these countries also invested significantly in their human capital and therefore they could not invest all their oil and gas rents in physical capital per the genuine savings rule or even the Hartwick rule. Hence, these results overestimate the counterfactual capital stock and income. Assuming that the source of investments in human capital are the oil and gas rents, similar to savings in SWF and development aid, one can subtract the expenditure on human capital from the oil and gas rents to come up with the amount of rents available to be invested in physical capital. This amount can be used in place of R_t in Equations (2), (3), and (4).

This paper uses public expenditure on education as a measure of expenditure on human capital. The World Development Indicators website has public expenditure on education as a percent of GDP; this can be multiplied by GDP in constant dollars to give us the variable of interest. Unfortunately, this variable is not available for every year since 1970. Table 4 shows how many observations are available for each country over time. Libya, Bahrain, and Qatar, for example, have very few observations. To increase the number of observations, interpolation can be used. If we have data for the years before and after the years for which this variable is missing, we can interpolate the available data to come up with the missing ones. The number of observations will increase compared to those listed in the right column of Table 4. For example, for Oman, the number of observations increases from 24 to 31, while we do not gain any more observations for Bahrain. As a result, only countries for which we have enough observations (i.e. Egypt, Iran, Kuwait, Oman, Qatar, Saudi Arabia, and Syria) can be used in this analysis.

Subtracting this from the total oil and gas rents would give us the available rent for investment in capital. Using this in place of R_t, one can calculate new counterfactuals of capital stock and income. These are reported in Tables 5, 6, and 7. Table 6 uses the Cobb-Douglas production function to estimate the income counterfactuals and Table 7 reports income from investments in offshore accounts. It is more reliable to look at investments in offshore accounts for countries that have large oil and gas rents relative to their population, such as Kuwait and Saudi Arabia.

Not surprisingly, the ratios of the counterfactuals to actuals (for both capital and income) become smaller. However, they are only slightly smaller, which means public expenditure on education in these countries was significantly smaller than the amount of rent generated. Nevertheless, one can see that Qatar has done better than what the Hartwick rule suggests, while Egypt is not far behind. However, countries like Saudi Arabia and Kuwait could have had about 23% more income (Table 7) if they had followed the Hartwick rule.

5. Conclusion

The fact that for all countries, following the zero-net savings (the Hartwick rule) would have led to higher incomes, let alone constant genuine savings, is an important indication that their macroeconomic policy needs revision. What needs to be done is careful examination of where the oil rent is directed. Oil and gas revenues should not be used to fund day-to-day operations of governments. Instead, they should only be used for investment purposes. One policy is to enact checks and balances, such as laws limiting the power of governments to assign these revenues to anything apart from investment. Moreover, governments may be required to balance their operational budget with only tax revenues.

Some governments invest their natural resource rents in projects that later lead to an increase in operational expenses without social returns. For example, oil and gas revenues would be invested in earmarks such as building infrastructure (a road or an airport, for instance), which have low social returns. Even though these earmarks are investments, they eventually increase operational expenses without providing enough returns and therefore, force governments to use natural resource revenues to pay for their upkeep in the future. By limiting the usage of natural resource rents, governments are forced to calculate long-run benefits and costs and avoid projects that are not economically sound. This would raise the rate of return on national projects. Moreover, binding governments to follow the Hartwick rule or better, constant genuine savings rule, may reduce corruption.

While some countries are doing relatively better, for others the income could have been significantly larger than what it is today. Not surprisingly, these are countries with the least checks and balances. This re-emphasizes the importance of institutions in the implementation of socially beneficial policies. At the same time, Tsani (2013) shows that resource funds can improve institutional and governance quality and lessen the deterioration caused by resource abundance.

Better informed elites do not necessarily lead to better policies, as elites also care about their personal long-term welfare that might be hurt by these policies. However, a new model by Rodrik (2013) argues that new and better policy ideas might be able to affect the outcomes even if the political structure does not change for the better. One hopes the results of this study lead to actual changes in policies, rather than just becoming another source of information for policy makers.

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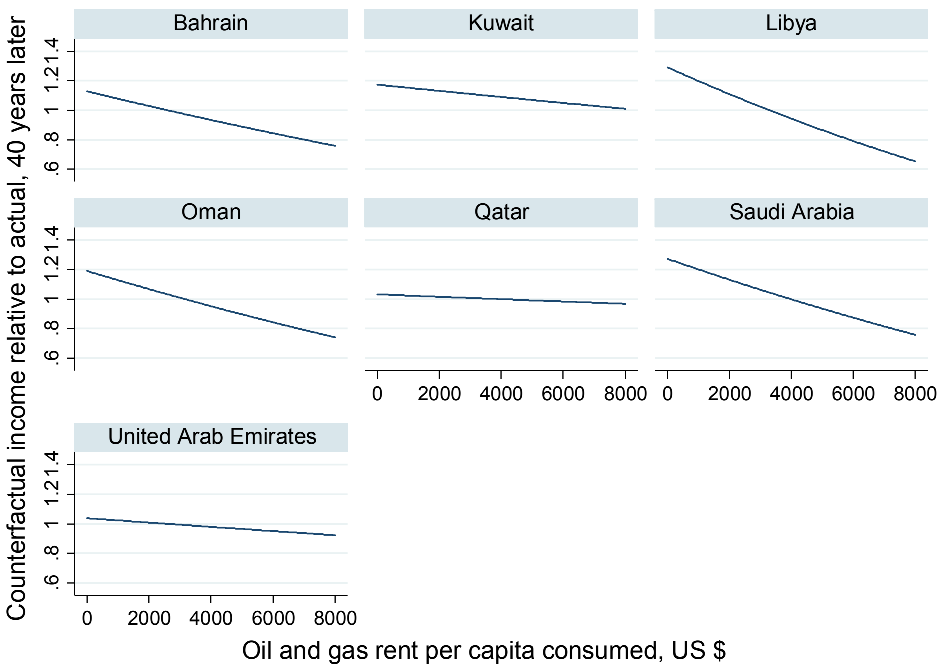
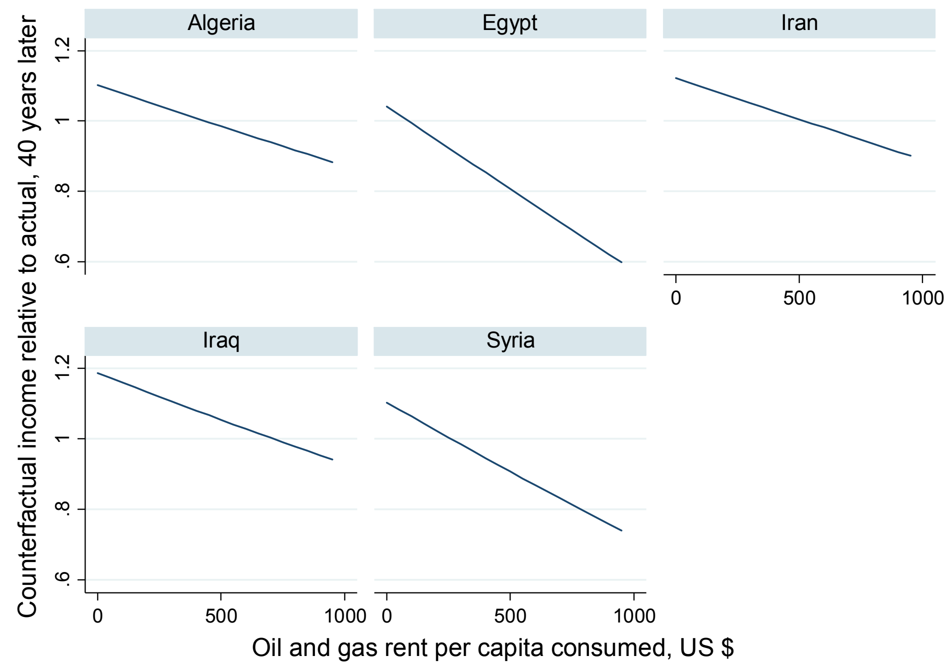
Figure 1: Change in Counterfactual Income (Second Method) As More Rent Is Consumed



(a)



(b)

Note: The counterfactual income is estimated based on the assumption that (part of) oil and gas rents are going to be invested abroad with an annual return of 3.3%. The figures show how incomes 40 years later would change as more of the oil and gas rents are consumed (and less is invested abroad). The ratio of counterfactual income to actual income 40 years from the initial year becomes equal to one for the following countries respectively: Bahrain at US$26,000, Kuwait at US$8,000, Libya at US$3,300, Oman at US$3,150, Qatar at US$4,050, Saudi Arabia at US$4,000, Egypt at US$100, Iran at US$500, Iraq at US$700, Syria at US$250, and the UAE at US$2,550.

Table 1: Actual and Counterfactual Capital Stocks

Country	Initial year	Actual capital stock in 2008 (in B.of 2005 US $)	Counterfactual capital stock in 2008 relative to actual			Average annual growth rate in capital stock (in %)			Counterfactual capital stocks relative to actual, 40 years after the initial year	
			H	G	M	Actual	H	G	H	G
Algeria	1979	337	2.0	2.4	2.4	2.5	5.1	5.7	2.7	3.3
Bahrain	1989	32.3	2.1	2.3	2.3	3.3	7.5	7.9	4.9	5.7
Egypt	1970	187	2.0	2.6	2.6	7.4	9.3	10.1	2.0	2.7
Iran	1974	744	2.4	2.7	2.7	4.2	6.9	7.3	2.8	3.3
Iraq	1989	87.0	4.6	5.4	5.4	3.8	12.5	13.4	25.0	34.4
Kuwait	1989	122	3.7	3.9	3.9	7.2	14.7	15.1	15.4	17.2
Libya	1989	42.8	8.4	9.3	9.3	-2.2	10.1	10.7	114.7	143.1
Oman	1989	74.4	3.0	3.2	3.2	4.4	10.6	11.0	10.0	11.5
Qatar	1989	113	1.4	1.5	1.5	10.1	12.2	12.6	2.2	2.4
Saudi Arabia	1989	589	3.8	4.0	4.0	3.2	10.7	11.1	16.3	18.7
Syria	1979	41.1	3.7	4.3	4.3	4.1	8.9	9.5	6.0	7.4
United Arab Emirates	1989	391	1.4	1.6	1.6	2.8	4.6	5.2	2.0	2.6

Note: Three counterfactuals of capital stock are estimated based on the Hartwick rule (shown in columns heading H), constant genuine saving (shown with G), and maximum of genuine saving and net investment (shown with M).Capital stock based on the Hartwick rule is calculated using $K_{2008}^{H} = K_{19xx} + \sum_{t=19xx}^{2008} R_t$, K_{19xx} is the capital stock in the initial year, and R_t is the oil and gas rent in year t. Capital stock with constant genuine saving is calculated using $K_{2008}^{G} = K_{19xx} + \sum_{t=19xx}^{2008}(I^G + R_t)$, and I^G is the 'genuine saving is equal to 5% of GDP in 1990 (1989 for Iraq). Capital stock based on maximum of constant 'genuine saving' and net investments is $K_{2008}^{M} = K_{19xx} + \sum_{t=19xx}^{2008} max(NI_t, I^G + R_t)$ in which K_{2008}^{M} is, NI_t is the net investment in year t.

Table 2: Actual and Counterfactual Incomes – Investing in Domestic Physical Capital

Country	Initia l year	Actual income in 2008 (in B. of 2005 US $)	Counterfactual income in 2008 relative to actual			Average growth rate in income (in %)			Counterfactual incomes relative to actual, 40 years after the initial year	
			H	G	M	Actual	H	G	H	G
Algeria	1979	159	1.11	1.14	1.14	2.6	3.0	3.1	1.16	1.20
Bahrain	1989	20.3	1.12	1.13	1.13	7.1	7.7	7.8	1.26	1.29
Egypt	1970	151	1.11	1.15	1.15	4.3	4.5	4.6	1.11	1.16
Iran	1974	330	1.12	1.14	1.14	2.5	2.9	2.9	1.14	1.17
Iraq	1989	122	1.25	1.28	1.28	3.1	4.3	4.4	1.61	1.69
Kuwait	1989	136	1.20	1.21	1.21	7.5	8.5	8.5	1.47	1.49
Libya	1989	86.4	1.16	1.17	1.17	4.4	5.3	5.3	1.39	1.42
Oman	1989	56.1	1.17	1.19	1.19	7.8	8.8	8.8	1.40	1.43
Qatar	1989	107	1.06	1.06	1.06	13.7	14.0	14.1	1.12	1.14
Saudi Arabia	1989	441	1.39	1.42	1.42	6.4	8.3	8.4	2.01	2.08
Syria	1979	48.7	1.21	1.24	1.24	2.7	3.4	3.5	1.30	1.34
United Arab Emirates	1989	292	1.05	1.07	1.07	8.8	9.0	9.1	1.11	1.15

Note: Counterfactuals of income are calculated based on plugging capital counterfactuals in a constant return Cobb-Douglas production function, $y_t = A_t L_t^{1-\alpha} K_t^{\alpha}$. See notes for Table 1 on how capital counterfactuals are calculated. Assuming that technology and human capital change the same way as they actually changed under counterfactual scenarios, it can be shown that $y_{j,2008} = \left(\frac{K_{j,2008}}{K_{a,2008}}\right)^{\alpha} y_{a,2008}$ in which $j = H, G$ and $y_{a,2008}$ is the actual income in 2008. See the text for more information.

Table 3: Actual and Counterfactual Incomes - Investing Abroad

Country	Initial year	Actual income in 2008 (in B. of 2005 US $)	Counterfactual income in 2008 relative to actual			Average growth rate in income (in %)			Counterfactual incomes relative to actual, 40 years after the initial year		Elasticity*	
			H	G	M	Actual	H	G	H	G	H	G
Algeria	1979	159	1.09	1.12	1.12	2.6	2.9	2.9	1.10	1.14	0.09	0.12
Bahrain	1989	20.3	1.07	1.08	1.08	7.1	7.4	7.5	1.13	1.15	0.12	0.13
Egypt	1970	151	1.05	1.08	1.08	4.3	4.4	4.4	1.04	1.07	0.04	0.06
Iran	1974	330	1.12	1.16	1.16	2.5	2.8	2.9	1.12	1.15	0.11	0.14
Iraq	1989	122	1.10	1.12	1.12	3.1	3.5	3.6	1.19	1.23	0.17	0.20
Kuwait	1989	136	1.10	1.10	1.10	7.5	7.9	7.9	1.17	1.19	0.15	0.17
Libya	1989	86.4	1.15	1.17	1.17	4.4	5.1	5.1	1.29	1.33	0.24	0.27
Oman	1989	56.1	1.10	1.12	1.12	7.8	8.3	8.4	1.19	1.21	0.17	0.18
Qatar	1989	107	1.02	1.02	1.02	13.7	13.8	13.8	1.03	1.04	0.03	0.04
Saudi Arabia	1989	441	1.15	1.16	1.16	6.4	7.0	7.1	1.27	1.30	0.23	0.25
Syria	1979	48.7	1.09	1.11	1.11	2.7	3.0	3.0	1.10	1.13	0.10	0.12
United Arab Emirates	1989	292	1.02	1.03	1.03	8.8	8.9	8.9	1.04	1.05	0.04	0.05

Note: Counterfactuals of income are calculated assuming that all available rent is invested abroad and accrues an annual average return of 3.3%. * The columns on the furthest right show elasticity of income counterfactuals relative to actual (40 years after initial year) with respect to the annual average return of 3.3%.

Table 4: Number of Observations for Public Expenditure on Education Across countries

Country	Number of observations: Raw data	With Interpolation
Bahrain	3	3
Egypt	23	38
Iran	31	40
Iraq	3	13
Kuwait	24	36
Libya	1	1
Oman	24	36
Qatar	9	38
Saudi Arabia	23	28
Syria	29	38
United Arab Emirates	6	8

Source of data: World Development Indicators.

Table 5: Actual and Counterfactual Capital Stocks Considering the Public Education Expenditure

Country	Initial year	Actual capital stock in 2008 (in B. US $)	Counterfactual capital stock in 2008 relative to actual			Average annual growth rate in capital stock (in %)			Counterfactual capital stocks relative to actual, 40 years after the initial year	
			H	G	M	Actual	H	G	H	G
Egypt	1970	187	1.4	2.0	2.0	7.4	8.3	9.3	1.4	2.1
Iran	1974	744	2.0	2.4	2.4	4.2	6.3	6.9	2.3	2.7
Kuwait	1989	122	3.2	3.4	3.4	7.2	14.0	14.4	11.8	13.4
Oman	1989	74.4	2.8	3.0	3.0	4.4	10.1	10.6	8.5	9.9
Qatar	1989	113	1.3	1.4	1.4	10.1	11.7	12.0	1.8	2.0
Saudi Arabia	1989	589	3.3	3.6	3.6	3.2	9.9	10.4	12.4	14.5
Syria	1979	41.1	2.9	3.5	3.5	4.1	8.0	8.7	4.3	5.6

Note: Please see the notes for Table 1 for more information. Here, public expenditure for education was subtracted from oil and gas rent and the result was used in place of R_t in Equations (2), (3), and (4).

Table 6: Actual and Counterfactual Incomes Considering the Public Education Expenditure – Investing in Domestic Physical Capital

Country	Initial year	Actual income in 2008 (in B. US $)	Counterfactual income in 2008 relative to actual			Average growth rate in income (in %)			Counterfactual incomes relative to actual, 40 years after the initial year	
			H	G	M	Actual	H	G	H	G
Egypt	1970	151	1.05	1.11	1.11	4.3	4.4	4.5	1.05	1.11
Iran	1974	330	1.09	1.12	1.12	2.5	2.8	2.8	1.11	1.14
Kuwait	1989	136	1.18	1.19	1.19	7.5	8.4	8.4	1.41	1.44
Oman	1989	56.1	1.16	1.17	1.17	7.8	8.7	8.8	1.37	1.40
Qatar	1989	107	1.04	1.05	1.05	13.7	14.0	14.0	1.09	1.11
Saudi Arabia	1989	441	1.35	1.37	1.37	6.4	8.1	8.2	1.88	1.95
Syria	1979	48.7	1.17	1.20	1.20	2.7	3.3	3.4	1.24	1.29

Note: Please see the notes for Tables 1 and 2 for more information. Here, public expenditure for education was subtracted from oil and gas rent and the result was used in place of R_t in Equations (2), (3), and (4).

Table 7: Actual and Counterfactual Incomes Considering the Public Education Expenditure – Investing Abroad

Country	Initial year	Actual income in 2008 (in B. US $)	Counterfactual income in 2008 relative to actual			Average growth rate in income (in %)			Counterfactual incomes relative to actual, 40 years after the initial year		Elasticity*	
			H	G	M	Actual	H	G	H	G	H	G
Egypt	1970	151	1.02	1.05	1.05	4.3	4.3	4.4	1.02	1.04	0.02	0.04
Iran	1974	330	1.09	1.12	1.12	2.5	2.7	2.8	1.09	1.12	0.08	0.11
Kuwait	1989	136	1.08	1.09	1.09	7.5	7.8	7.9	1.14	1.16	0.13	0.14
Oman	1989	56.1	1.09	1.10	1.10	7.8	8.3	8.3	1.17	1.19	0.15	0.17
Qatar	1989	107	1.01	1.02	1.02	13.7	13.8	13.8	1.02	1.03	0.02	0.03
Saudi Arabia	1989	441	1.12	1.14	1.14	6.4	6.9	7.0	1.23	1.25	0.19	0.21
Syria	1979	48.7	1.06	1.08	1.08	2.7	2.9	3.0	1.07	1.10	0.07	0.09

Note: Please see the notes for Tables 1 and 3 for more information. Here, public expenditure for education was subtracted from oil and gas rent and the result was used in place of R_t in Equations (2), (3), and (4). * The columns on the furthest right show elasticity of income counterfactuals relative to actual (40 years after initial year) with respect to the annual average return of 4%.

Appendix

Table A1: Saving Rate for Each Sovereign Wealth Fund

Country Funds	Inception	S (in %)
Algeria	2000	15.4
Bahrain	2006	19.9
Iraq	2003	4.9
Kuwait	1953	10.1
Libya	2006	28.2
Oman - SGRF	1980	1.0
Oman - OIF	2006	5.3
Qatar	2005	75.3
Saudi Arabia - SAMA	N/A*	3.7
Saudi Arabia - PIF	2008	0.8
UAE - Abu Dhabi - ADIA	1976	21.9
UAE - Abu Dhabi - IPIC	1984	4.2
UAE - Abu Dhabi - MDC	2002	9.9
UAE - Dubai	2006	19.8
UAE - Federal	2007	3.7
UAE - Ras Al Khaimah	2005	0.3

Note: This is the list of funds formed prior to 2009.
Data source: www.swfinstitute.com and author's calculation.
* The year of inception for this fund is not available. Since its asset value is over $600 B. (larger than Kuwait fund) one may assume that it was formed prior to 1970. I chose 1970 as the initial year for this asset, which overestimates S.