TIME SERIES STUDY OF EFFECTS OF PETROLEUM PRODUCTION ON GDP

An Honors Fellow Thesis

by

Leslie Allyse Ballinger

Submitted to Honors and Undergraduate Research
Texas A&M University
in partial fulfillment of the requirements for the designation as

HONORS UNDERGRADUATE RESEARCH FELLOW

May 2012

Major: Sociology

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ABSTRACT

Time Series Study of Effects of Petroleum Production on GDP. (May 2012)

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This paper uses Maddison data on GDP in major oil-producing countries to analyze whether correlations exist between metric tonnage of oil produced and the economic development of the country. For my purposes I use GDP per capita to measure economic development. The countries studied include: Argentina, Canada, Colombia, the United States, Mexico, Venezuela, Peru, and Indonesia. The dates of analysis are different for every country due to data reliability. This paper focuses mainly on a time series analysis of the correlations between GDP and oil data. GDP is compared to oil production to determine if any statistically significant relationships exist, both conterminously and with GDP lagged behind oil production by one or two years. I examine discontinuities, or sudden changes in oil data that might indicate a significant development in that year. Most data produced correlation coefficients between .60 and .90, showing overall strong positive relationships between oil production and GDP. This is to be expected since the countries picked for this analysis were chosen because of their prominence as major oil producers. None of the countries studied produced a negative correlation, meaning that as petroleum increased, so did GDP. The countries in which GDP and oil output were

almost or exactly coterminous, it can be inferred that the economy is less diverse; that is, the fewer the variables available to affect the economy, the more likely it is that the variable will have a strong effect. Venezuela showed the strongest coterminous relationship and Mexico showed the weakest statistical correlations. Because oil eventually ceases to produce exponentially growing profits, the corresponding results appear as a "curse" or negative economic effects. The oil production is essentially a catalyst in the resource cycle.

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CHAPTER I

INTRODUCTION AND LITERATURE REVIEW

Introduction

Economic development is a complex process dependent on many intervening factors. One important factor is the presence or lack of natural resources, and the efficiency of the government in managing these resources. Previous research indicates that the presence of natural resources can harm the economic development of a country, a paradox most commonly referred to as the "resource curse." This paper aims to analyze whether a resource curse occurs in major oil-producing countries by comparing GDP per capita growth to output of crude petroleum in the crucial historical developmental period between 1900 and 1950. Petroleum production has a wide impact on GDP because it is a central industry around which several other industries can profit. The actual production process creates jobs, generates investments, and requires the collection of raw materials such as steel and iron for equipment. Petroleum can be used domestically and exported for profit. However, the effect of petroleum can sometimes lag because of bureaucratic inefficiencies and physical implementation delays. Therefore, the time series focus of this paper will take in to account possible lagged effects of petroleum output on economic development.

This thesis follows the style of the *American Journal of Sociology*.

Literature review

Most literature indicates that natural resources affect developing countries more than developed countries because the former are more dependent on internal resources and have less diverse economies. Scholars still debate as to the existence and exact causality of the resource curse. Natural resource profits can "curse" a country in two ways. First, corrupt official in the government can seize the assets from a resource such as oil, charge rent on land, bribe people of power, and extort the general public (Buttonwood 2012: 74). All discussions of resource management in this paper will follow Dam's assumption that "resources are almost certain to be owned at the outset by the government" (Dam 1976: 3). Second, the money from the resource production can cause the country's own manufacturing to plummet in value; literature names this phenomenon the "Dutch Disease" after it happened in the Netherlands in the 1960's (Kohler 2011: 1). Torvik's research shows that onshore oil drilling can often cause disruptive conflict (Torvik 2009: 249). De Tiago, Kamiar Mohaddes, and Mehdi Raissi used complex econometric statistics to determine the existence of a resource paradox. Their empirical studies suggested that "oil abundance by itself does not seem to be a curse" (de Tiago, Mohaddes, and Raissi 2011: 315). Scholars are starting to recognize that the poor economic development of resource-rich nations may be due not to the resources themselves but to corruption in government (Kurtz, Marcus, and Brooks 2011: 763).

Government, when it controls natural resources, must always form a contract with a private company because governments are not manufacturing companies. David H. Bearce and Jennifer A. Laks Hutnick attribute the resource curse to a “political immigration curse”; that is, oil-rich countries tend to import foreign labor and thus offset the political equilibrium of the country (Bearce and Hutnick 2011:712). Torvik found that most developed countries with stable and diverse economies did not suffer from resource production (Torvik 2009: 248). Norway has gained economic prestige through its numerous resources: timber, minerals, oil, natural gas, and fish (Torvik 2009: 250). Natural resources have the potential to act favorably towards economic development. However, most empirical research has been conducted on data from the late twentieth century (van der Ploeg 2011: 379). This paper will take a less-traveled path toward the resource curse at the very start of the twentieth century, when oil and similar resources became crucially important for the first era in history.

CHAPTER II

METHODS

Data

I use Angus Maddison's data on GDP (Maddison 2010) in major oil-producing countries to analyze whether correlations exist between metric tonnage of oil produced and the economic development of the country. For my purposes I use GDP per capita to measure economic development. Petroleum is recorded in 1,000 metric tons. In the graphs the GDP is scaled so that the increases and decreases can be viewed simultaneously with the changes in crude petroleum production. I scaled the GDP by multiplying the raw numbers so they matched the range of the petroleum data. This makes the graph easier to read and the changes in both variables more apparent. The countries to be studied include: Argentina, Canada, Colombia, Indonesia, Mexico, Peru, the United States, and Venezuela. For countries in which no scaling was needed, the multiplier is marked "1" (Table 2.1).

Table 2.1 Multipliers Used to Scale GDP in Major Oil-Producing Countries

Country	**Multiplier**
Argentina	1000
Canada	1
Colombia	10
Indonesia	10
Mexico	10
Peru	1
United States	10
Venezuela	1

The dates of analysis are different for every country due to data reliability (Table 2.2). The graphs begin five years before the start of major oil production to show general economic stability. In some countries in which oil production started early or remained relatively stable and unchanging, the years of analysis start as early as reliable data allow.

Table 2.2 Years of Analysis for Major Oil-Producing Countries

Country	**Years of Analysis**
Argentina	1915-1950
Canada	1929-1950
Colombia	1927-1950
Indonesia	1905-1950
Mexico	1909-1949
Peru	1915-1950
United States	1907-1950
Venezuela	1921-1948

Analyses

This paper will focus mainly on a time series analysis of the correlations between GDP and oil data. Both graphs and statistical tables will be used for data analysis. On the graphs, I will look for discontinuities, or sudden changes in oil data that might indicate a significant development in that year. GDP will be compared to oil production to determine if any statistically significant relationships exist. I will use the statistical tables to calculate the correlational coefficients. Once these correlations have been determined, I will separate the countries into various categories:

I) Countries whose oil production has no significant effect on GDP.

II) Countries whose oil production has an instantaneous effect on GDP. Instantaneous effects are defined as those that appear within two years of the change in oil production. This two-year time gap is meant to allow for time lags created by bureaucracy and policy implementation.

III) Countries whose oil production has a lagged effect on GDP. If data allows, these countries will be further divided:

   a. Countries whose oil production has a short-term lagged effect (three to seven years).

   b. Countries whose oil production has a long-term lagged effect (eight or more years.)

After these countries have been categorized accordingly, I will analyze which group has the most significant positive changes in GDP (i.e. which countries profit most from their oil production): the countries with "slow" oil, or oil that produces lagged effects, or countries with "fast" oil (oil that creates instantaneous effects). I will conduct the same analyses with countries in which oil had a slow or fast negative affect on GDP. I will then divide the population of cases into stratified subsamples that will theoretically behave differently and retry different correlations until I can identify any substantial variable that might be key in determining whether oil will have a negative or positive effect on economic development. The literature suggests that developing countries will demonstrate a “resource curse” effect; theoretically, oil will negatively affect GDP in these countries, while developed countries should have positive aftermaths from oil. However, the literature does not discuss in great length any institutional variables that might result in lagged effects. Lags could occur because the complex bureaucracy of a government is less efficient when initiating change (resulting in a positive but lagged effect). Time is required for wealth from petroleum production to “trickle down” into other economic sectors that give rise to per capita GDP. Instantaneous effects from “fast oil” most likely result from abstract economic indicators such as stock market values increasing.

CHAPTER III

RESULTS

Statistical correlational coefficients

Simple perusal of the scaled GDP and petroleum production graphs can be misleading. Rather than using these graphs to estimate correlation, I used them for a post-statistical research on stability of the economy before oil production and to identity large trends in the data. Using standard statistical software, I calculated the correlation coefficients between oil production and GDP for the years of analysis in each country. For every country, three coefficients were produced:

1) The “non-lagged” coefficient, in which the GDP and oil production from the same year were compared.
2) The “one-year lag” coefficient, in which oil production was compared to GDP from the following year.
3) The “two-year lag” coefficient, in which oil production was compared to GDP from two years later.

Because of the small date ranges for each country, lags larger than two years became impractical and led to too many lost cases. If the study extended past 1950, larger time lags would become available for analysis.

Argentina

Three ratchet changes in particular are noticeable on Argentina's graph (Figure 3.1). In the first, oil production decreases between 1915 and 1916. Between 1917 and 1918, GDP also decreases. The second ratchet change starts with an oil decrease between 1929 and 1930 followed by a GDP decrease between 1933 and 1934. The third noticeable lag begins with an increase in oil between 1942 and 1943; the correlating GDP increase occurs between 1944 and 1945. The non-lagged correlation coefficient for the GDP and oil production data from 1915 to 1950 was .7973. When GDP was lagged one year behind oil production, the correlation coefficient decreased to .7913 (for the years 1916 to 1949) and decreased again in the two-year lag to .7863.

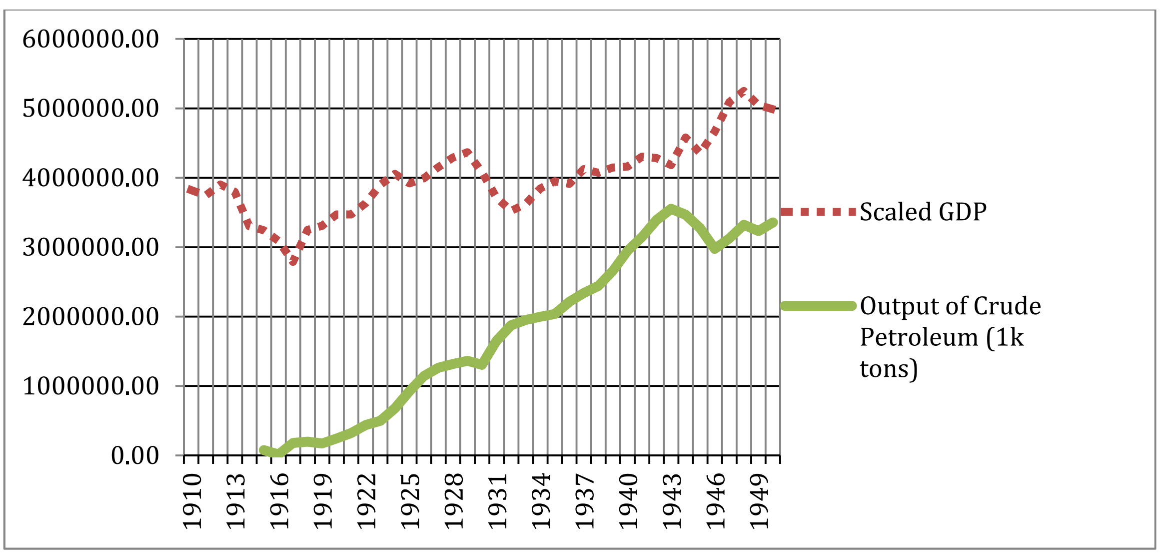

Figure 3.1 Argentina: Scaled GDP and Output of Crude Petroleum

GDP decreases for a few years before oil production began; this may indicate poor initial investment potential. This would account for the dip in oil production before steady growth begins in the early 1920's (i.e. the industry was not able to sustain itself).

Canada

Canada's graph shows a stable economy before the start of oil production, suggesting the potential for high initial capital in exploratory wells (Figure 3.2). The sudden changes in GDP not due to petroleum should be viewed in the context of other historical phenomena, such as the geographic expansion of Canada during the twentieth century. A dip in the oil production during the late 1940's (when United States oil production spiked) might indicate resources being diverted to investments other than oil. The non-lagged correlation coefficient for the GDP and oil production data from 1929 to 1950 was .7311. Lagging the GDP data dramatically increased the correlation coefficients in Canada: the one-year lag coefficient was .8404 and the two-year lag coefficient was .9477. Therefore, Canada has a "slow" rather than an instantaneous oil effect.

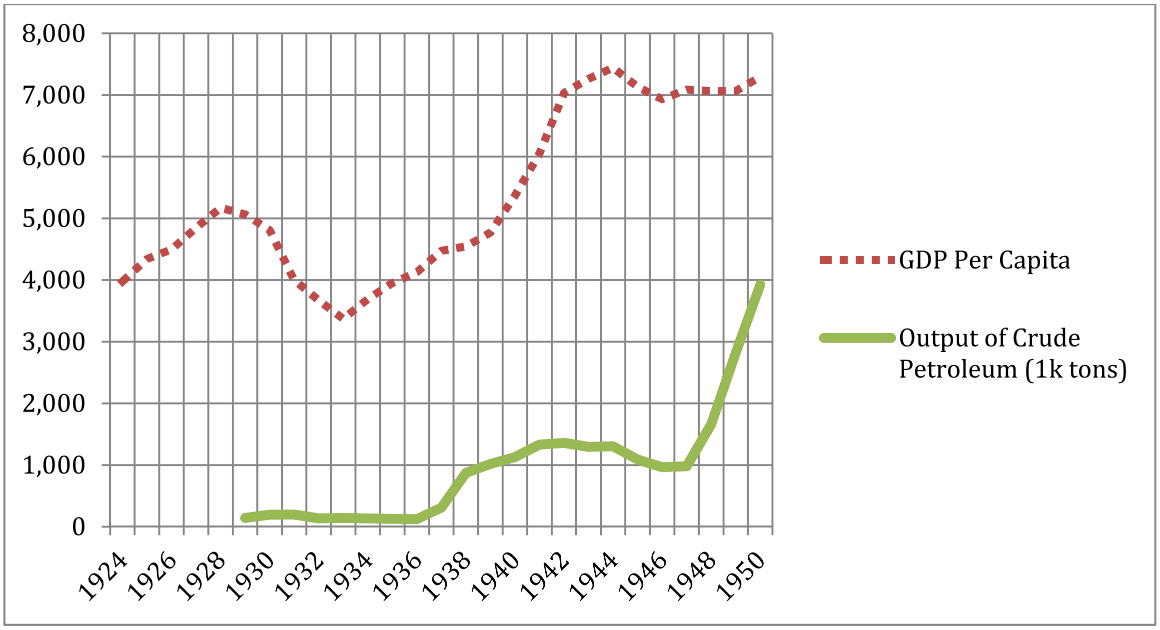

Figure 3.2 Canada: Scaled GDP and Output of Crude Petroleum

Colombia

A small decrease in petroleum output between 1941 and 1942 corresponds to a small ratchet change in GDP between 1943 and 1944 (Figure 3.3). While Colombia's graph suggests small lags, its non-lagged coefficient was the highest, indicating that whatever effect oil had on GDP was instantaneous. The non-lagged correlation coefficient for the GDP and oil production data from 1927 to 1950 was .6668. The coefficient decreased as the data lagged from .5833 (one-year lag) to .3920 (two-year lag). Colombia's coefficients suggest that its oil production can generate immediate wealth but disappears soon and does not leave lingering effects. The literature might classify this as a resource cursing a developing country, but the lack of a strong positive effect should not be equated with a negative effect.

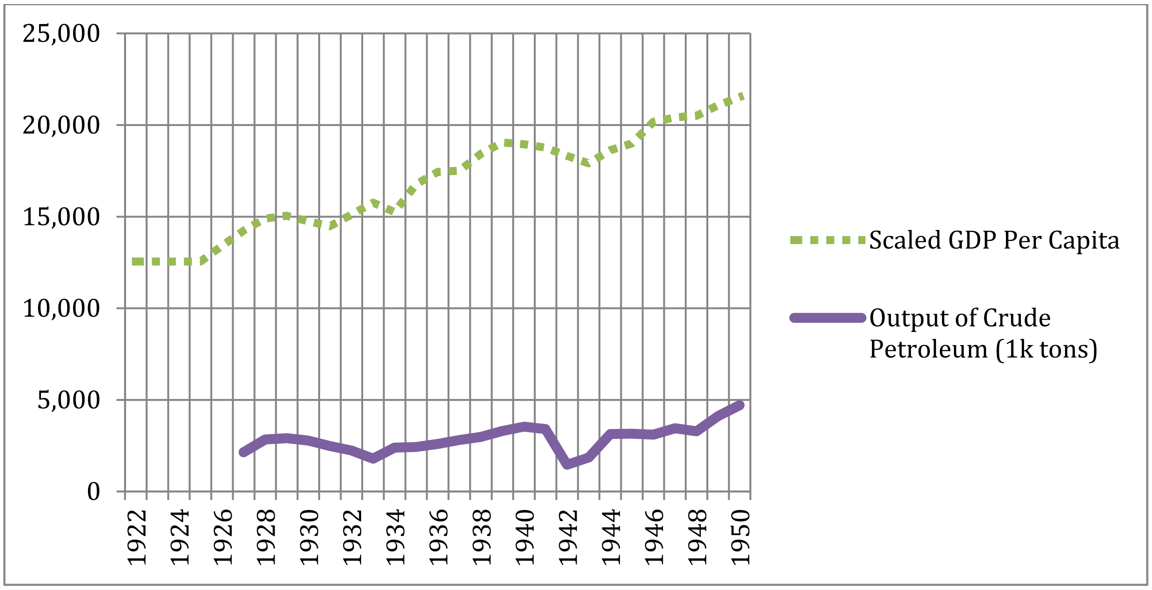

Figure 3.3 Colombia: Scaled GDP and Output of Crude Petroleum

Indonesia

Indonesia's graph shows no clear correlation, and its statistical correlations are moderately strong (Figure 3.4). Political turmoil during the 1940's most likely caused the plummet in oil production, although the missing GDP data prevent further analysis. Indonesia shows small lags, but full analysis is hindered by gaps in GDP data during the 1940's. The non-lagged correlation coefficient for the GDP and oil production data from 1905 to 1950 was .7506. The coefficient increased to .7774 (one-year) and .8202 (two-year). These coefficients indicate that if the change in GDP is attributed to oil, the effect is lagged. Most likely this is a spurious relationship because extensive wars in the early twentieth century in Indonesia are confounding variables the oil production data.

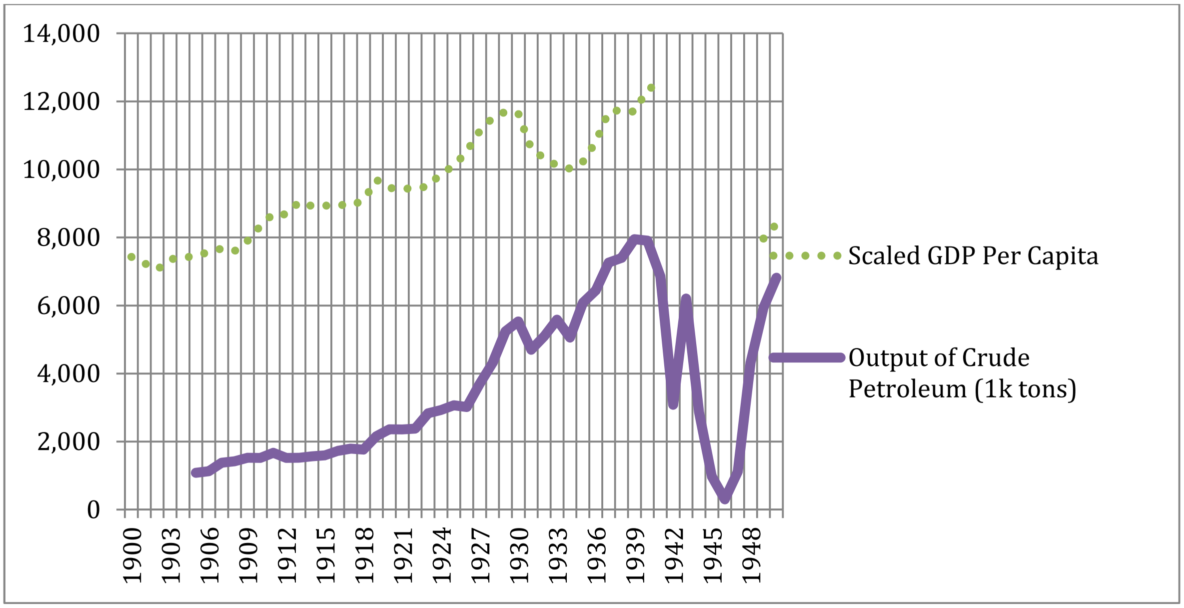

Figure 3.4 Indonesia: Scaled GDP and Output of Crude Petroleum

Mexico

Mexico's graph indicates almost no relationship between oil production and GDP per capita (Figure 3.5). The coefficients are some of the weakest found in this study and decline in very small amounts. The non-lagged correlation coefficient for the GDP and oil production data from 1909 to 1949 was .1453. The one-year lag coefficient was .1251. The two-year lag coefficient was .1069.

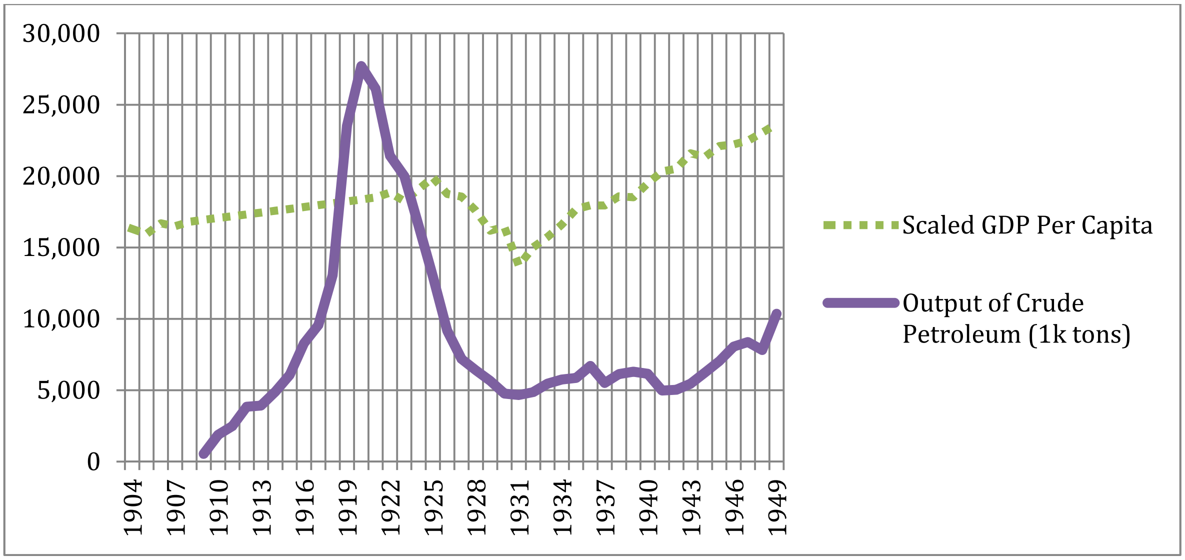

Figure 3.5 Mexico: Scaled GDP and Output of Crude Petroleum

Peru

Peru's graph indicates that the two variables are coterminous until the early 1930's and then shows lag effects in the late 1930's and early 1940's (Figure 3.6). Peru's graph shows a small lag effect during the early 1940's. These relationships are confirmed by Peru's correlation coefficients. The correlation coefficient for the GDP and oil production data from 1915 to 1950 was .8927. The coefficient decreased slightly in the one-year lagged data to .8824. It decreased again in the two-year lagged data to .8371. Peru's oil is "fast" in that its effects on GDP are relatively immediate.

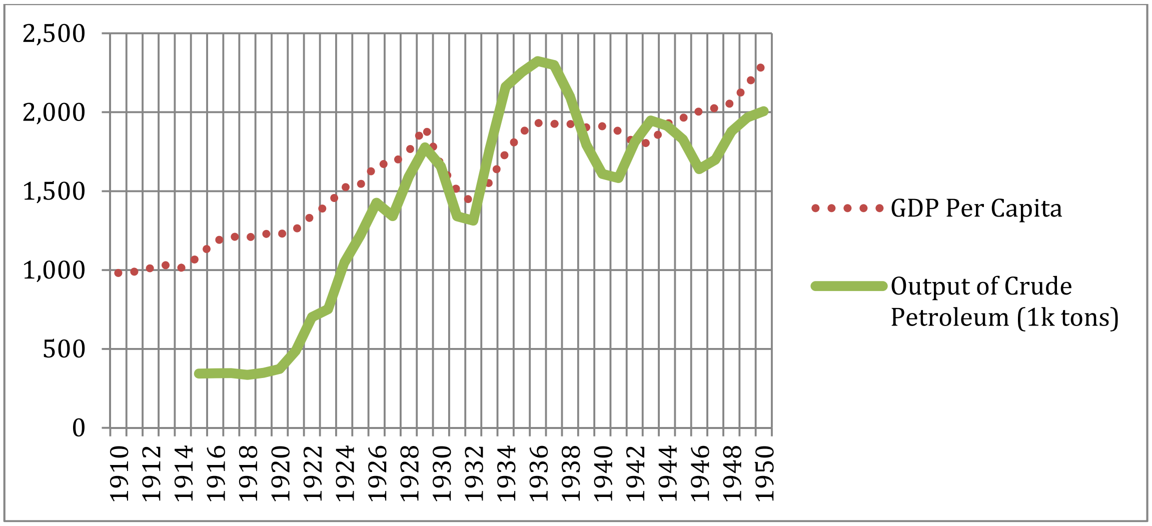

Figure 3.6 Peru: Scaled GDP and Output of Crude Petroleum

United States

The gaps between the GDP and petroleum lines on the United States graph belie the high correlation coefficients from the data (Figure 3.7). The most obvious GDP ratchet changes can be attributed to historical circumstances such as the Great Depression in the 1930's and the postwar economic boom in the late 1940's. The non-lagged correlation coefficient for the GDP and oil production data from 1907 to 1950 was .8325. When the data was lagged one year, the correlation coefficient decreased to .8143. The two-year lag coefficient was .7936. Although the United States has a diverse economy its oil can still be classified as "fast."

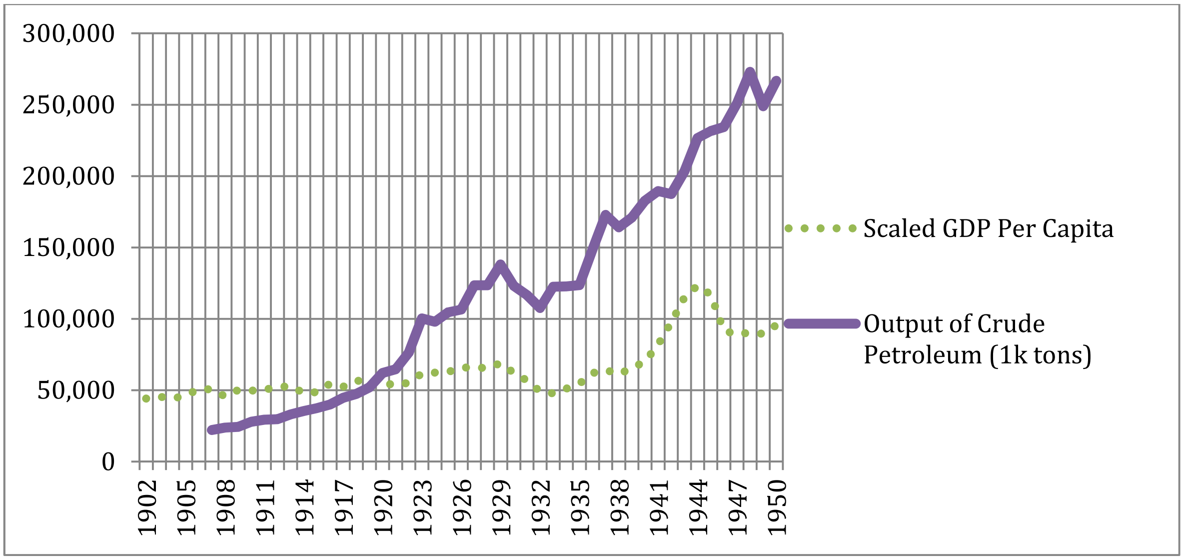

Figure 3.7 United States: Scaled GDP and Output of Crude Petroleum

Venezuela

Venezuela's graph shows a steadily increasing GDP before the start of major oil production (Figure 3.8). It is safe to assume that Venezuela's economy was stable enough for efficient investment in petroleum, which allowed the oil to influence GDP more quickly. The year 1921 was significant in Venezuelan oil history; on December fifth Rockefeller's Standard Oil incorporated a Venezuelan division (Martinez: 39). Venezuela's data show a very close correlation between GDP and petroleum production. The correlation coefficient for the GDP and oil production data from 1921 to 1948 was almost perfect at .9835. The one-year lag coefficient was .9586 and the two-year lag coefficient was .8961.

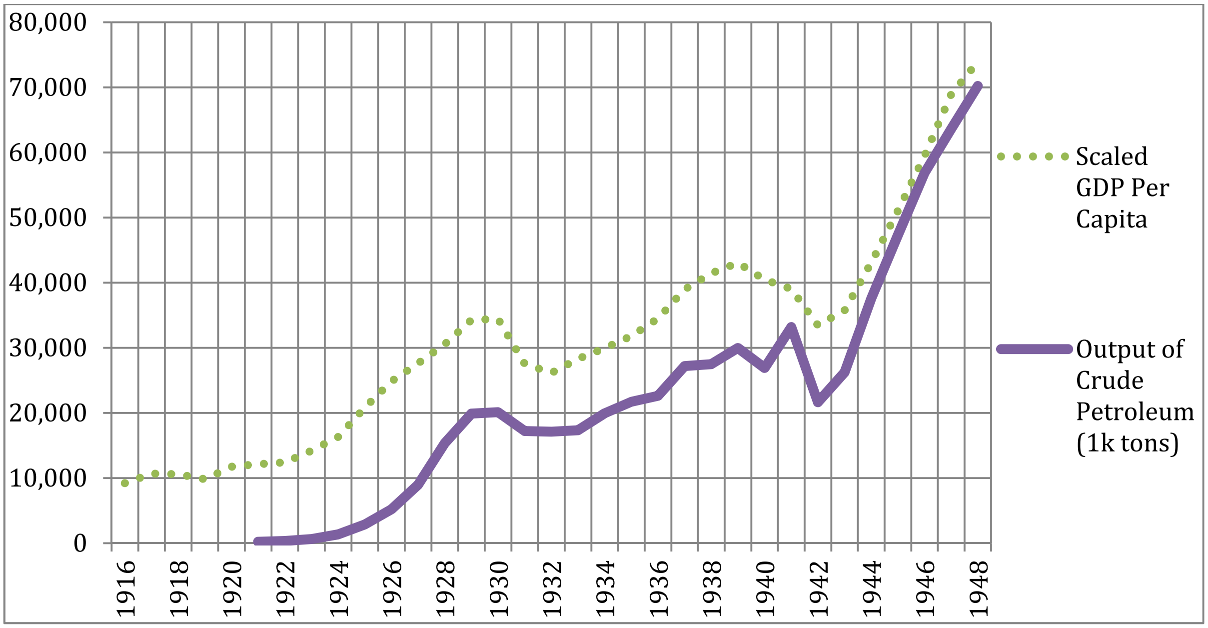

Figure 3.8 Venezuela: Scaled GDP and Output of Crude Petroleum

Overall results

The countries did not fit into the categories I first proposed for this paper, because not as many lag effects as I expected appeared in the data. Instead of dividing the countries into categories, I divided the "lag periods." That is, a country's one-year lag data would be classified separately from its two-year lag data set and its non-lagged data set. I included numerical boundaries for the correlation coefficients for each category (Table 3.1). The new categories are:

I) Countries/Lag Periods whose oil has little or no significant effect on GDP. This group includes data sets in which the correlation coefficient was less than .60.

II) Countries/Lag Periods whose oil has a moderate effect on GDP. The correlational coefficient range for this group was .61 to .84.

III) Countries/Lag Periods whose oil has a high effect on GDP. The correlational coefficient minimum for this category was .85.

Table 3.1 Data Sets Grouped by Correlation Coefficients

Group I: Coefficients at or below .60	**Country**	**Lag Period(s)**
	Colombia	1 year lag 2 year lag
	Mexico	Non-lagged 1 year lag 2 year lag
Group II: Coefficients between .61 and .84	**Country**	**Lag Period(s)**
	Argentina	Non-lagged 1 year lag 2 year lag
	Canada	Non-lagged 1 year lag
	Colombia	Non-lagged
	Indonesia	Non-lagged 1 year lag 2 year lag
	Peru	2 year lag
	United States	Non-lagged 1 year lag 2 year lag
Group III: Coefficients at or above .85	**Country**	**Lag Period(s)**
	Canada	2 year lag
	Peru	Non-lagged 1 year lag
	Venezuela	Non-lagged 1 year lag 2 year lag

Overall, Mexico and Colombia show the weakest correlations between GDP and petroleum output. Peru and Venezuela have the strongest correlations. There is no significant lag effect in Argentina, the United States, and Indonesia (i.e. all three data sets of those countries fall into the same group). Peru and Venezuela's oil production has an instantaneous effect on GDP. There is no consistent grouping by geographical location. In Mexico, the United States, and Indonesia, the coefficients remain fairly close in all lag periods.

CHAPTER IV

SUMMARY AND CONCLUSIONS

I hypothesized that petroleum production would cause the GDP to change, but these correlations should not be interpreted as causations. It is just as likely that initial capital and the state of the economy (i.e. GDP) could cause the increase in petroleum production. Therefore, the correlation coefficients show only the strength of the relationship between the two variables.

The country with the lowest non-lagged coefficient was Mexico. The country with the highest non-lagged coefficient was Venezuela. Most data produced correlation coefficients between .60 and .90, showing overall strong positive relationships between oil production and GDP. This is to be expected since the countries picked for this analysis were chosen because of their prominence as major oil producers. None of the countries studied produced a negative correlation, meaning that as petroleum increased, so did GDP. The countries in which GDP and oil output were almost or exactly coterminous, it can be inferred that the economy is less diverse; that is, the fewer the variables available to affect the economy, the more likely it is that the variable will have a strong effect. This inference is supported by every case except the United States. In the case of Venezuela, it seems that petroleum dominates the economy unhindered by other commodities. Lagged effects were different for almost every country, but their presence suggests a need for individual case studies. I maintain that economic diversity is crucial in any study involving these variables. The fewer resources that exist in an economy, the larger and more instantaneous effects they will have on overall growth.

When separated into categories of core, semi-periphery, and periphery, the countries did not produce similar coefficients. Therefore I do not attribute the results I found to government efficiency of each country; the explanation necessitates a business investment perspective on the diversity of each economy. I propose that the “resource curse” is actually a resource cycle. If a country’s economy is initially successful, the capital can be invested in profitable industries such as oil. The industry then produces more economic capital that can be divided between reinvestment in the same industry and new investment in different industries, thus diversifying the economy. The government of the investing nation determines the path that follows this cycle. When major oil production begins, the industry itself creates a micro-economy. The establishment of oil production creates revenue in various sectors of the economy: jobs for skilled and unskilled workers, monetary investments and stock exchanges, manufacturing and raw materials to produce exploratory equipment, and business contracts between management companies, production companies, and (in most cases) the state government. At the initiation of major oil production, this micro-economy booms and creates revenue and instant GDP, provided the startup capital was adequate for quality investments. The managing entity (i.e. the government) then has an opportunity to disperse this income. The two options are: reinvest in oil production or divert the resources into other sectors, thus diversifying the economy. Once oil production plateaus or the rate of increase slows, the boom from the initial investment disappears. Long-term oil production does not in itself produce exponential revenues; the exploration of new wells acts as a catalyst for additional investment. The countries with lagged effects (e.g. the United States) have diverse economies; the monies from oil production most likely were reinvested in different industries. Time is required to reinvest and the funds to influence other parts of the economy. Less diversified countries generally do not show lagged effects of oil production on GDP. In countries with instantaneous oil effects (e.g. Venezuela), the money was reinvested in oil exploration and extraction. Because oil eventually ceases to produce exponentially growing profits, the corresponding results appear as a “curse” or negative economic effects. Past scholars have blamed the natural resources as “cursing” a nation, but resources are simply pieces of larger economic cycles – therefore, the term “curse” is misleading because it indicates a one-way trajectory. The oil production is essentially a catalyst in the resource cycle.

Implications for further research

The “resource course” theory extends over countless variables, all of which can be studied in correlation with economic development. Further research on this subject should include natural resources other than petroleum, such as coal. GDP should be combined with other indicators of economic development. For a worldwide perspective, all oil-producing countries should be included and can be divided into the original categories proposed at the beginning of this paper.

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