Avoiding the natural resource curse: an optimal use of oil rents to reduce its potential negative effects upon economic growth.

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Abstract

Crude oil is a commodity that is often traded between countries. When countries begin their commercial export of crude oil, their national economic statistics look very favorable. However, the experiences of several oil-exporting countries have shown a decline in their economic performance in the long run. Strong oil export revenues have long been speculated to be the key antecedent for the poor economic performance of oil-rich nations. This study has two main objectives. The first is to empirically identify the determinants of the natural resource curse; the second is to explore policy mechanisms to avoid the resource curse by addressing the robust oil export revenues in a manner that would not compromise a country’s economic performance. From a panel of 18 countries over the 2001 to 2017 period, this study found that petroleum natural resource abundance could have a negative relationship with real per capita GDP growth. Thus, oil-rich developing countries should be cautioned about the potential for high oil export revenues eventually cause a reduction in their real per capita GDP growth. This study contributed to the natural resource curse literature by its presentation of an alternate scenario for the management of natural resource funds. This study suggests that the PIH is not the optimal scenario for the management of natural resource funds as it induces a government to commence borrowing before the onset of the boom. When the boom comes to an end, inertia in public spending may cause the government to continue borrowing. This study proposes that the optimal approach for the management of natural resource funds is one in which a proportion of the natural resource rents is saved in a low risk–interest bearing natural resource fund, and the remainder is used to develop the productive capacity of the economy.

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1 Introduction

Some countries are very fortunate to be endowed with commercial deposits of recoverable crude oil reserves. Even if a country was historically poor, and lacked the required technology and technical expertise to develop its oil industry, it will be able to attract the required foreign direct investment (FDI) to facilitate its oil industry’s development.

In the early years of an oil export boom, a country’s economic performance is favourable. The gross domestic product (GDP) is likely to grow at high (double-digit) rates. Although the oil industry is capital intensive, the country is likely to experience an increase in employment. Furthermore, the government is likely to gain large royalties and other oil export tax revenues, which in turn can be used to finance its social expenditure programs. In fact, the government may act as the critical intermediary between the oil sector, and the non-oil sector in the redistribution of the country’s oil wealth.

Due to these initial positive economic outcomes, one may think that high oil export revenues may automatically result in the improvement of the economic performance of oil-exporting countries in the long run. The experience of several countries has proven the reverse.

In the literature, there are many examples of resource-rich countries that have performed poorly over time. Angola, Nigeria, Sudan, and Venezuela are all rich in the oil resource, yet they have experienced poor economic fortunes. Contrastingly, countries such as Japan, Korea, Taiwan, and Singapore are natural resource-poor, yet they achieved high standards of living (Frankel 2010). This phenomenon whereby there is a paradox of plenty has come to be known as the resource curse (Auty 2001). Alternatively expressed, the resource curse refers to the failure of many resource-rich countries to benefit fully from their wealth (NRGI 2015).

Despite this experience, developing countries embarking on the commercial development of their crude oil industry can benefit from policy measures to avert the natural resource curse. Moreover, the governments of oil-rich developing countries can benefit if they are aware of strategies to optimally allocate their natural resource wealth.

The main objectives of this study are as follows:

i. To empirically identify the determinants of the natural resource curse;

ii. To explore policy mechanisms to avoid the resource curse by addressing the robust oil export revenues in a manner that would not compromise a country’s economic performance.

This study is structured as follows. The next section, Section 2, provides a literature review of the Natural Resource Curse. Section 4 will provide the data and methodological framework to empirically investigate the determinants of the natural resource curse. Section 4 display the results.
Section 5 presents some policy measures to combat the natural resource curse. Section 6 concludes this study.

2 Literature Review

Sachs and Warner (1995) found a negative relationship between the share of primary commodity exports in GDP and economic growth in a panel of countries over the 1970 to 1989 period. Although the negative relation was established, Sachs and Warner (1995) failed to establish the mechanism through which the resource curse operates. In other words, they did not clearly explain why some countries rich in natural or mineral resources experienced a weaker economic performance than natural or mineral resource scare countries.

Sachs and Warner (ibid) measure of resource abundance was more a measure of resource dependence. The share of primary commodity exports in GDP measures the extent to which an economy depends upon a particular export basket. Sachs and Warner (1997) used alternative specifications of mineral abundance: the share of mineral production in GDP, and the percentage of primary commodity exports in total exports. They found that their original results held.

Sala-i-Martin and Subramanian (2003) challenged Sachs and Warner (1995) findings. Sala-i-Martin and Subramanian (ibid) found that natural resources might impede economic growth by impairing institutional quality. They measured institutional quality by a composite index comprising of concepts such as property rights, rule of law, etc. They found that fuel and mineral resources could have a negative impact on institutions. However, non-mineral resources had insignificant relationships with institutions and economic growth. Such finding was significant since it suggests that the natural resource curse may actually be a mineral resource curse.

Papyrakis and Gerlagh (2004) generally agree that natural resource abundance can have a negative relation with economic growth. However, when variables such as corruption, investment, openness, and terms of trade (ToT) are taken into consideration, a positive relationship can be found between natural resource abundance and economic growth. Papyrakis and Gerlagh (ibid) used the share of mineral production in GDP as a measure of resource abundance. Additionally, since Sala-i-Martin and Subramanian (ibid) found that mineral natural resources could be the specific type of natural resources that have a negative relationship with economic growth, then it implied that Papyrakis and Gerlagh (ibid) findings may apply only to mineral resources rather than all natural resources.

Gylfason (2001) outlined four popular explanations for the natural resource curse. They include:

i. a Dutch Disease effect;
ii. rent-seeking behavior;
iii. a crowding out of human capital; and
iv. a crowding out of investment and physical capital.

Dutch Disease refers to a situation in which windfall export revenues from the rapidly expanding tradable sector of an economy may eventually cause the appreciation of a country’s real exchange rate, which in turn causes a decline in the competitiveness, and deindustrialization of the non-booming tradable sector (Corden 1984). In the original Corden and Neary (1982) model, the Dutch Disease explained a situation that occurred in the Netherlands in the oil sector. Since oil is a mineral resource, the Dutch Disease may be regarded as a mineral resource version of the natural resource curse.

The original Dutch Disease model did not refer to the resource curse. The Sachs and Warner (1995) paper did not refer to the Dutch Disease. However, in both cases, the economy performs poorly because of natural resource wealth. Several studies have observed the similarities between the Dutch Disease, and the natural resource curse (Gylfason 2001; Larsen 2004; Van der Ploeg 2006), and now the Dutch Disease is considered as a special case of the natural resource curse.

Many economists believe that the deindustrialization of the non-booming tradable sector in the Dutch Disease model impairs economic growth in such countries (Gylfason 2001; Kronenberg 2004; Papyrakis and Gerlagh 2004). Some empirical studies of Dutch Disease have placed less focus on real exchange rate movements, and instead emphasized how economic distortions or commodity price volatility may encourage a country to increase its dependence upon the mineral sector, and decrease dependence upon manufacturing sectors (Gylfason 2001; Pendergast 2007).

The rent-seeking behavior justification has been widely used to explain the resource curse. In the rent-seeking models, resource wealth is treated as a rent that is subject to dissipation. In the political economy framework, rent-seeking refers to the event where an economic agent seeks to capture or increase their share of existing wealth without increasing productivity. Rent-seeking results in reduced economic efficiency, increase income inequality, and decreased economic performance through the poor allocation of resources (Wade and Dabla-Norris 2001).

Rents can take many forms. They can include extra income from the ownership of a resource, extra income from politically organized transfers, higher than competitive rates of return in monopolies, incomes earned from bribing, and political lobbying (Di John 2011).

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1 Some countries which have been noted to experience the Dutch Disease include Azerbaijan, Indonesia, Nigeria, and Venezuela.
In developing countries, resource rents are often dissipated through corruption, bureaucratic inefficiency, and policies designed to benefit special interest groups. Such governments enriched by resource wealth may be induced by patronage, as they may pay off supporters to stay in power. Such issues result in reduced accountability and an inferior allocation of public funds (Kolstad and Søreide 2009).

Arezki and van der Ploeg (2007) notes the potential impact trade openness can have upon economies facing the natural resource curse. They note that institutional quality and trade openness could account for the per capita differences between countries where natural resources are present. They assert that corruption, bad governance, and conflict in countries are potential consequences of being endowed with natural resources. This is in turn could affect the openness of a country, as well as its trade policies.

With regard to the crowding out of capital, Gylfason (2001) asserts that countries richly endowed with natural resources may have reduced incentives to invest in human capital. Such myopic vision may cause a long-run decline in economic growth. This is due to temporary windfalls earned from the exploitation of the natural resource. When the period of accelerated growth from the natural resource sector comes to an end, the country’s labor force may not have the productivity and skills required to develop new industries that can produce revenues than the previously rapidly accelerating exportable commodity.

Myopic governments may be tempted to increase government expenditure in proportion to government revenues. Such fiscal policy contains a fundamental flaw because government revenue (taxation and royalties) from the exploitation of the natural resource may fluctuate due to external shocks. Thus, revenues may unexpectedly decline. However, the economics literature has firmly established that government expenditure is sticky downwards (Ljungqvist and Sargent 2004; Mankiw 2015; Garín et al. 2017). Thus when revenues decline, the government may not be able to proportionally cut their expenditure without causing a de-multiplier effect in the economy.

As a result of increased government expenditure during periods of rapid economic growth, very little national savings may occur. Such limited saving may result in a limited investment. Subsequently physical capital may experience a crowding out due to government spending.

Apart from Gylfason (2001) explanations for the resource curse, other reasons have been cited. These include: i) the occurrence of armed conflict in mineral dependent economies; and ii) the volatility in commodity prices. Lujala et al. (2005) elaborate on how natural resource abundance may be related to armed conflict. They cite three possible reasons for such an occurrence. The first reason is mineral rents provide large income for corrupt
government officials subsequently increasing their desire to hold political power. The second reason is the large mineral rents increase the motivation for opponents of the government to overthrow the government. The third reason is the commercial exploitation of mineral resources provides an avenue for looting and extortion. Insurgents can raise money under such avenues to fund rebellions.

The Prices of primary commodities are volatile (Blandford 1983; Page and Hewitt 2001; Collier and Hoeffler 2005). They fluctuate due to shocks in their demand and supply. Manufactured goods, however, typically do not experience such frequent and sharp price movements (Page and Hewitt, 2001). Such information is important for mineral dependent economies since their commodity price volatility would result in volatility in export revenues and government revenues. High commodity prices could result in economic booms of such mineral exporting economies. However, low commodity prices can result in a shortfall of revenues. This problem, when combined with Dutch Disease, can result in the economic bust of countries when the price of the commodity declines. After cycles of boom and economic bust, some countries highly dependent upon mineral revenues may find their long-term economic growth being low and unsustainable.

An assessment of the literature has identified potential causes for the resource curse. Collier et al. (2010) have highlighted that unsustainable increases in consumption as a result of a resource boom is undesirable. Collier et al. (2010) goes on to elaborate on the importance of saving some proportion of the revenues from a resource boom. While the author generally agrees with this principle of saving, there is room for improvement in the literature in stating how the resource rents should be allocated. This paper contributes by recommending how the resource rents should be allocated/distributed. This is discussed in detail in Section 5.

3 Methodology

3.1 Variables

As previously stated, the factors that literature identifies as determinants of the natural resource curse are: i) the abundance of the natural resource; ii) the rise in the real exchange rate (through the Dutch Disease effect), iii) trade openness, iv) volatility in the terms of trade volatility (or primary commodity prices volatility).  

2 It is noteworthy that corruption (which causes rent-seeking behaviour), the crowding out of human capital, and the crowding out of physical capital have also been proposed by Gylfason (2001) as possible determinants of the resource curse. However, these variables are not included in the model due to the difficulty in acquiring data for all the countries in the table over time.
To distinguish the direct effect of natural resource abundance and the negative resource curse effects through the above-mentioned mechanisms on economic growth, the model for the analysis is specified follows:

Real GDP growth per capita = f(Natural Resource Abundance, Real exchange rate, Trade Openness (measured by the Trade to GDP ratio))

The variables used in the analysis are real GDP growth per capita; natural resource abundance; real exchange rate; terms of trade; and trade to GDP ratio.

Real GDP growth per capita: The data on the real GDP growth per capita was obtained from the World Bank database.

Natural Resource Abundance: Most studies investigating the Natural Resource Curse Theory use natural resource exports as a percentage of GDP as a measure of natural resource abundance (Sachs and Warner 1995; 1997; Papyrakis and Gerlagh 2004; Aslaksen 2007). However, as previously mentioned, natural resource exports as a percentage of GDP measure resource dependence rather than resource abundance.

Brunnschweiler and Bulte (2008) and Alexeev and Conrad (2009) highlight that the use of resource dependence measures in the investigation of the Resource Curse Theory creates an endogeneity problem. Structural problems in an economy, which are independent of resource wealth, can result in poor growth and a lower GDP. Subsequently, when mineral exports are expressed as a percentage of GDP, it may result in a high share. Thus, there is an omitted variable bias as unobserved structural factors may result in the high value of the mineral dependence statistic.

Brunnschweiler and Bulte (ibid) recommended resource wealth per capita as a better measure of resource abundance. Subsequently, this study uses energy exports per capita as a measure of energy abundance. Thus, this study is an improvement over previous studies (Sachs and Warner 1995; 1997; Papyrakis and Gerlagh 2004; Aslaksen 2007) in its measure of resource abundance.

Petroleum exports (SITC 3) data is obtained from the WITS database, while population data is obtained from the World Bank. Energy exports per capita is computed as the ratio to petroleum exports to population size, for each country in the panel.

Real Exchange Rate: The real effective exchange rate (REER) is used as a measure of the real exchange rate. The REER data was obtained from the World Bank Development Indicators online database.

Terms of Trade: Net barter terms of trade index is used as a measure of terms of trade. The terms of trade data was obtained from the World Bank Development Indicators online database.

Trade Openness: Trade openness is measured by the Trade to GDP ratio. It is calculated by the following equation

\[ T0_{it} = \frac{(X_{it} + M_{it})}{GDP_{it}} \]
where $TO_i$ denotes the trade openness of country $i$, $X_{it}$ denotes country $i$’s total exports, $M_{it}$ is a country $i$’s total imports, $GDP_{it}$ is a country $i$’s GDP. Such data was obtained from the World Bank Development Indicators database. It is important to note that a low ratio does not necessarily imply high (tariff or non-tariff) barriers to foreign trade, but may be due to factors such as the size of the economy and geographic remoteness from potential trading partners.

It is noteworthy that human capital and corruption are also recognized as variables that contribute to the resource curse in countries. Data was not available for all the countries for human capital and corruption for the entire period. In fact, this data limitation would result in the reduction of the panel to only six countries: Iran, Mexico, Nigeria, Russia, Trinidad and Tobago (T&T), and Venezuela. This would create a small panel, which limits the ability of the study to make inferences about oil-exporting countries in general.

3.2 Data

The following countries were considered in the study: Angola, Argentina, Australia, Azerbaijan, Bahrain, Brazil, Brunei, Canada, Colombia, Congo, Denmark, Algeria, Ecuador, Egypt, Gabon, Indonesia, Iran, Iraq, Kazakhstan, Kuwait, Libya, Mexico, Malaysia, Nigeria, Norway, Oman, Qatar, Russia, Saudi Arabia, South Sudan, Sudan, Syria, Trinidad and Tobago, Timor-Leste, Tunisia, United Arab Emirates, United Kingdom, United States, Venezuela, Vietnam, and Yemen. These were the top 41 oil-exporting countries (which includes Trinidad and Tobago) based on the barrels of oil produced per day.

Due to data limitations, several countries were excluded from the panel. For instance:

- Angola, as it had no oil export data before 2007, and no oil export data for 2008, 2016, and 2017;
- Congo, as it had no oil export data before 2007, and no export data for 2015 and 2016;
- Gabon, as it had no oil export data beyond 2009;
- Libya, since it only had oil export data for 2007-2010;
- South Sudan, since it had no per capita GDP data;
- Sudan, since it only had export data for 2012, 2015, 2017;
- Syria, as its civil war and conflict caused the absence of GDP data;
- the United States, since its Congress only lifted the ban on the export of slightly refined oil in December 2015;
- Azerbaijan, Argentina, Brunei, Ecuador, Iraq, Kazakhstan, Kuwait, Oman, Qatar, United Arab Emirates, Vietnam, and Yemen were excluded as the World Bank database had no REER data;
- Timor-Leste, since it had no export data on the WITS database.
The remaining countries included Australia, Bahrain, Brazil, Canada, Colombia, Denmark, Algeria, United Kingdom, Iran, Mexico, Malaysia, Nigeria, Norway, Russian Federation, Saudi Arabia, Tunisia, T&T, and Venezuela.

It is noteworthy that there was no trade to GDP ratio data for T&T on the World Bank database. Therefore, the trade to GDP was manually computed. The import and export data for T&T was collected over the 2001 to 2015 period. They were summed to produce the total trade. The years 2016 and 2017 was forecasted with Microsoft Excel’s forecast function, which estimates based on Ordinary Least Squares (OLS). The GDP for T&T was collected from the World Bank database over the 2001 to 2017 period. Since there were 17 periods and 18 cross-sections, there were 306 observations per variable in the balanced panel.

3.3 Methodology—Pretesting

Before any regression is performed, first the data is tested for stationarity. Stationarity is a stochastic process whose joint probability distribution is independent of time. Stationarity in the weak sense requires that the mean and variance be independent of time.

\[ E(y_t) = \mu, \text{ for all } t \quad (01) \]
\[ Cov(y_t, y_{t-k}) = \gamma_k, \text{ for all } t \quad (02) \]
\[ Var(y_t) = \gamma_0, \text{ for all } t \quad (03) \]

Non-stationarity may be categorized as random walk or trend stationary. A random walk series is one with a stochastic trend. It is a non-stationary series that only becomes stationary, if it is differenced a minimum of “n” times. Such is series is said to be integrated on order \( n \), denoted \( I(n) \).

\[ y_t = \mu + y_{t-1} + u_t \quad (04) \]

where \( \mu \) is a drift, and \( u_t \) is an error process that is assumed to be independently identically distributed (i.i.d.).

Stationarity is a desirable property of data. If the data is non-stationary and its first and second-order moment conditions of mean, and variance are changing with every observation, then population inferences from the sample would be inaccurate.

The panel unit root tests used in this study are the Levin-Lin-Chu (LLC) test, the Im-Pesaran-Shin (IPS) test, the Fisher ADF and PP tests.

In each of the aforementioned panel stationarity tests, the null and alternative hypothesis are given by:

\[ H_0: \text{each time series contains a unit root } (\theta_i = 0) \]
\[ H_1: \text{each time series is stationary } (\theta_i = \theta < 0) \]

The rejection of the null hypothesis suggests that the data is “weak-sense” stationary.
3.4 Methodology-Estimation

Ordinary Least Squares (OLS) is a widely used econometric model. The model is simple, easy to apply, and can be relatively accurate if its assumptions are met. Apart from the Classical Linear Regression Model (CLRM), a basic OLS model, several regression models are based on the analysis of the conditional mean of a dependent variable. These models produce point estimates. They use data from a sample and try to determine a likely value for a population parameter. As the model estimation will produce an error, the point estimate will vary from the true parameter. If the model estimation process is reliable, valid, and consistent, the value of the estimated parameter would not significantly vary from the true parameter. Nevertheless, the limitation of the variance between the estimated value and the true value is well known in statistics, and it can be addressed by confidence interval estimation.

It is notable in statistics that a confidence interval can be computed for a point estimate, once the sample size and variance is known. However, Koenker and Bassett (1978) proposed an estimation methodology that incorporates the idea of confidence intervals and quantiles into the regression modeling. This methodology is referred to as the quantile regression.

Quantile Regression is a statistical methodology created to model, and conduct inference about, conditional quantile functions (Koenker 2000). It permits a more complete description of the conditional distribution than analysis based solely on the conditional mean.

The well-known quartiles are the median or middle quartile (Q2), the lower quartile (Q1), and the upper quartile (Q3). The median of a data set is equal to the 50th percentile of the data. It is the exact middle of a population distribution. The lower quartile is equal to the 25th percentile of the data. It separates the lowest 25% of data from the highest 75%. The upper quartile is equal to the 75th percentile of the data. It isolates the highest 75% of data from the lowest 25%.

In contrast to the OLS model which estimates the conditional mean of the response variable given certain values of the predictor variables, Quantile Regression computes the conditional median or any other quantiles of the response variable.

The Quantile Regression Model (QRM) and the CLRM are similar in certain respects, as both models can be linear, and model the relation between a dependent and several independent variables. However, the QRM and CLRM depend upon different assumptions about the residuals.

The assumptions about the error term in OLS models are:

1. The error term has a population mean of zero: \( E(u_t) = 0 \)
2. The error term has a constant variance (no heteroscedasticity): \( \text{var}(u_t) = \sigma^2 < \infty \)

3. The observations of the error term are uncorrelated with each other: \( \text{cov}(u_i, u_j) = 0 \) for \( i \neq j \)

4. The error term is normally distributed: \( u_t \sim N(0, \sigma^2) \) \( i.i.d \)

The OLS estimator is also assumed to be consistent and unbiased, given that it will hold these properties in the presence of stochastic (random) regressors when the regressors are not correlated with the error term (Brooks 2008). When the assumptions of the OLS estimator do not hold, which often occurs in empirical estimation, the estimated parameters may be inaccurate.

Quantile Regression is very attractive as it makes no assumptions about the distribution of the residuals (Koenker 2000; Austin and Schu 2003).

Assume that a researcher desires to understand the relation between two variables: \( y \) and \( x \). Following Koenker and Bassett (1978), the QRM may be expressed as

\[
y_i = \beta_0^{(p)} + \beta_1^{(p)} x_i + u_i^{(p)}
\]

where: \( y_i \) is the dependent variable, \( \beta_0^{(p)} \) and \( \beta_1^{(p)} \) are estimated coefficients, which were estimated at the \( p \)th percentile, \( x_i \) is the dependent variable, and \( u_i^{(p)} \) is the error term from the \( p \)th percentile.

Therefore, for each percentile, the QRM can compute parameters with different values. The QRM is more robust to outliers than the CLRM. Quantile regression minimizes the sum that produces asymmetric penalties for overprediction and underprediction.

The advantages of the QRM are:

a) QRM is more robust to non-Gaussian errors and outliers, in contrast to the OLS which can become inefficient if the residuals are not normally distributed;

b) QRM also provides a richer characterization of the data, allowing researchers to consider the impact of several measures of central tendency of the independent variable \( x \) on the dependent variable \( y \), not merely its conditional mean; and

c) ORM is invariant to monotonic transformations, such as \( \log(.) \).

In this study, a QRM will be used to regress the variables in the balanced panel.

4 Overview of Results

First, all the variables used in the model were logged. This transformation was performed to reduce the potential incidence of heteroscedasticity in the data, and to allow the coefficients to be interpreted as elasticities. Table 1 displays how the variables are labeled in the pretesting and estimation phases.
As a pretest, all the variables are tested for stationarity. The results are displayed in Table 2.

The results of the panel stationary tests suggest that all the variables are stationary. This is evidenced by the probability of the test statistics residing below the 10%, 5% level of significance of most of the variables, suggesting the rejection of the null hypothesis – the presence of a unit root (non-stationarity). The estimation results from the QRM are displayed in Table 3.

As can be seen in Table 3, all variables are statistically significant at the 10%, and 5% levels. This is evidenced by the probability of the t-statistic residing below the 10% and 5% rejection levels. Additionally, the probability of the Quasi-LR statistic, which is the panel version of the F-statistic for the QRM, is below the 1% significance level. This would suggest the rejection of the null hypothesis that all the estimated parameters as statistically insignificant from 0.

The marginal effect of the oil rents variable (LORENT) was -0.17. The negative coefficient suggests a negative relation between the oil rents and real per capita GDP growth for the countries in the panel. This result is consistent with the findings of multiple studies on the resource curse (Sachs...
and Warner 1995; Gylfason 2001; Sala-i-Martin and Subramanian 2003; Papyrakis and Gerlagh 2004; Kolstad and Søreide 2009) which noted a negative relation between oil export revenues and the economic performance of countries.

Table 4 displays three confidence intervals for each estimated parameter. The 90% confidence interval suggests that as a lower bound for the marginal effect of oil rents on per capita GDP growth in the panel is -0.32, but the upper bounds is -0.03.

### Table 4: Confidence Intervals for Each Variable

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coeff</th>
<th>90% CI (Low, High)</th>
<th>95% CI (Low, High)</th>
<th>99% CI (Low, High)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LORENT</td>
<td>-0.179790</td>
<td>-0.328779, -0.030801</td>
<td>-0.357489, -0.002091</td>
<td>-0.413871, 0.054291</td>
</tr>
<tr>
<td>LNBTT</td>
<td>0.861608</td>
<td>0.289648, 1.433569</td>
<td>0.179430, 1.543786</td>
<td>-0.037017, 1.760234</td>
</tr>
<tr>
<td>LREER</td>
<td>-0.782691</td>
<td>-1.220505, -0.344877</td>
<td>-1.304873, -0.260510</td>
<td>-1.470555, -0.094827</td>
</tr>
<tr>
<td>LT2GDP</td>
<td>-1.361330</td>
<td>-1.624820, -1.097840</td>
<td>-1.675595, -1.047065</td>
<td>-1.775307, -0.947353</td>
</tr>
</tbody>
</table>

Recall, a strength of the QRM is its consideration of different quantiles. Figure 2 displays 10 different quartiles for each of the estimated parameters. The confidence bands for the quantiles are narrow, suggesting that the ‘true’ value of the variables would be close to their estimated parameters.

Notable results of the QRM displayed in Table 3 are:

1. The negative relation between the REER and the real per capita GDP, suggesting as the REER appreciates countries experience a decline in economic performance. This suggests the potential for the Dutch Disease if the real exchange rate appreciation is not controlled.

2. The negative relation between trade openness (the trade to GDP ratio) and the economic performance of the oil-exporting economy. This result is plausible since the resource curse could only occur in an open economy. This result must not be misinterpreted to mean that a country should close its economy to autarky. Indeed, exports can lead to export-led growth in countries. However, countries need to be mindful of the potential of negative trade shocks to impact their economy.

3. The positive relation between the NBTT and the economic performance of the countries in the panel. Again, this result is plausible since commodity price appreciation would lead to increase revenues for oil-exporting countries.
As a robustness check, the results of the QRM is compared to a Panel OLS model. The Panel OLS Results are displayed in Table 5. In Table 5, a negative relation was found between the oil export rents and the real per capita economic growth of the countries in the panel. This result is consistent with the results of the QRM. A negative relation was also observed between the trade openness variable and the economic performance variable, similar to Table 3. However, estimated parameters for the REER and the NBTT were not statistically from 0. These results undermine the Panel OLS model.
As previously noted, the OLS model results tend to become inaccurate with its assumptions are violated. One important assumption for OLS models is normality. A normal population has a skewness of 0, a kurtosis of 3. As can be seen in Table 5, some of the variables are positively skewed and others are negatively skewed. The kurtosis of several variables is not equal to 3. This suggests that the data is not normally distributed.

The Jarque-Bera test can be used to statistically verify the normality of data. The probability of the Jarque-Bera test statistic is less than the 10% level of significance for three variables. This suggests that three variables are not normally distributed, while the other two are normally distributed. This violation of the normality assumption suggests that the Panel OLS model is not the best model. Therefore, the results of the QRM model are used over the Panel OLS model.

5 Discussion and Policy Recommendations
Petroleum natural resource abundance was found to have a negative relation with real per capita GDP growth. Additionally, a negative relation was empirically found between the real effective exchange rate and the real per capita GDP, suggesting the potential for the Dutch Disease if the real exchange rate appreciation is not controlled.
The endowment of crude oil allows a country to acquire petroleum revenues. However, natural resource rents differ from taxes earned from non-natural resource-based sectors in two aspects. First, petroleum resources are finite, so it is reasonable to infer that petroleum revenues will also be finite. Rents from the petroleum sector may peak when production peaks, but it may eventually decline as the industry becomes mature and more technically difficult to extract the oil from wells. Second, crude oil and refinery fraction prices have known to be volatile. Thus, rents from the petroleum sector would also be volatile.

Despite volatility in petroleum rents, a government’s development agenda is ongoing. The citizens of a country expect to enjoy the benefits of public expenditure. The contraction in government expenditure during periods of low revenue from the petroleum sector would result in pro-cyclical fiscal policy. Furthermore, contraction in government expenditure on public and merit goods, and social services would be disliked by voters (Bruhn 1996; Snyder and Yackovlev 2000; Ghate and Zak 2002).

As a result, a government acquiring petroleum rents should save a portion of the rents in order to avoid pro-cyclical fiscal policy. How much should a government save? The Hartwick Rule advocates that a nation should invest all rent earned from exhaustible resources in reproducible capital. “Invest all profits or rents from exhaustible resources in reproducible capital such as machines. This injunction seems to solve the ethical problem of the current generation short changing future generations by ‘over-consuming’ the current product, partly ascribable to current use of exhaustible resources” (Hartwick 1977, 972).

The reproducible capital can be any capital investment that would generate returns. For instance, the government can save all its petroleum rents in a natural resource fund. This fund, in turn, would have a fund manager, which would invest the fund in low risk fixed income securities to generate financial returns/interest, on an annual basis. When the petroleum rents are eventually depleted due to petroleum production becoming economically unfeasible, the country would be able to sustain its consumption pattern as it would be able to access the interest earned from its natural resource fund.

Fully applying the Hartwick Rule as a development policy would be extreme. Several developing countries need to address development needs. For instance, poor developing countries are likely to have high poverty rates, high unemployment levels, and weak public infrastructure (such as roads, bridges, schools, hospitals, electricity transmission, water, etc.). Moreover, the population of the resource-rich country will expect its government to increase spending on social programs. Failure to do so would weaken the ruling administration’s popularity, and strengthen opposing parties.
Therefore, it is unrealistic to expect any government of a developing country to allocate all of its rents it earns from the oil sector to a natural resource fund. The principle of “saving for rainy day” enshrined in the Hartwick Rule is sound. However, the government must spend some of its oil rents to remain in power. This raises the question of how much rents should be saved, and how much should be spent.

Consider Figure 3 which outlines various scenarios of how the resource rent may be utilized. Assume that the rents from production and export of crude oil, and possible refinery fractions start to occur in 2020. For simplicity, assume that commercial oil production and export last for 50 years. If the government spends all its natural resource rents, its expenditure would be equal to the “Revenue flow” line in Figure 3. If the government spends all its natural resource rents, its expenditure will peak whenever peak oil occurs and will contract thereafter. This expenditure pattern would result in a pro-cyclical fiscal policy. Furthermore, no savings will be acquired during the economic boom.

![Figure 3: Scenarios of Managing Petroleum Rents](source: Adapted from Collier et al. (2010))

To accurately determine the duration of the petroleum industry in any country, the reserve to production ratio would have to be calculated. Different countries would have different reserves to production ratios. For simplicity to allow for the generalization of the policy recommendations for countries, this paper assumes a 50-year duration to explain the different scenarios of the petroleum rent management.
Consider the scenario where the Hartwick Rule is implemented, and all the petroleum rents are allocated to a natural resource fund. In Figure 3, this government expenditure pattern is represented by the dotted line labeled ‘hartwick’. The line starts positively sloped to reflect the gradual increase in interest that can be earned from the natural resource fund as all the resource rents are deposited in the natural resource fund. The government does not touch the principal, so the interest grows over time. The government only spends the interest from the natural resource fund. Since the interest grows over time, the government expenditure will grow over time. At some point in time, the petroleum reserves will be fully exhausted. By this time, no further contributions can be made to the natural resource fund. However, since the natural resource fund’s principal is untouched, it can provide a constant interest every year.

While the long-run outcome of the Hartwick Rule may be desirable, it is highly likely that the government would face increased political pressure to increase its public expenditure from the onset of receiving petroleum rents. Therefore, in a real-life scenario, a government may be unable to fully implement the Hartwick Rule.

In the permanent income hypothesis (PIH) scenario, the state attempts to smooth expenditure between the present and the future. To do such, it requires the government to borrow during periods in which its permanent income is greater than its actual income, but save and accumulate assets when actual income becomes larger than its permanent income. While such argument seems logical, once the government starts borrowing on the cusp of the boom to finance increases in its public expenditure, it may be difficult for a government to stop borrowing, or curb increases in public expenditure at the end of the period of robust growth. Indeed, government expenditure has built-in inertia.

If a government applied the permanent income hypothesis, it would immediately increase its borrowing to finance higher public expenditure, based on the expectation of petroleum revenues. Increases in public expenditure, and borrowing before a barrel of oil has been produced is likely to result in dissaving in the presence of robust economic growth. At the end of the boom, the government would have higher public debt and high public expenditure that would be difficult to reverse. This would place the government in a very challenging fiscal position.

In Figure 3, the application of the PIH results in a constant expenditure (on the top half of the diagram), but continuous dis-saving (on the bottom half of the diagram). It is noteworthy that this study’s interpretation of the savings under the PIH differs from the scenario proposed by Collier et al. (2010). The savings under the PIH in Collier et al. (2010) study eventually becomes positive. However, this study makes a different argument by asserting early borrowing by the government may induce a propensity to
excessive borrow, a habit that may be difficult to turn away from when the strong growth eventually tapers off. Subsequently, too much borrowing and inertia in public spending may cause dis-savings to be continuous. Dis-savings, and the accumulation of public debt is a serious issue for concern. As a country’s external debt grows to unsustainable levels, it tends to experience debt overhang. Furthermore, as noted in a study by McLean and Charles (2018), debt overhang can comprise the economic growth of countries. Moreover, the study found that that a 1% rise in the debt to GDP ratio results in a 0.015% decline in real GDP growth for the countries analyzed in their panel of Caribbean countries. That suggests that debt has a pernicious effect on the economic growth of Caribbean economies. What is even more disturbing was the finding that Caribbean economies did not display the traditional non-linear (bell-shaped) causal relationship between debt and growth, where there is a range in which a positive relation between debt and growth exists.

This study contributes to the literature by recommending a new optimal scenario. The optimal scenario is where the government decides to save a proportion of its natural resource rents in a natural resource fund, and the remainder is allocated towards the building of economic productive capacity in the country. Such government expenditure may be represented by the dotted line ‘optimal’ in Figure 3.

The key aspect of the optimal scenario is how the government spends its resource rents. Rather than using resource rents to cover recurrent expenses (such as wages, and bills), it should be utilized to develop the productive capacity of the economy. For example, rather than extracting US$20 million in crude oil from the ground, and recording only US$20 in the national treasury, investment should be undertaken in business activity to increase the US$20 million to US$60 million. In other words, investment should be undertaken to extract more monetary value from the crude oil than the value, which is created by the product of oil price, and the quantity produced. The combination of such investment strategy, as well as the returns from the natural resource fund, would result in continuous accumulation of savings as well as sustainable public expenditure patterns.

It is important to note, the optimal scenario recommended in this paper differs from that recommended by Collier et al. (2010), to the extent that Collier et al. (2010) recommendations would be a parallel line to the Hartwick scenario. The interest from the natural resource fund is what is

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4 It is noteworthy that the optimal scenario proposed in this study is different from the scenario proposed by the Collier et al. (2010). Collier et al. (2010) recommendation would have resulted in the government spending some funds, and saving the rest. This is depicted on a curve that is parallel but lower than the Hartwick Rule scenario. This study contribution is on how the money should be spent. This study accentuates that the government should save part of its oil rents, but the part that it spends should be allocated on building the productive capacity of the economy.
Avoiding the Natural Resource Curse: An Optimal Use of Oil

used to sustain consumption in Collier et al. (2010) optimal scenario. However, this paper argues that the optimal scenario is one in which the government channels its expenditure to build productive capacity, which eventually generates sustainable income, in addition to the interest earned from the natural resource fund.

The optimal strategy is not automatically achieved. It may only be attained by the combination of local content policy, an investment strategy to encourage business activity, labor policy to ensure good industrial relations and a productive labor environment, and education policy to guarantee the correct technical skills are generated to supply industries.

A big question that arises is what political economy will support the optimal strategy? Certainly, a democracy would be preferred to prevent autocracy, and to facilitate the removal of inept leaders. The optimal strategy requires fiscal prudence and discipline. This can be complemented by the implementation of fiscal rules. Fiscal rules are rules which are generally backed by legislation to regulate how governments manage their public finance. In general, there are four main types of rules: i) revenue rules which limit how much revenues are allowed to enter the budget; ii) expenditure rules which limit the size of government expenditure; iii) balanced budget rules; and iv) a ceiling on the amount of public debt the government can acquire in relation to GDP (Bauer 2014).

Rules for the allocation of rents to natural resource funds are revenue rules. To avert the ad hoc allocation of petroleum rents to a natural resource fund, the allocation should be based on well-defined rules. For instance, if the price of oil crosses a particular dollar amount, then x percentage of the marginal revenue should be automatically allocated to the natural resource fund. The allocation of some of the petroleum rents to a natural resource fund can restrict the spending effect that typically occurs in the Dutch Disease model. Restricting the spending effect is likely to curb the rapid increase in domestic prices, and prevent large-scale appreciation of the real exchange rate.

However, it is possible for governments to make allocations to their natural resource fund, and still borrow to finance wasteful expenditure. Fiscal expenditure rules place a legal limit on government expenditure. They can be used to directly prevent a government from proportionately increasing its expenditure in a Wagner’s Law like manner in the presence of robust economic growth. Fiscal expenditure rules are transparent, can be administered very easily, and they can be directly targeted at reducing the high expenditure pressures, which cause excessive and persistent fiscal deficits. Fiscal expenditure rules are very important tools for restraining government expenditure, especially when the general public may expect the government to spend more funds on transfers and subsidies (Cordes et al. 2015).
Although this study did not include a variable for corruption in the model estimation, corruption has been noted as a variable that affects countries’ economic performance in the natural resource curse literature (Gylfason 2001; Kolstad and Søreide 2009).

Large petroleum rents create enormous temptations for corrupt rent-seeking behaviors by public officials (Karl 1997; Leite and Weidmann 1999). Second, the lack of free-market competition for natural resource rents tends to encourage corruption (Ades and Di Tella 1999). Non-properly defined property rights, loopholes in tax legislation, labor shortages in public license offices, deficiencies in the reporting and recording of information all make the rent-seeking by bureaucrats easier (Gylfason 2001).

It is noteworthy that there is scope for corruption to occur in energy ministries in the awarding of exploration blocs, and production sharing contracts. Additionally, there is also room for nepotism to occur in the hiring “political party favorites” in the energy ministry. This paper argues that all instances of corruption will undermine the proposed optimal scenario is the ‘best’ value will not be earned from every dollar spent. Rather, corruption, in its various forms, would favor rent-seeking behavior.

Transparency is increasingly viewed as an integral measure of limiting corruption in resource-rich developing countries (Kolstad and Wiig 2009). In this regard, countries can be encouraged to join the Extractive Industries Transparency Initiative (EITI) to encourage transparency in petroleum taxation reporting. The EITI could also encourage transparency by reporting how the government spends its petroleum revenue.

Furthermore, strengthening and enforcing legislation to penalize the violation of public procurement rules, and the miss-management and appropriation of public funds are useful policy measures to discourage corruption.

6 Conclusion

From a panel of 18 countries over the 2001 to 2017 period, this study found that petroleum natural resource abundance can have a negative relationship with real per capita GDP growth. Thus, oil-rich developing countries should be cautioned about the potential for high oil export revenues eventually cause a reduction in their real per capita GDP growth. The energy exports per capita is a better measure of energy abundance than the natural resource exports as a percentage of GDP, which is typically used in many studies. Thus, by the better measurement of energy abundance, this paper provides an empirical contribution.

This study contributed to the natural resource curse literature by its presentation of an alternate scenario for the management of natural resource funds. This study suggests that the PIH is not the optimal scenario for the management of natural resource funds as it induces a government to...
commence borrowing before the onset of the boom. When the boom comes to an end, inertia in public spending may cause the government to continue borrowing.

This study proposes that the optimal approach for the management of natural resource funds is one in which a proportion of the natural resource rents is saved in a low risk – interest bearing natural resource fund, and the remainder is used to develop the productive capacity of the economy. The development of such productive capacity would require policies to encourage local content, enable business activity, foster good industrial relations, and generate a productive labor supply.

This study also found that the appreciation of the real exchange rate, as well as increases in corruption perception, were also found to negatively affect economic growth. Real exchange rate appreciation can cause Dutch Disease effects in an economy. However, the optimal revenue management strategy proposed in this paper can be complemented by fiscal rules to regulate government spending; curbing the spending effect which occurs in the Dutch Disease framework, and implementing an industrial restructuring and export diversification programme to move away from an over-reliance on natural resource exports where applicable. Furthermore, institutional strengthening can be undertaken to avert potential corruption and the mismanagement of natural resource rents.

In going forward, oil prices and likely to remain volatile. Unexpected economic events may cause sharp changes in the price of oil, subsequently resulting in large changes in oil export revenue. What is worrisome for several oil-exporting countries is an unexpected decline in oil prices as it would result in a large decline in oil export tax revenues.

Future research could be directed at the modeling and forecasting of oil prices. Econometric models such as the Autoregressive Integrated Moving Average (ARIMA) model, or the Artificial Neural Network (ANN) model could be used for this forecasting. If oil prices can be predicted with a good degree of accuracy, then governments of oil-exporting countries may make budgetary allocations based upon realistic oil prices rather than upon optimistic estimates.

Future research can also be directed upon how the government may manage its oil revenues and oil-related expenditure in the face of oil price volatility. The Generalized Conditional Heteroscedasticity (GARCH) family of models can be used to model oil price volatility. The results of the GARCH could be integrated with structural models such as the Vector Autoregressive (VAR) family of models to quantify the impact of oil price volatility upon government revenue, government expenditure, the fiscal balance, government debt, and other public finance metrics. Scenario analysis can also be performed to determine the potential impact of oil prices, on the
public finance metrics under various scenarios. This information can be very useful for governments, and help them develop comprehensive budgetary frameworks in the face of oil price uncertainty. The aforementioned future research can complement this present research, as the forecasted oil prices can determine the potential oil rents, which in turn would affect how much oil rents could be allocated towards the development of the productive capacity of oil-rich economies.

References


Avoiding the Natural Resource Curse: An Optimal Use of Oil


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