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The Ownership of Oil, Democracy, and Iraq's Past, Present, and Future

W A Razzak

School of Economics and Finance, Massey University, PN, New Zealand

W A Razzak
Honorary Research Fellow
School of Economics and Finance
Massey University
Private Bag 11222
Palmerston North 4442
NEW ZEALAND
Email: razzakw@gmail.com

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W A Razzak
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School of Economics and Finance, Massey University, New Zealand

Abstract

We show that the share of oil in real output is relatively large, nearly 60 percent. Effectively, the government of Iraq– not the people – owns and manages the oil wealth. This dependence on oil as the main income is also consistent with the rentier economy and the Resource Curse phenomenon. The interest elasticity of oil production with respect to global oil consumption is greater than one. This high dependence on oil as income and the sensitivity of oil production to global oil consumption would not be sustainable in the future, where there is a growing global aversion to hydrocarbon production and consumption. The developed countries aim at zero carbon by 2050. We show that the expected decline in global consumption of oil has an adverse effect on the Iraqi economy. We provide stress tests and produce dynamic stochastic projections from 2020-2050 under a number of adverse scenarios. A quick transfer of ownership of oil to the Iraqi people should guarantee a functional democracy and a better future for the Iraqis.

Keywords Iraq, oil share, private ownership, FM-OLS, VAR, Stress testing

JEL Classifications C1, C53, D24, E17, Q3, Q34

1. Introduction

In March 1921, Churchill, the newly appointed Secretary of the State for the Colonies, announced the creation of new country, Iraq, in a large meeting with his advisers in Cairo. Although it is not entirely clear that the British involvement in Iraq early in the 20th century was only about oil, Churchill, as the First Lord of the Admiralty, "*was always on the lookout for new sources of oil for the Royal Navy, preferably from places under the British control. Up until then, most British oil for the Navy had come from the United States; but substantial oilfields were found in Persia. Churchill was quick to exploit them for British advantages*." *Oil explorations were underway in Iraq.* Colonel A. T. Wilson, the English acting ruler wrote in his later memories that in late 1918 *"oil is the only immediately available asset of the Occupied Territories, the only real security…"* (Catherwood, 2005). Oil plays a major role in the story of Iraq's past, present, and future.

"*In 1944, then-President Roosevelt showed the British ambassador a rough sketch he had made of the Middle East. Persian oil, he told the ambassador, is yours. We share the oil of Iraq and Kuwait. As for Saudi Arabian oil, it's ours*," the American historian Daniel Yergin described the exchange, see Shah (2004, p. 14) and Vitalis (2002).

Since 1921, Iraq's oil wealth was under total control of the government. The idea is that the Iraqi people cannot manage their own oil wealth. The government then provides *all* the services to the people, invested in infrastructure projects, education, and health from 1921 to 1962. Since 1963 to be precise, socialist autocratic military dictatorships established tight control over market activity, implemented social welfare policies, and distributed rent. What happened in 2003 is not significantly different. The Iraqi opposition before 2003 prepared itself for total control over the oil. They insisted that the constitution could not be written until after the first election. Therefore, the constitution does not reflect the aspirations of the majority of the Iraqi people but rather the desires of those who were positioned to win the election and form the first government. The political elite who won the first election after 2003, are effectively still in power. They have total control over oil revenues.

Article 109 of the constitution states,

"Oil and gas is the property of all Iraqi people in all the regions and provinces."

The constitution acknowledges that oil and gas belong to the Iraqis, but there is a wrinkle because Article 110, says,

"The federal government and the governments of the producing regions and provinces together will draw up the necessary strategic policies to develop oil and gas wealth to bring the greatest benefit for the Iraqi people, relying on the most modern techniques of market principles and encouraging investment."

The Article states that the government controls, manages oil revenues and public spending, and redistributes the *rent* in a fashion similar to what has been happening in the past 85 years or so. It seems clear that the constitution maintains the old rules under the old assumptions of government agent's benevolence and omniscience. Boettke *et al.* (2006) cite Buchanan (1969, pp. 77-92) who questioned such assumptions. The rulers of the past Iraqi regimes since the birth of the country in 1921, and increasingly after 1963, chose political and economic institutions that inhibited individual freedom and creativity and eventually were responsible for the backwardness of the Iraqi society and its dismal economic performance.

At present, the government of Iraq's White Paper (2020) explains that the causes of the financial problems that gripped the country after the sudden fall in oil prices in March 2014, and COVID-19 have deeper structural roots. It says,*"The imbalance in the economic structure is the sum of accumulated public and economic policies since the 1970s – employing the growing oil revenues as a tool to amplify the role of the state in the economy and society through expanding: (i) the public sector; (ii) direct and indirect control of the economy by the state; and (iii) the rentier role of the state in public service delivery to the society. Opportunities have existed to change this course in 2003. However, the new political regime wasted and misused those opportunities, as it was unable to create a free and diversified economy in accordance with the principles approved by the constitution, and continued to apply the previous philosophy, with the emergence of new power centers, and trends towards…etc.*"

The repeatedly stated objective of diversifying the sources of income away from oil, whether in Iraq or in most of the Gulf Cooperation Council countries (GCC) is not new; it would be quickly forgotten when the price of oil is high.

Political and economic institutions matter for economic growth and prosperity (e.g., Acemoglu *et al.* 2005). However, almost all oil-producing countries regardless of their political and economic institutional arrangements suffered from sharp budget deficits after the negative oil price shock in March 2014. Iraq is a classic rentier economy case just like the GCC, Iran, or Venezuela. They too have budget deficits although different institutional arrangements.

In this paper, we examine the impact of oil on the past, the present and the future of the Iraqi economy. First, we show the historical oil-dependency by estimating the share of oil in *real* GDP from 1970 to 2019, and compare it to the shares in other oil producing countries, namely the GCC countries. To estimate the share, we examine the nature of the trend in the time series, and then estimate the share of oil in real GDP in addition to the shares of labor, capital, and human capital by fitting a log-linear Cobb-Douglas production function by FM-OLS (Phillips – Hansen, 1990).

Second, at present, there is a global push to reduce current and future hydrocarbon consumption and production because of global warming. Globally, politicians together with businesses and the support of popular movements are taking actions to induce reduction in hydrocarbons demand and production. Because the target is zero carbon by 2050, the global demand for hydrocarbon products is expected to fall between now and 2050. The U.S. government is leading the charge by introducing more than 4 trillion dollars in subsidies to sectors that are affected by the cut in hydrocarbon, International Renewable Energy Agency (IRENA). The IAE latest flagship report (2021) says, "*Building on the IEA's unrivalled energy modeling tools and expertise, the Roadmap sets out more than 400 milestones to guide the global journey to net zero by 2050. These include, from today, no investment in new fossil fuel supply projects, and no further final investment decisions for new unabated coal plants. By 2035, there are no sales of new internal combustion engine passenger cars, and by 2040, the global electricity sector has already reached net-zero emissions."*

Investments in alternative energy are also trending up, including in China, see Bloomberg NEF Clean Energy Investment Trends (2020). The Economist magazine May 22, 2021 edition has a story entitled, *"The Green Meme, a Green Bubble? We Dissect The Investment Boom," where they show that "Since the start of 2020 our portfolio, when companies are equally weighted, has more than doubled; when firms are weighted by market capitalization, our portfolio has jumped by more than half. The reason for that difference is that many green firms are small—their median market capitalization is* *about $6bn—and the tiddlers have gone up the most. The smallest 25% of the firms have risen by an average of 152% since January 2020. Firms that derive a greater share of their revenue from green activities, such as ev-makers and fuel-cell companies, have also outperformed. The greenest 25% of firms saw their share prices rise by 110%.*"

There is an increasing agreement that the world is heading towards greener investments, a decline in the hydrocarbon economic activities, and rise in non-fossil fuel energy activities. A decline in global demand and consumption of fossil fuel is highly anticipated. For these reasons, we examine the relationship between Iraq's oil production and global consumption of oil, and show that there is a statistically significant long-run relationship between Iraq's oil production and global oil consumption. Iraq oil production is highly sensitive to global oil consumption.

Third, we then study the impact of a decline in oil production on the Iraqi economy – in response to decline in global demand – on the economy up to 2050. We use the data to fit an unrestricted VAR, solve it, and generate dynamic stochastic baseline projections of real GDP to 2050. Then we examine three *stress-testing* scenarios, low, medium, and severe, where oil production tumbles in response to the expected decline of global demand for hydrocarbons because of global movements to deal with climate change. Under each scenario, we solve the model, generate dynamic stochastic projections of real GDP, and show the deviations from the baseline production.

We found that (1) the share of oil in real output is relatively high; however, it is high in the GCC countries too. (2) There is a statistically significant relationship between Iraq's oil production and global oil consumption. (3) The deviations of the dynamic stochastic projections under the three stress test scenarios from baseline, over the period 2020 to 2050, show significant decline in real GDP.

Finally, and based on the empirical evidence we argue that the future of Iraq's democracy under the current political and economic institutions is uncertain. Public policy, institutional and cultural changes needed to carry the country into the 21 century and to ensure the survival of democracy. There is only workable way to doing so and begins with an immediate actual transfer of oil wealth from the government to every Iraqi citizen.

The next section presents a description of the Iraqi economy with comparison to the Gulf Cooperation Council countries (GCC). Section (3) is a time series analysis, estimation of the shares, and stress testing. Section (4) is a policy discussion. Section (5) is a conclusion.

2. The Rentier Economy

The price of oil is exogenous, subject to global supply and demand unpredictable shocks, and beyond the control of any single country. It also behaves like an asset price; hence very difficult to predict. An unexpected sharp drop in the price of oil causes a budget deficit because oil is the main source of revenue. The inability to rationalize public spending, mostly social welfare and wages and salaries of the public sector, which is the largest employer, induces budget deficits. Lower oil prices also cause a decline in export values. Iraq (the GCC countries too) import's bill is sizable; it includes the cost of all consumer and capital goods. The inability of the government to rationalize spending in bad times causes a current account deficit. These are typical pictures of the rentier economies. Import licenses are a sort of corruption; the governments distribute them exclusively to cronies and clients. Iraq and the GCC countries have no history of external borrowing, but external borrowing has increased after the 2014 adverse oil price shock, except Kuwait. Figure (1) plots the budget deficit – GDP, current account – GDP, and the external debt – GDP ratios.[i] Iraq external debt increased significantly after the change in the regime in 2003; it fell nicely over time, but it is relatively very high. The IMF estimate is 81 percent of GDP in 2020. It is approximately 11 percent in Kuwait, 81 percent in Oman, 71 percent in Qatar, 32 percent in Saudi Arabia, and 38 percent in the UAE.

In addition to the occasional financial and budgetary problems, which usually result from unexpected drop in oil price below the breakeven price, Iraq (GCC countries and the developing oil producing countries) problems include very low productivity growth. The Conference Board reports estimates of total factor productivity (TFP) growth. Iraq has zero to negative growth rates for most of the period from 1990 to 2019. Figure (2) plots the data.

Low productivity growth is consistent with the Resource Curse, the phenomenon of countries with abundant natural resources having low economic growth rates, autocratic or dictatorships political systems, or worse development outcomes than countries with fewer natural resources. There are a number of theories for the Resource Curse. For evidence in the Arab, oil-producing countries see for example, Elbadawi and Gelb (2010), Elbadawi, and Soto (2012).

For labor productivity, figure (3) plots the Conference Board estimates of average output per employed person over the period 1950-2019 (in 2019 USD) for Iraq (and the GCC countries). Iraq has the lowest income per worker since 1950. Therefore, low productivity is a chronic problem and not all related to any particular government. Since Iraq is considered a rentier economy, figure (4) plots an estimate of oil rent as a percent of GDP for Iraq (and the GCC countries) for 1975 and 2019 because the time series is incomplete. While a number of GCC countries improved over time slightly, the Iraqi and Kuwaiti economies remained unchanged. Many successive Iraqi governments since then were unable to diversify away from oil. Rent was about 40 percent of GDP in 2019.

Iraq has a vast hydrocarbons wealth. Figure (5) plots the proven oil reserves in 2018. Iraq is fifth after Venezuela, Saudi Arabia, Canada, and Iran. The most striking feature of the Resource Curse is poverty associated with vast natural resource wealth. There are many different measures of poverty, which are controversial. Figure (6) plots the percentage of urban population living in slums over a number of years. For Iraq (GCC countries do not have poverty measures) in 1990, just a year after the end of the Iraq-Iran war, there were about 3 million Iraqis lived in slums (16.9 percent of the population). The number increased to about 15 million people in 2005, a staggering 52.8 percent, and to more than 17 million people in 2014, 47.2 percent. These statistics suggest that Iraq is an oil-rich country and poor population. This bleak picture will persist unless there are serious attempts to change the culture, the political and the economic institutions.

The collapse of the oil price in March 2014 resulted in a sharp and sudden budget deficit, which reduced social welfare payments, failure of the government to pay wages, salaries, and pensions to millions of Iraqis, and increasing unemployment especially among young people.

The government's White Paper (2020) stated, "*The official figures for unemployment are 13.8% for 2018, and youth unemployment for those between (15-24) years is 27.5%. It is likely that these percentages have increased in the recent period.*" The popular uprising in October 2019 was a popular response to the dire economic conditions. Then COVID-19 delivered the final blow; it exposed the weakness of the Iraqi institutions. Note that Iraq is still without regular electricity supply since 2003. The government's White Paper (2020) provides some technical figures about this failed sector. The health and education systems are dysfunctional. The list of socioeconomic problems is long.

Next, we estimate the share of oil in output over history, from 1970 to 2019, where the data are readily available.

3. Estimating the Share of Oil in the Economy

The Cobb-Douglas production function is a typical microeconomic construct used in macro modeling. There is evidence that it is highly consistent with SNA data, where the shares of capital and labor are gross operating surplus / nominal GDP and compensations to employees / nominal GDP ratios respectively. Because the SNA data are not readily available, we estimate the shares by estimating the following log-linear Cobb-Douglas production function:

$$lnY_t = \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 lnH_t + \alpha_4 lnP_t^O + e_t, \quad (1)$$

where $Y_t$is real GDP; $K_t$is the stock of capital; $L_t$is labor; $H_t$is the human capital stock (based on the average years of schooling and the Minceran return to education); $P_t^O$is the real production of oil in barrels; and $e_t$is an error term with the usual classical assumptions. The inclusion of the first two explanatory variables, i.e., capital and labor, needs no further explanation. Human capital is an intangible capital; e.g., Mankiw *et al.* (1992) explain the importance of the inclusion of human capital in the Solow model production function. The last variable, i.e. oil production, is rather the most important in the case of oil-producing countries, and in Iraq, in particular because oil revenues are used in the creation of capital, labor, and human capital. Stiglitz (1974) for example, measures it as the ratio of resource utilization to the stock of natural resources, while Solow and Wan (1976) only use the flow of oil. The appendix has the data sources and measurement units.

The Data

Before we estimate equation (1), we examine the time series properties of the data, i.e., the nature of trend and cointegration. We assume that the Cobb-Douglas production function equation is correctly specified. We estimate the shares for Iraq (and the GCC countries for comparisons).[ii] We plot the data for Iraq and the GCC countries in logs in figure (7). All the data exhibit trends. The trend could be either deterministic or stochastic. A time series, which exhibits a deterministic trend, is trend-stationary, i.e., I(0) after de-trending it. A time series that exhibits a stochastic trend – i.e., a unit root, is said to be integrated of order (1), hence, I(1), and is differenced-stationary because the first difference operator removes the unit root, hence renders it stationary, an I(0).

For robustness, we test for trend and unit root using a number of commonly used tests, e.g., the Dickey - Fuller (1979) – Augmented Dickey-Fuller (Said and Dickey, 1984), the GLS (Elliot, Rothenberg, and Stock, 1996), and Phillips-Perron (1988). We also used the The Ng – Perron (2001) test, which is a modified Phillips – Perron, two test statistics Z_α and Z_t, Bhargava (1986), and finally the ADF with breakpoint. In applying these tests, we considered a number of specifications for robustness. We run the regressions in different specifications, without a constant, with a constant, and with a constant and linear trend. These specifications have different distributions. We also used a variety of Information Criteria – e.g., the AIC, SIC, HQ (and some modified versions of these criteria) to determine the lag structure.[iii] The output of these tests is quite large, therefore, we do not report these tables, and however, they are available on request.

None of these tests rejects the null hypothesis of unit root. However, we have to emphasize that these tests are weak – i.e., have low power against stationary alternatives and do not reject the null too often. There is a very large literature on the power of unit root tests. In addition, Stock (1991), Cochrane (1991), Rudebusch (1993), and Christiano and Eichenbaum (1990) argued that these tests could not distinguish between a root of one and 0.98 for example. Nonetheless, economists seem to agree that these variables, i.e., real GDP, capital, labor and human capital, are likely to exhibit unit root. We find the coefficient of the deterministic trend regressor only marginally significantly different from zero, which probably gives confidence in the unit root case.[iv]

Secondly, we test whether, or not, these five variables share a long run common trend, i.e., cointegrated – that is a stationary linear combination of the five variables. We use the Johansen's Maximum Likelihood Test, Johansen (1988, 1991 and 1995) and Johansen and Juselius (1990), λ- max (or maximum eigenvalue test) and the Trace statistics. It turned out that they do. We do not report the results but they are available on request. The results suggest that there is at least one significant cointegrtaion relationship, and at most two cointegrtion relationships, depending on the assumptions we made about the trend in the VAR. We tested the data under the assumption that there is no intercept and trend in the cointegration relationship; intercept but no trend in the cointegration relationship; and linear deterministic trend.

Estimation

Cointegration suggests that we could estimate the production function using an OLS in log-levels and fully modified OLS, i.e., FM-OLS (Phillips and Hansen, 1990), which is highly efficient, and accounts for endogeneity and serial correlation in the residuals.[v] Table (1) reports the FM-OLS results of the estimated shares for Iraq, and for comparison, Kuwait, Oman, Qatar, Saudi Arabia (KSA), and the United Arab Emirates (UAE), using a sample from 1970 to 2019. The results indicate that the share of oil in real GDP is significantly large. The shares are 0.57, 0.67, 0.90, 0.32, 0.70, and 0.20 for Iraq, Kuwait, Oman, Qatar (gas), Saudi Arabia, and the UAE. Iraq's share is relatively high. The UAE has the smallest share of oil because it has a relatively more diversified economy in Dubai in particular. The estimates, except for the UAE, are nevertheless, consistent with the Resource Curse and the rentier economy definitions.

The shares of the stock of capital are high, 0.40, 0.73, 0.95, 0.99, 0.32, and 0.43 for Iraq and the GCC countries (Kuwait, Oman, Qatar, KSA, and the UAE respectively). These estimates are not surprising for these countries, where a tremendous amount of capital is in real estate. However, labor input estimates are more interesting. Iraq's labor share is 0.14. The GCC labor shares are -0.46, -0.40, 0.20, and 0.33 for Oman, Qatar, Saudi Arabia, and the UAE respectively. Kuwait data has missing values for the period of the Gulf War I, hence has no estimate. Labor share is significantly negative in Oman and Qatar, small in Saudi Arabia too. The working age population includes unskilled expats in the GCC, which explains the negative and low signs of the estimates of human capital and labor.

The share of human capital is relatively high in Iraq, 0.51, however, negative is all GCC (Oman excluded because it does not report data on average years of schooling, which is required to compute the human capital index). Iraq had a superior education outcome up to 2003 and fewer imported low-skilled labor as in the GCC.

For FM-OLS estimator in particular, $R^2$is usually high because the explanatory variables include many lags, which induce over-fitting, thus we did not report it. We plot, instead, the *actual* log real GDP data against the estimated long-run relationship $\alpha' ln x_t$, where $x_t$is a vector includes the logs of K_t, L_t, h_t, and P_t^O. In other words, we exclude the dynamic part of the FM-OLS regression, which includes Δx_t and Δx_{t-k}. Figure (8) illustrates a closely tight long-run relationship for Iraq.[vi]

Note finally that the estimated total factor productivity (TFP) derived from equation (1) differs significantly from a typical Cobb-Douglas production function with only capital and labor inputs. Figure (9) plots total factor productivity index (2017=1) – TFP for Iraq, which we derived from our equation and TFP_PT, which the TPF reported by the Penn World table 10.0. Our measure of TFP is relatively higher.

To examine the future, we conduct a number of stress tests under alternative scenarios about oil production.

Stress tests

The estimates of the production function by FM-OLD indicate that there is a strong relationship between the level and the growth rate of real GDP with the level and the growth rate of oil production in Iraq. Figure (10) plots the growth-rates of these two variables. Recall that FM-OLS estimates the levels and the dynamics jointly. There is a relationship between lagged values of the explanatory variables, capital, labor, human capital, and oil production, and the dependent variable, i.e., current real GDP. The Iraqi economy was fully state-controlled during the period from 1970 before 2003. A higher oil production increases revenues at any give price of oil, and increases spending on education, hence human capital increased because the government invested in education from grade school to graduate school and paid for training of the labor force. Similarly, an increase in capital spending on infrastructure projects such as power generations, roads, schools, hospitals etc. increased real GDP. Human capital increases real GDP, and productivity. Employment also increased in response. Therefore, a VAR, where the *lags* of each variable affect the *current* values of the other variables, is a reasonable method for stress testing in this case.[vii]

Because oil is the only source of income, the Iraqi economy (the GCC too) is vulnerable to oil shocks. If global demand declines, Iraq's oil production has to decline too, otherwise the price will plummet, and that would have a significant adverse effect on revenues. To estimate the responsiveness of Iraq's oil production to global oil consumption (as a proxy for global demand), we test the null hypothesis "no cointegration" between Iraq oil production and global oil consumption using the bivarite Engle-Granger (1987) test. First, we regress the log of Iraq oil production on log global oil consumption using OLS; second, output the residuals and test them for unit root using the ADF test; and finally estimate an error-correction equation and test the hypothesis that the error correction term – i.e., the lagged residuals from the first regression, is zero. The two variables are cointegrated. Table (2) reports the statistics. Furthermore, the error correction term in the last regression is highly significant, which is a theoretically stronger test for cointegration than the ADF test in the second regression.

Given that Iraq's oil production and global oil consumption are cointegrated, we then estimate the point elasticity of Iraq's oil production with respect to global oil consumption to be 1.5. It suggests that a one percent increase (decrease) in global oil consumption leads to

1.5 percent increase (decrease) in Iraq's oil production. Table (3) reports the FM-OLS estimator's results. To understand the implications of climate change on the global demand for oil, the production of oil in Iraq, and the Iraqi economy, we provide stress tests to the Iraqi economy. To estimate the effects of this expected outcome on real GDP, we run three stress-testing scenarios in response to decline in global consumption of oil by 13.4, 26.7, and 40 percent a year from 2020 to 2050. Such cuts imply that Iraq cuts its oil production by 20 (1.5×13.4), (1.5×26.7) 40, and (1.5× 40) 60 percents a year from 2020 to 2050.

The (unrestricted) VAR is in the standard form:

$$y_t = A_1 y_{t-1} \cdots A_p y_{t-p} + \varepsilon_t, \qquad (2)$$

where $y_t = (y_1, y_{2t}, \cdots y_{kt})'$ is a $k \times 1$ vector of endogenous variables. There is also an exogenous constant term, $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \cdots \varepsilon_{kt})'$ is a $k \times 1$ vector of white-noise innovations with $(\varepsilon_t) = 0$; $E(\varepsilon_t \varepsilon_t') = \sum \varepsilon$, and $E(\varepsilon_t \varepsilon_s') = 0$ for $t \neq s$.

Let $(pk + d) \times 1$ vector:

$$Z_t = (y_{t-1}' \cdots y_{t-p}')',$$

And write the VAR is a compact form:

$$Y_t = BZ_t + \epsilon_t\ . \qquad (3)$$

y is (lnP_t^O, $ln\mathrm{H}_t$, $ln\mathrm{L}_t$,$ln\mathrm{K}_t$,$ln\mathrm{Y}_t$) and ϵ is $(\epsilon_{1t}, \quad \epsilon_{2t,} \quad \epsilon_{3t} \cdots \epsilon_{5t})$ both, are matrices of the endogenous variables are the innovations. The matrices $B = (A_1, \quad A_{2,} \quad A_{3,} \cdots A_5, \text{constant})$ and $Z = (Z_{1t}, \quad Z_{2t}, \quad Z_{3t} \cdots Z_{5t})$ are the matrix of coefficients and matrix of regressors respectively.

First, we estimate a VAR ($k = 5$) from 1970 to 2019, which has the following variables in order: log oil production, log human capital, log labor, log capital, and log real GDP. We test for the number of lags using a variety of Information Criteria (sequential modified LR tests, final prediction error, AIC, SIC, and HQIC), and a Chi-squared lag exclusion test. We found that AIC predicts three lags, but all the other Criteria suggest two lags, so we decided to use a VAR with two lags, thus, ($p = 2$). The chi-squared test for the hypothesis that lags equal are *jointly* zero is rejected with p values, 0 for the first lag and the second lag. The test for the first lag and the second lag *in each equation* also rejected the hypothesis, except for the second lag in the real GDP equation, which is only marginally significant. We fit two lags. The residuals are serially uncorrelated and homoskedastic.[viii]

Figure (11) is the variance decomposition. The standard errors are estimated using a Monte Carlo with 1000 repetitions. Although the variances of human capital, wages, and the stock of capital due to oil production are positive, they are very small. Probably that was not the case before 2003. The new governments after 2003 did not invest in education, and infrastructure, therefore, the effects on these variables are small. However, more than 60 percent of the variance of real GDP is due to oil production. Oil production variance is unexplained by any of the other four variables. The ordering of the VAR matters for these two variables. Figure (12) plots the *generalized impulse response functions*, Pesaran and Yongcheol (1998).[ix]

Second, we solve the model. Third, we generate baseline dynamic stochastic projections of the endogenous variables from 2020 to 2050.[x] Fourth, we re-estimate the VAR under the three scenarios separately, solve it, and generate three sets of dynamic stochastic projections from 2020-2050.[xi]

Figure (13) plots the baseline dynamic stochastic projections from 2020 to 2050. Figure (14) plots the deviations of each of the three scenarios from the baseline projections. Real GDP, human capital, the stock of capital and labor fall below the baseline projections.[xii] The results suggest that an adverse global demand shock for oil would significantly reduce Iraq's ability to produce oil, and that would basically grind the economy to a halt.

4. Our Proposed Remedy

We have shown that the Iraqi economy has been oil-dependent since the creation of the country. Oil production shares a long run common trend with, and highly sensitive to, global oil consumption. There is evidence that the world is moving away from hydrocarbons in the 21 century, which makes Iraq very vulnerable. Stress tests show that a decline in future oil production over the period 2020 to 2050 results in sharp decline in real GDP, and factor inputs. Given that, the future of Iraq under the current political and economic institutions is uncertain.

In addition to the political and policy problems described earlier, the Iraqi government's White Paper (2020) points to economic and demographic pressures on the government's finances. The trend in public sector's employment reached more than 3 millions in 2020, 30 percent of total labor force. The wage bill is approximately 15 percent of GDP and rising. In real terms, public sector salaries and pensions increased by 350 percent between 2006 and 2020. The payroll payments expenditures increased by more than 360 percent, and pensions expenditures increased by more than 30 percent. Population grew 53 percent from 2004 to 2020. Young population (under 30 year) makes up 66 percent, which puts a strong pressure on public spending. Population is expected to grow by 25 percent by 2030; population under 30 years expected to grow at 17 percent. The government has to, but it cannot, create 5 million jobs, all in the public sector, between 2020 and 2030.

To deal with the expected decline in the global demand for hydrocarbons and the consequent expected fall in *trend* oil prices, government revenues, and the enlargement of the public sector, we argue for a complete and immediate change in the political and economic institutions. The size of the government in GDP should be smaller than it has been so far. This reduces the crowding out of private investment. Here is the point, oil is the property of the Iraqi people therefore; the Iraqis must own it, not the government.

From an economic standpoint, people's ownership is associated with political and economic freedom, See for example, Hayek (1944), Friedman (1962), Pipes (2000), and O'Driscoll and Hoskibs (2003). Sound economic development requires market institutions and most importantly private property rights. There is reliable empirical evidence on the significance of private ownership on GDP growth. For example, historians North and Thomas (1973), and Rosenberg and Birdzell (1986) presented evidence that private property played a major role in enriching the West. Barro (1991) used proxies for the quality of private property to test the effect on GDP growth. Kormendi and MeGuire (1985) used measures of political freedom and civil liberties to proxy the quality of property rights and reported positive association with GDP growth. Heitger (2003) illustrates the same point.[xiii]

Ross (2001) examines the effect of oil on democracy empirically. He examined a panel of 113 countries over the period from 1970 to 1997. Testing several hypotheses (the rent state, the repression effect, and the modernization effect) revealed that oil adversely affects democracy and more so in poorer countries. Elbadawi and Makdisi (2011) provide evidence that oil is one of the main reasons for the lack of democracy in the Arab countries. Rotunda (2004), Wolf (2005) and Razzak (2006) proposed privatization of oil for Iraq. It means immediate transfers of the oil wealth to the Iraqi people; it does not mean selling out to multinationals.

In most market-oriented democracies, the people own resources and factors of production. All the Eastern European countries (e.g., Russia, Poland, Hungary, the Czech Republic, etc), which became democracies after the fall of the USSR, privatized their economies rather quickly. Iraq could do the same if the political climate and the culture change. The method of privatization could be different, however, depending on the objectives and the economic and political conditions. The Russian and the Czech Republic, for example, privatization processes were different from Poland or Hungary or even the U.K. The distribution of the oil wealth is different in Alaska from Norway. That is beside the point now. Most Iraqis agree that since 2003, (1) economic development has never occurred; (2) oil wealth has been squandered; and as a result, the Iraqi people have been impoverished. Ending the economic hegemony and control of the state is the only solution to free the economy and the people now.

It is only natural that the Iraqi people own their oil, gas. Oil shares must be distributed to all the Iraqi people *equally*. Each eligible individual receives one share. It is essential that shares are tradable in a free market immediately so ordinary Iraqis can benefit from buying and selling these oil shares, thus oil wealth could generate oil income. One expects that some Iraqis who need cash would sell their shares to other Iraqi buyers who want to buy at an agreeable price for the share. Allowing free exchange guarantees the establishment of a functional market. We would argue that the ownership of government-controlled assets in general and government-controlled lands should also be transferred to people *a la* the Homestead Act in the U.S. (1862), and many other countries (e.g., Anderson 2011). When the Iraqi people own their oil, gas, and land under the law of property rights, no one can steal the resources.

In Russia, the government handed shares in state-owned companies to the people directly. In the Czech Republic, people were sold vouchers (each included 1000 investment points) then they bid on shares in a large number of the state-owned companies. The bid-offer process converted these points into share prices. The Czech Republic objective of the privatization was to establish a free market economy. In the UK, state-owned companies were sold directly to the public. In Russia, the Oligarch went door-to-door offering to buy the shares from the people. However, Iraq could learn from others' experiences. The mistakes that occurred in the Eastern European countries must be avoided by appropriate regulations.

Regulations are necessary to protect people; however, the politicians are not reliable regulators in this case because they are implicated in squandering the oil wealth. There is no obvious way to deal with regulations in this case. One possibility is to establish an independent court to manage the process of ownerships, sales, transfer, inheritance, and to safeguard the integrity of the privatization process. It is necessary to protect women, the elderly, and the sick shareholders from exploitations.

Eventually, the shareholders will have to establish a private oil company with a sound governance system to manage their wealth. Private ownership will enhance democratic practices and contribute to the building of market institutions such as the banking system, the tax system to replace oil revenues with more sensible tax revenues, the share market etc. that are required to achieve efficiency in the distribution of wealth. Iraq has an old functioning tax system with expertise and rules. Even a significant large communist country like China has adopted market-oriented structures, which has already benefited the people. The incentive structure will be set properly, which will help allocate resources efficiently. Reforms of such magnitude and depth would take time to work, but it would work eventually. New Zealand, which is a democracy that enjoyed political and judicial stability, took a long time to realize the fruits of its market-oriented policy and institutional reforms of 1984, e.g. Evens *et al.* (1996).

If the privatization of oil is implemented the Iraqi people will be better off and have the financial means and the right incentives to make their own investments and businesses. As a result, we envisage some rearrangements of public sector employment. Government employees who receive a share in oil either voluntarily exit from the public sector to pursue private businesses; laid-off, or, reassigned, albeit with different negotiated contracts whereby wages are consistent with productivity. This will reduce the swelling of the inefficient public sector, and decrease waste and public spending significantly.

When Iraqis begin to receive dividends from oil shares they will become more interested in the performance of the oil industry as a whole regardless of the regions because when any one regional company makes profits all Iraqis will benefit. Sharing oil wealth and the independence of the oil business will unify the country, as the people of Iraq will recognize that they own and share their country. It might also eliminate the need for federalism.

Private property laws reduce corruption and thus, increase potential growth. The strategy will make the Iraqis rich. There is evidence about the negative correlation between corruption and economic growth, for example see, Chafuen and Guzman (1996). High-expected rate of regulations makes corruption more possible. Private individuals who bribe government officials increase in order to have their contracts honored. Iraq is one of the worst countries in the world in terms of freedom from repudiation of contracts. Iraq also scored high on almost all corruption indices, Easterly (2002).

Finally, peoples' ownership of oil is more consistent with Islam because it encourages investments in stocks and equity rather than receiving interest income so buyers and sellers share the gains and losses. The Iraqi shareholders will benefit when their oil company, or any regional company, does well and the share price increases. However, if the government of Iraq elects to pursue the old policies and keeps control over oil it will eventually become another authoritarian government and economic development will stall. This has been happening already.

The political elite will strongly oppose our proposed strategy to save Iraq as a country in the 21 century because the have entrenched interests in the status quo. The majority of the educated Iraqis who have grown under military socialist dictatorship will also oppose it because they have learnt nothing better than social welfare benefits. They like to have a free education and health benefits, a secure public job, and a fully funded retirement pension regardless. This is the only game played in Iraq historically and despite the disastrous outcomes, many people cannot learn to play another game. There is one big hope, however, that the new generation, which did not grow up under dictatorships, and more outward and forward looking, maybe able to force the change.

5. Conclusions

Iraq is an oil rich country. It has large proven oil reserves, about 150 billion barrels, and an enormous amount of natural gas. The share of oil in real output is approximately 60 percent, along with poverty, lack of infrastructure such as modern roads, electricity, hospitals, and schools especially after the invasion in 2003. There is widespread corruption, waste of oil wealth, and other problems typically associated with rentier, government controlled economies. Further, the production of oil is highly responsive to global oil demand. Thus, Iraq is very vulnerable to oil shocks. Stress testing scenarios suggest that a decline in the global demand for oil, which is highly likely due to the global change of taste and policies against it arising from concerns about global warming, could reduce Iraq's real oil production, real GDP over the period from 2020 to 2050.

We argued that if Iraq continues to be oil-dependent and have oil wealth under the control of the government, it would be a very poor country by 2050. We proposed an immediate transfer of oil wealth, and public assets including lands, to the Iraqi people in equal share per person. The shares would have to be tradable – freely exchangeable – such that people can sell and buy them at a market price. This enriches the Iraqi people because they could make investments in various economic activities when oil prices begin to decline, e.g., someone without a home could build one. The process, however, requires an optimal amount of sensible regulations and management by an independent court; not by the political elite because they are untrustworthy, to ensure fairness, protect the integrity of the process, to protect the women, the elderly and the vulnerable. Democracy cannot flourish and progress if a few politicians and businesses continue to control the economy and steal the wealth of the people.

A change in ownership of oil and income diversification constitutes a significant socioeconomic change, a significant shock to the system. Expected prices, wages, and income adjustment would take some time. This dynamic is hard to predict. The time lag is a function of the ability and speed of the society to adapt and the speed at which new sound institutions replace the old ones. Therefore, we anticipate high variability at the beginning and for some time. Russia took a long time to stabilize.

Those who have entrenched interests in the status quo system, however, will resist the idea of transferring ownership of oil and government assets to people. There are cultural and institutional hurdles. The cultural hurdles include, at least, (i) the political elites who currently control revenues since 2003, those who collect the rent and vote for the politicians, and foreign beneficiaries who buy smuggled oil and collect rent for supporting the system; and (ii) a strong belief in social welfare policies among some people. Although people have not received adequate services such as schooling, health, water and power supply, housing, roads, etc. since 2003, some people are so used to governments providing free services for them with the majority of workers being tax-exempt, may still believe in this old system.

There will be difficulties and strong resistance to the idea of oil wealth transfers, more so than in Russia or any other country because of the abovementioned hurdles, but there is a change in demography, where people aged 15 to 24 are forward looking and untarnished by past experiences. Unlike Russia in 1991, this group of Iraqi people has not lived under dictatorship and socialism. They have not been recipients of rent and social welfare, highly connected with the rest of the world and are aware of democratic practices, institutions, and culture. They may be the key to change. We believe that cultural change in Iraq is necessary to ensure a better development model for Iraq, however, how oil ownership policy, political, and economic institutional changes can induce cultural change remains unquantifiable and the subject of more research.

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Table (1) Fully Modified OLS Estimator –
$lnY_t = \alpha_1 \ln K_t + \alpha_2 \ln L_t + \alpha_3 lnH_t + \alpha_4 lnP_t^O \quad + e_t$ (i)

	Iraq(ii)	Kuwait(iii)	Oman(iv)	Qatar(v)	KSA(vi)	UAE(vii)
Constant	-	-	-	4.66	-	-
	-	-	-	(0.0005)	-	-
α_1	0.40	0.73	0.95	0.99	0.32	0.43
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
α_2	0.14	-	-0.46	-0.40	0.20	0.33
	(0.0023)	-	(0.0003)	(0.0012)	(0.0006)	(0.0000)
α_3	0.51	-3.77	-	-1.78	-0.74	-0.17
	(0.0000)	(0.0000)	-	(0.0118)	(0.0000)	(0.0000)
α_4	0.57	0.67	0.90	0.32	0.70	0.20
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
σ	0.18	0.17	0.16	0.13	0.06	0.12

(i) $\boldsymbol{Y_t}$denotes real GDP constant 2011 national prices (in mil. 2011US$); $\boldsymbol{K_t}$denotes the stock of capital at constant 2011 national prices (in mil. 2011US$); $\boldsymbol{L_t}$denotes labor measured by working age population (age 15-64); $\boldsymbol{H_t}$ is the human capital index, 2017=1 based on years of schooling and returns to education; see Human capital in PWT9; and $\boldsymbol{P_t^O}$ is oil production (thousands BD). Bahrain excluded because it not n oil producer. The cointegration relationship includes a dummy for the 1973 oil price shock and the Gulf War I 1990-1992. Iraq and Iran include an additional dummy for the second oil shock in 1979 and the Iran-Iraq war from 1979 – 1988.

(ii) Long-run covariance estimate (pre whitening with lags=2, max. lag = 3. Bartlett kernel, Newey-West automatic bandwidth 14.2003, NW automatic lag length=3. **(iii)** Long-run covariance estimate (pre whitening with lags=3, max.lag = 3, Bartlett kernel, Newey-West automatic bandwidth 2.4096 NW automatic lag length=3.Labor data have missing values, therefore excluded. **(iv)**Oman does not have data for human capital because it does not report average years of schooling data, thus excluded. Long-run covariance estimate (pre whitening with lags=2, max. lag = 3. Bartlett kernel, Newey-West automatic bandwidth 22.1284, NW automatic lag length=3. **(v)** Qatar is a major gas producer; therefore, we have gas production (BCM) instead of oil. Long-run covariance estimate (pre whitening with lags=3, max. lag = 3. Bartlett kernel, Newey-West automatic bandwidth 5.8171, NW automatic lag length=3. **(vi)** Long-run covariance estimate (pre whitening with lags=3, max. lag = 3. Bartlett kernel, Newey-West automatic bandwidth 7.9071, NW automatic lag length=3. **(vii)** Long-run covariance estimate (pre whitening with lags=1, max. lag = 3. Bartlett kernel, Newey-West automatic bandwidth 365.4973, NW automatic lag length=3.

Table (2a)
The Engle-Granger (1987) Test for Cointegration
OLS: $lnP_t^O = \gamma lnC_t^O + u_t$
1970-2019

Variable	Coefficient	Std. Error	t-Statistic	P Values
γ	1.5	0.05	29.9	0.0000
R-squared	0.17	Mean dependent var.	7.52	
Adjusted R-squared	0.17	S.D. dependent var.	0.64	
S.E. of regression	0.58	Akaike info criterion	1.78	
Sum squared res.	16.7	Schwarz criterion	1.81	
Log likelihood	-43.54	Hannan-Quinn criterion	1.79	
Durbin-Watson stat	0.439			

HAC standard errors and covariance, pre-whitening with lags=1 from AIC maximum lag=3, Bartlett kernel, Newey-West automatic bandwidth 2.9803, NW automatic lag length=3

Table (2b)
ADF Unit Root Test of the residuals u_t

$$\Delta u_t = \rho u_{t-1} + \sum_{i=1}^{k} \Delta u_{t-i} + \nu_t$$

Variable	Coefficient	Std. Error	t-Statistic	P Values
ρ	-0.22	0.09	-2.43	0.0188
R-squared	0.10	Mean dependent var.	0.001	
Adjusted R-squared	0.10	S.D. dependent var.	0.391	
S.E. of regression	0.36	Akaike info criterion	0.865	
Sum squared res.	6.54	Schwarz criterion	0.903	
Log likelihood	-20.1	Hannan-Quinn criterion	0.879	
Durbin-Watson stat	1.83			

Trend and constant found significant. Zero lagged differenced residuals found in the search

Table (2c)
OLS Error Correction

$$\Delta lnP_t^O = \delta_0 + \delta_1 \Delta lnC_t^O + \delta_2 u_{t-1} + \eta_t$$

Variable	Coefficient	Std. Error	t-Statistic	P Values
δ_0	-0.05	0.07	-0.7	0.5002
δ_1	5.17	1.68	3.0	0.0035
δ_2	-0.22	0.05	-3.8	0.0003
R-squared	0.194210	Mean dependent var.	0.022992	
Adjusted R-squared	0.159176	S.D. dependent var.	0.400017	
S.E. of regression	0.366802	Akaike info criterion	0.891280	
Sum squared res.	6.189002	Schwarz criterion	1.007105	
Log likelihood	-18.83635	Hannan-Quinn criterion	0.935224	
F-statistic	5.543421	Durbin-Watson stat	1.868836	
Prob(F-statistic)	0.006968			

HAC standard errors and covariance, pre-whitening with lags=2 from AIC maximum lag=3, Bartlett kernel, Newey-West automatic bandwidth 2.6668, NW automatic lag length=3

Table (3)
FM-OLS estimates
$lnP_t^O = \beta_0 + \beta_1 lnC_t^O + \varepsilon_t$

Coefficient	Estimates	Std errors	t-Stats	P values
β_1	1.52	0.02	68.1	0.0000
D_{1973}	-4.36	0.67	-6.4	0.0000
D_{79-88}	-2.59	0.40	-6.5	0.0000
D_{90-92}	-0.40	0.24	-1.7	0.0909
S.E. of regression			1.012101	
Long-run variance			0.445448	
Mean dependent var.			7.531556	
S.D. dependent var.			0.648780	
Sum squared res.			46.09568	

P_t^O is Iraq's oil production and C_t^O is global oil consumption.The sample is adjusted, 1971-2019 and is 49 observations after adjustments. The cointegration equation includes dummies deterministicD_{1973}; D_{79-88}; D_{90-92}. The long run covariance estimate includes pre whitening with lags =1 from AIC maximum lag =3, Bartlett kernel, Newey-West with automatic bandwidth chosen to be 21.5989, and automatic lag length = 3.

Figure (1)
Budget Deficits, CA Deficits, and Rising Debt

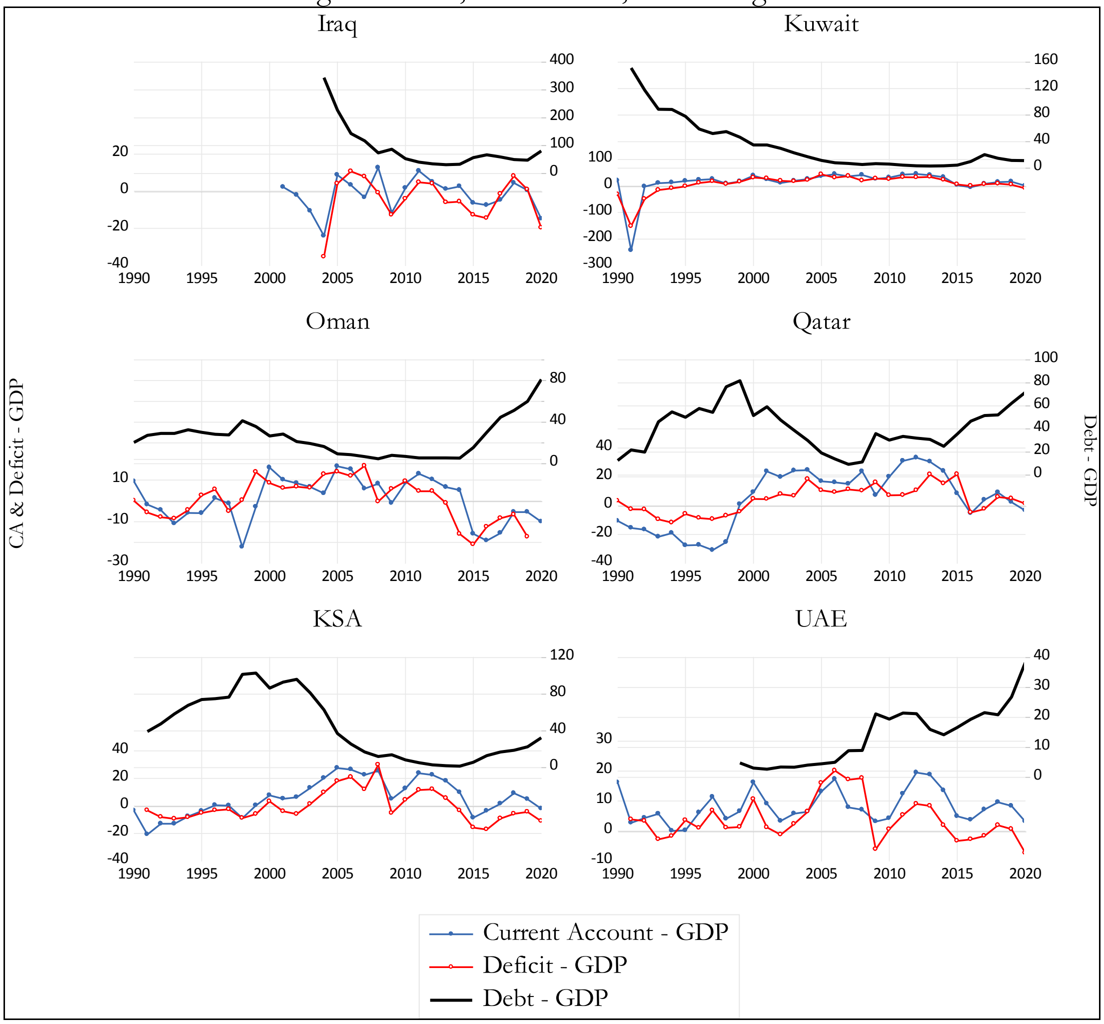
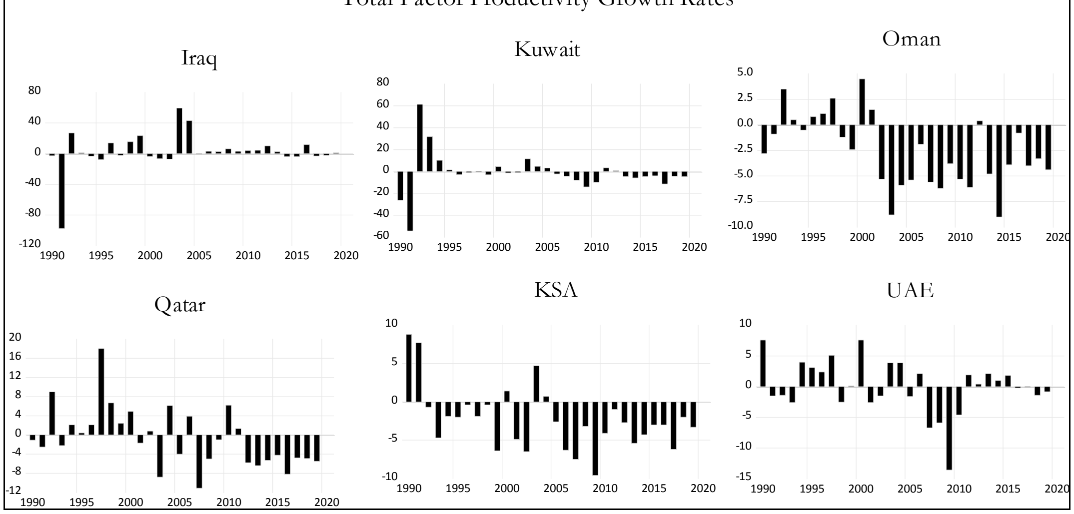


Figure (2)
Total Factor Productivity Growth Rates



Source: Conference Board

Figure (3)

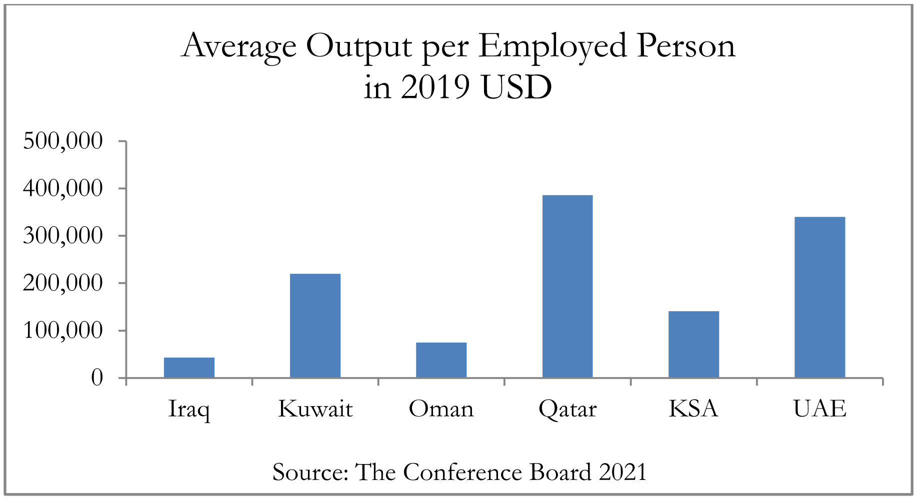


Figure (4)

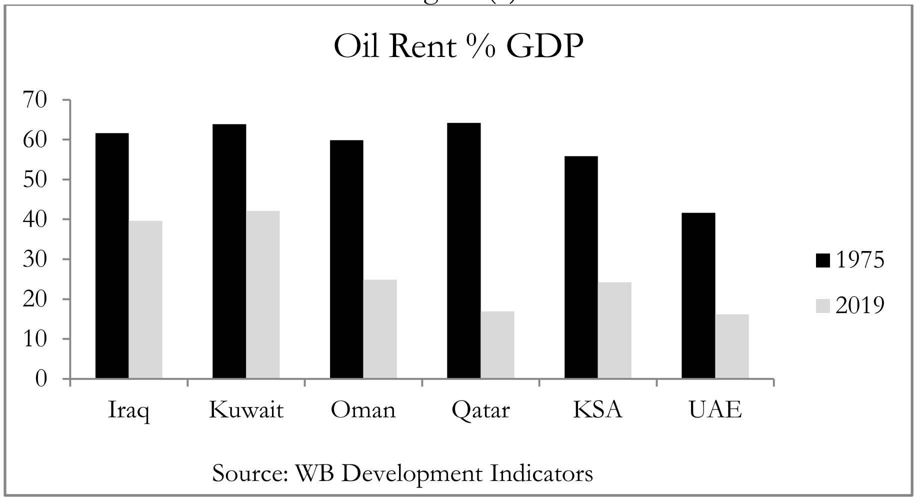


Figure (5)

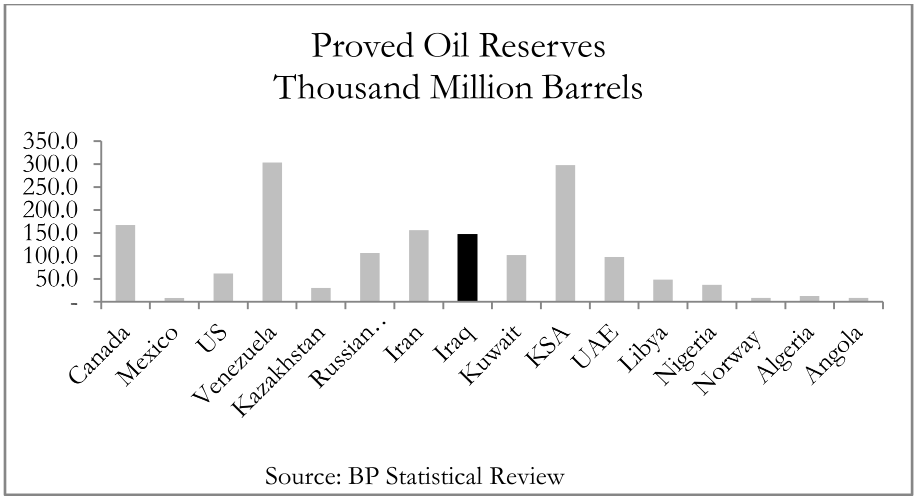


Figure (6)

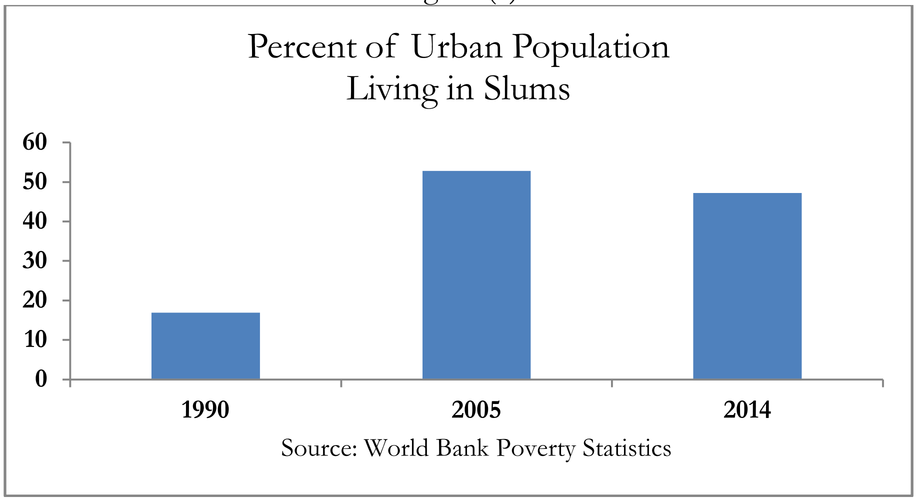
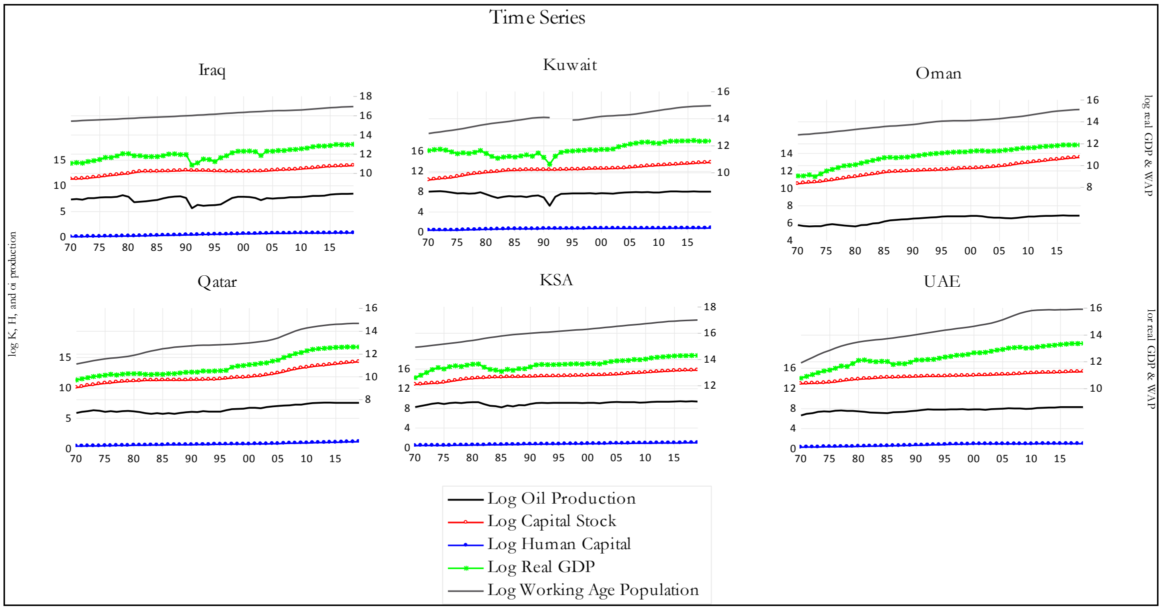


Figure (7)



The data are from the Penn World Table 10.0 except for oil production from BP Statistical Review 2020, and working age population from the World Development Indicators. Real GDP (right axis) and Capital stock are in national currency (2011prices). Human capital is an index (2017=1). Oil production is in barrels per day. Working age population (right axis)

Figure (8)
The Goodness of fit of the FM-OLS Regression of Equation (1)

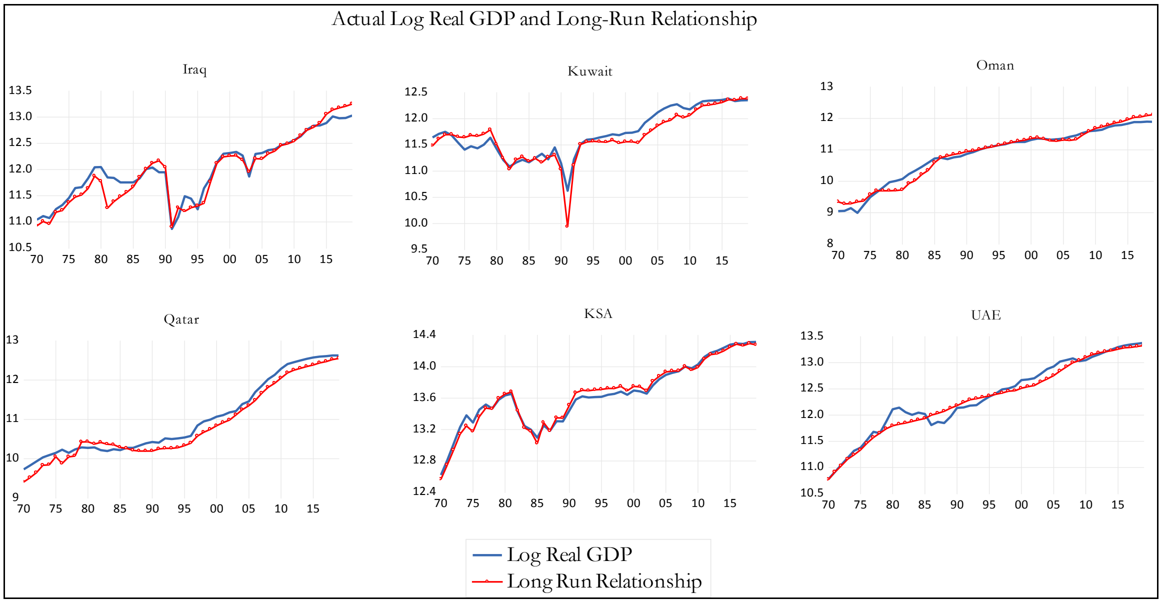


Figure (9)
TFP is $Y_t\,/(K_t^{\alpha 1} \times L_t^{\alpha 2} \times H_t^{\alpha 3} \times P_t^{O^{\alpha 4}})$

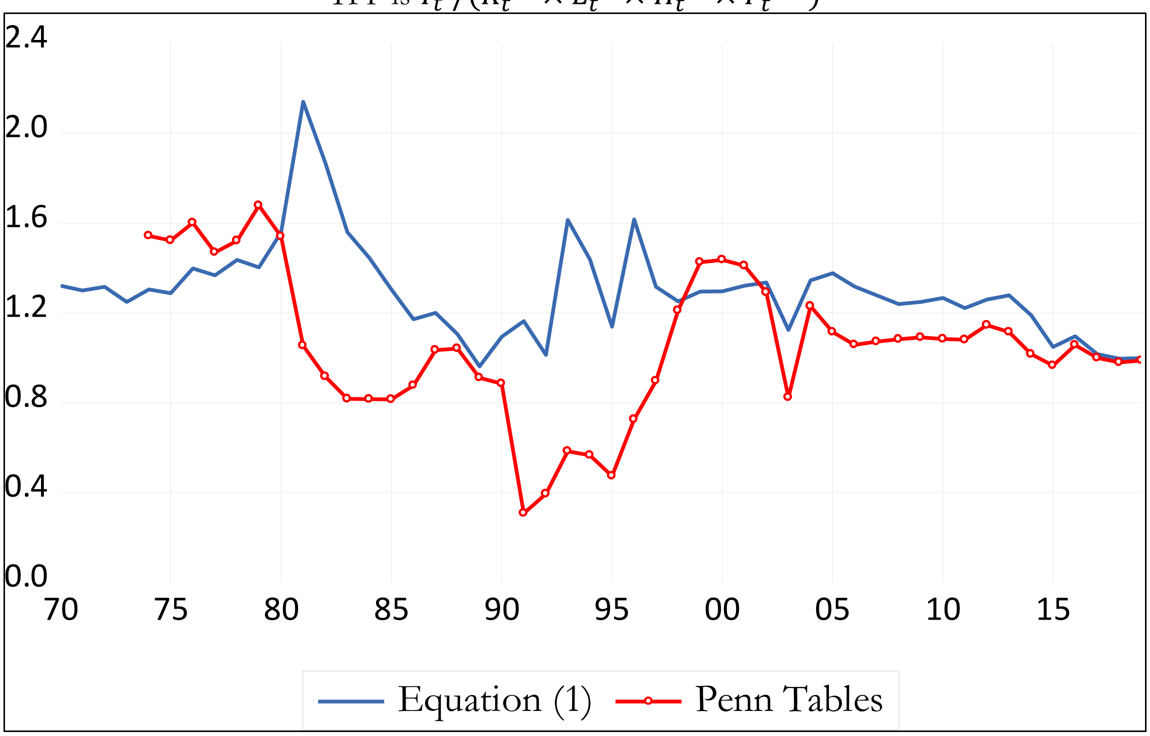


Figure (10)

The Relationship between Oil Production and Real GDP in Iraq

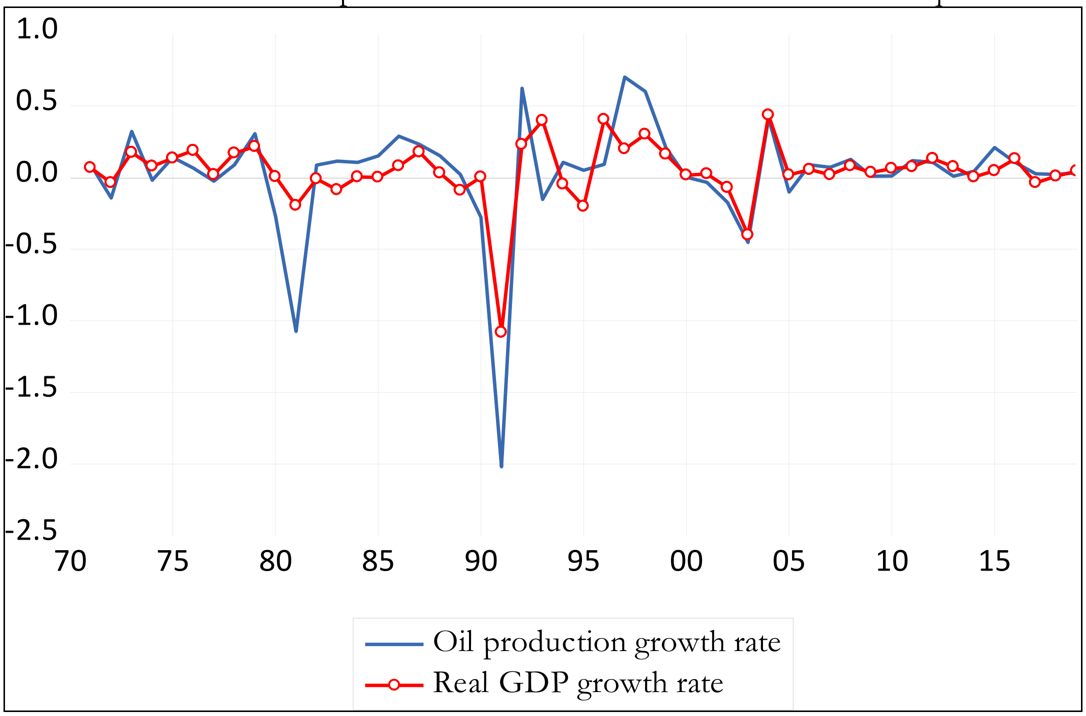


Figure (11)

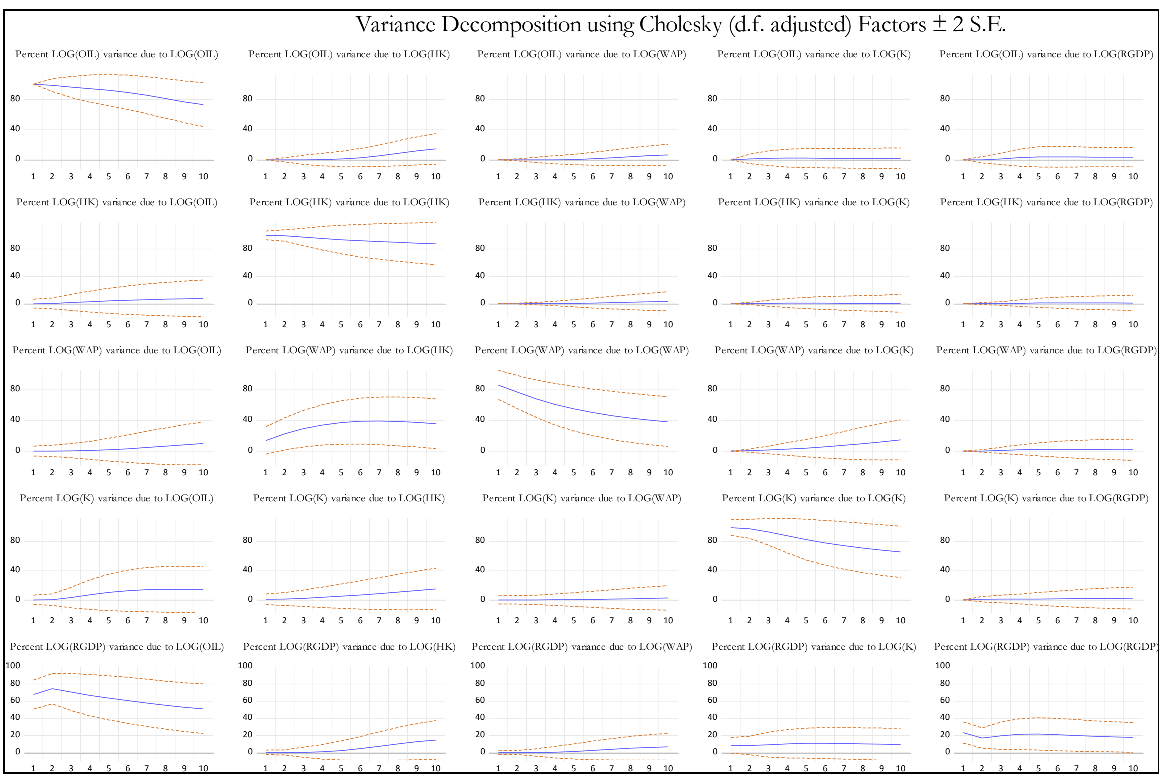


Figure (12)

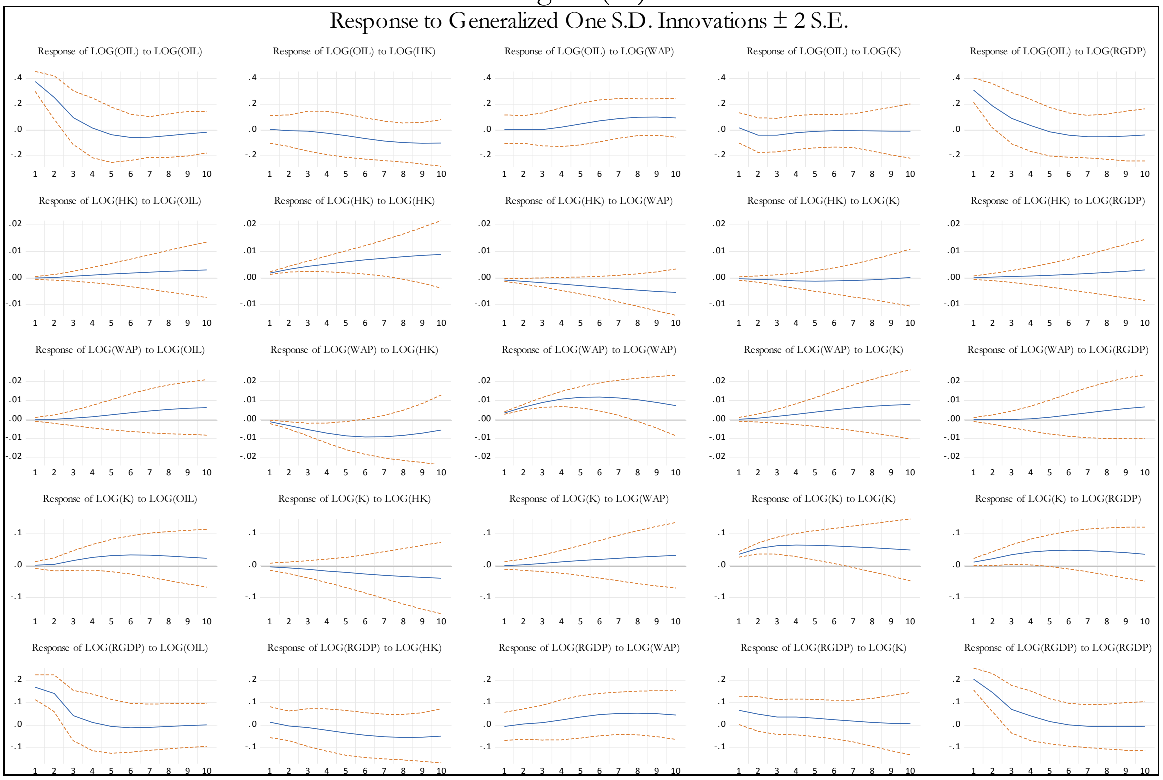

Response to Generalized One S.D. Innovations ± 2 S.E.
Response of LOG(OIL) to LOG(OIL)
Response of LOG(OIL) to LOG(HK)
Response of LOG(OIL) to LOG(WAP)
Response of LOG(OIL) to LOG(K)
Response of LOG(OIL) to LOG(RGDP)
Response of LOG(HK) to LOG(OIL)
Response of LOG(HK) to LOG(HK)
Response of LOG(HK) to LOG(WAP)
Response of LOG(HK) to LOG(K)
Response of LOG(HK) to LOG(RGDP)
Response of LOG(WAP) to LOG(OIL)
Response of LOG(WAP) to LOG(HK)
Response of LOG(WAP) to LOG(WAP)
Response of LOG(WAP) to LOG(K)
Response of LOG(WAP) to LOG(RGDP)
Response of LOG(K) to LOG(OIL)
Response of LOG(K) to LOG(HK)
Response of LOG(K) to LOG(WAP)
Response of LOG(K) to LOG(K)
Response of LOG(K) to LOG(RGDP)
Response of LOG(RGDP) to LOG(OIL)
Response of LOG(RGDP) to LOG(HK)
Response of LOG(RGDP) to LOG(WAP)
Response of LOG(RGDP) to LOG(K)
Response of LOG(RGDP) to LOG(RGDP)

Figure (13)

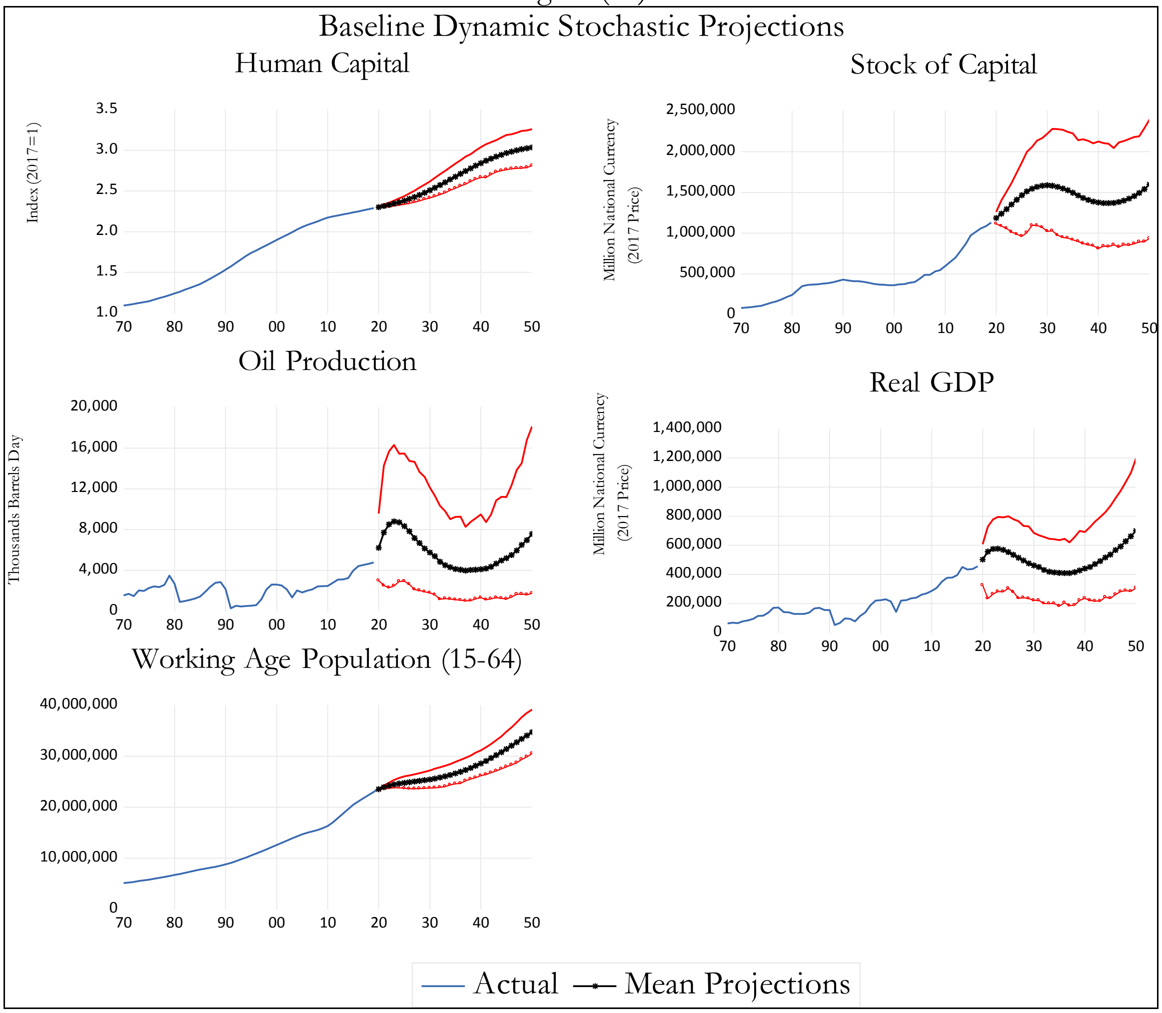
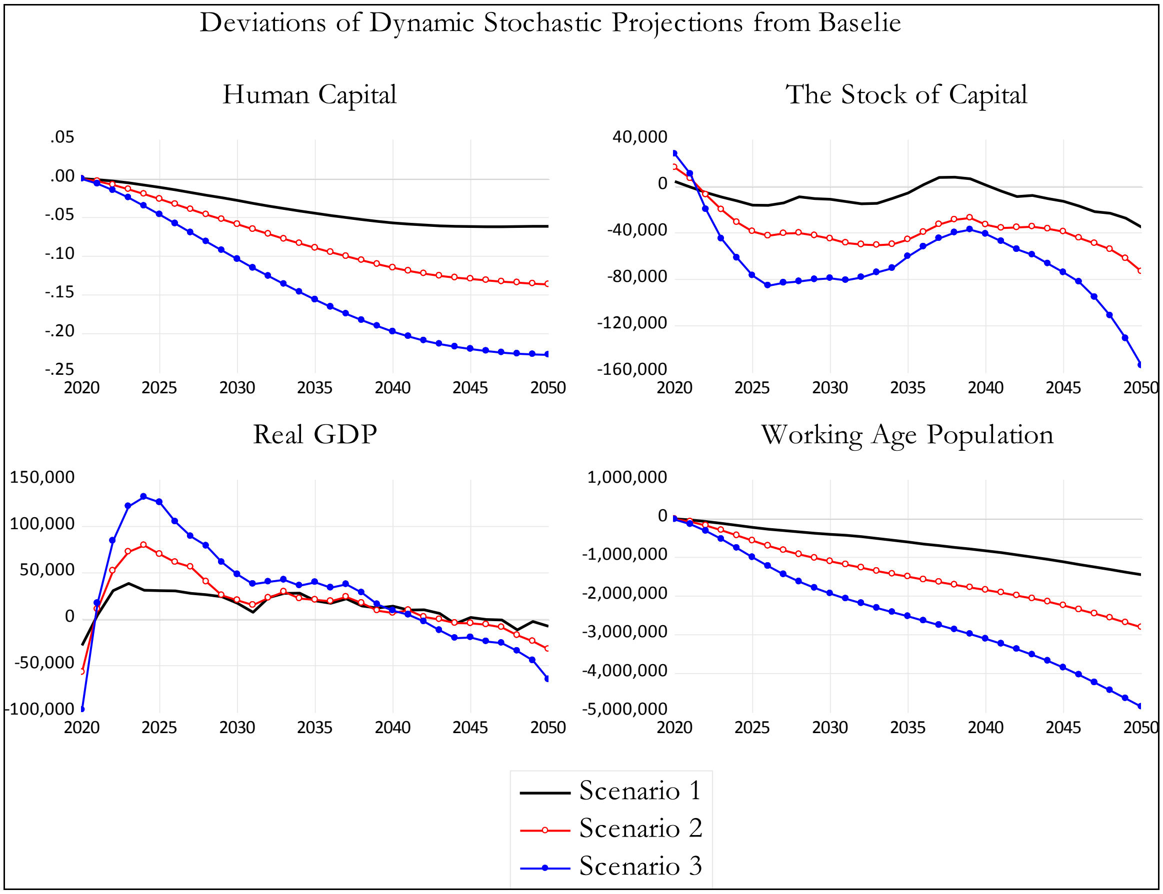

Baseline Dynamic Stochastic Projections
Human Capital
Index (2017=1)
Stock of Capital
Million National Currency (2017 Price)
Oil Production
Thousands Barrels Day
Real GDP
Million National Currency (2017 Price)
Working Age Population (15-64)
Actual
Mean Projections

Figure (14)


Deviations of Dynamic Stochastic Projections from Baselie
Human Capital
.05
.00
-.05
-.10
-.15
-.20
-.25
2020
2025
2030
2035
2040
2045
2050
The Stock of Capital
40,000
0
-40,000
-80,000
-120,000
-160,000
Real GDP
150,000
100,000
50,000
0
-50,000
-100,000
Working Age Population
1,000,000
0
-1,000,000
-2,000,000
-3,000,000
-4,000,000
-5,000,000
Scenario 1
Scenario 2
Scenario 3

Data Appendix

Y_t	Real GDP	Millions national currency in 2011 prices	Penn World Table 10.0
L_t	Labor	Working age population, 15-64	World Development Indicators
H_t	Human Capital	Index, 2017=1	Penn World Table 10.0
K_t	Stock of capital	Millions national currency in 2011 prices	Penn World Table 10.0
P_t^O	Oil production	Thousands barrels a day	BP Statistical Review, 2020
C_t^O	Global oil consumption	Exajoule	BP Statistical Review, 2020

[i] Latin American oil-rich countries too have budget deficits on average from 2004 to 2020, Colombia (-2.1), Guyana (-3.46), Mexico (-2.75), Trinidad and Tobago (-2.96), and the only socialist country Venezuela (-8.86).

[ii] We excluded Bahrain because it is not an oil producer.

[iii] The bandwidth parameter is l for the kernel-based estimators of f_0, which is the Newey-West (1994). They use AR1. So we choose the lag length p to minimize these criteria AIC -2 $\left(\frac{l}{T}\right) + 2k/T$); the SIC $-2\left(\frac{l}{T}\right) + kln(T)/T$; HQ $-2\left(\frac{l}{T}\right) + 2kln(\ln(T))/T$. The modifications add $\tau$to every k and $\tau = \alpha^2 \sum_t y_{t-1}^2 / \sigma_\varepsilon^2$.

[iv] Unlike all other tests for unit root, the KPSS test's null hypothesis is I(0), not I(1), therefore we cannot compare the power of the test to others.

[v] Dynamic – two-sided – OLS (Phillips – Loretan, 1991, Saikkonen 1991, and Stock and Watson, 1993) could not be used because the sample is short and it would not allow for searching for the optimal lag and the width of the kernel to correct for the standard errors. They are designed to estimate regressions under the assumption of cointegration between the variables.

[vi] The plots of the GCC are available on request. We do not include them to save space.

[vii] Iraq's or the GCC countries do not use such method for stress testing. Their Central Bank's Financial Stability Reports report linear OLS regressions at most. They do not provide dynamic stochastic projections as we did here.

[viii] We test the residuals serial correlation using the LM test. The null hypothesis of no serial correlation at lag 1, 2, and 3 could not be rejected with P values 0.1718, 0.6479, and 0.5964. The null hypothesis at lag 1 to 3 also cannot be rejected with P values 0.1718, 0.5329, and 0.6886. The joint chi-squared test for the null hypothesis of heteroskedasticity (levels and squares) has a P value of 0.0177.

[ix] Further, Koop, Pesaran and Potter (1996) and Isakin and Ngo (2020) show that when models are linear, traditional IRFs and variance decomposition.

[x] We solve the VAR using Broyden's method, which is a modified Newton's method. It uses an approximation instead of the true Jacobian when linearizing the model. We update the approximation at every iteration of the 5000 iterations by comparing the residuals from the new trial values of the endogenous variables with the residuals predicted by the linear model based on the current Jacobian approximation. In addition, we use analytic derivatives with the starting values being the actual values. Then we solve the model in both directions. We stop solving when we hit a missing value. In a stochastic simulation, we solve the equations of the model such that the residuals match to randomly drawn errors, and the coefficients and exogenous variables of the model change randomly. The solution generates a distribution of outcomes for the endogenous variables in every period. We approximate the distribution by solving the model many times using different draws (1000) or the random components in the model then calculating statistics over all the different outcomes. Only values of the endogenous variables from before the solution sample are used in the dynamic solution of the projections. Lagged endogenous variables are calculated using the solutions calculated in previous periods, i.e., not from actual historical values. A series for the mean is calculated. We consider one thousand repetitions reasonable to capture the true values; however, some random variation may be present between adjacent observations. The 95 percent confidence intervals are computed using an updating algorithm. We use bootstrapped innovations. For the diagonal covariance matrix, the diagonal elements are set to zero. We do not scale the variances.

[xi] Stochastic projections are usually considered a remedy to the Lucas critique.

[xii] We also estimated a VAR in log-differences and a VECM. The result changes in *magnitudes*. The deviations of the real GDP dynamic stochastic projections of scenarios 1, 2, and 3 from baseline also decline in a similar patern, however, more volatile as one expects.

[xiii] It might be worth mentioning that the solution of the neoclassical growth model, Ramsey (1928)-Cass (1965) - Koopmans (1965) under the social planner is the same as under the private market.