

# Oil, Population Growth, and the Resource Curse

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Durham, North Carolina

April, 2009

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Honors thesis submitted in partial fulfillment of the requirements for Graduation with  
Distinction in Economics in Trinity College of Duke University.

## Acknowledgements:

I am grateful for the wonderful mentorship of Professor Robert F. Conrad at Duke University and Professor Michael Alexeev at Indiana University at every step of the thesis process. Special thanks also go to Anca Grosav, Dr. Joel Herndon, Professor Allen Kelley, Professor Craig Burnside, Professor Tracy Falba, Paul Dudenhefer, and Elke Loichinger for helping me with brainstorming, finding data sets, the literature review, and thesis editing.

## **Abstract**

I find indications that an increase in a country's oil endowment results in an increase in its population growth rate, an increase in its fertility and birth rates, and a decrease in its mortality rate. To explain these results, I conjecture that an increase in oil endowment results in reduced female labor force participation, which increases the population growth rate. Additionally, I find no significant, negative relationship between a country's per capita GDP growth rate and its oil endowment, when variations in the population growth rate are controlled. This result and others affect the interpretation of the "resource curse" concept.

## 1. Introduction

The main purpose of this thesis is to investigate how a country's oil endowment affects its population growth rate. An understanding of this relationship is important for two reasons.

First, the relationship between the population growth rate and oil endowment may play an important role in the interpretation of a concept that is known as either the "resource curse" or the "curse of natural resources". This concept states that natural resource endowments, particularly oil, slow per capita GDP growth in a country. The primary regression used to support the curse shows that countries with higher endowments of natural resources, relative to their GDP, have lower average per capita GDP growth rates over a certain period of time, *certeteris paribus*. It is plausible, although not without criticism, to interpret this regression result as a negative, "curse", if this lower per capita growth rate is purely the result of a lower aggregate GDP growth rate.<sup>1</sup> However, if the per capita GDP growth rate is lower due to a higher population growth rate in the countries with higher natural resource endowments, the use of the word, "curse", may not be appropriate. This is because the higher population growth rate could be reflecting either an increase in the birth rate, an increase in the life expectancy, and/or an increase in immigration—changes that are not necessarily bad for the country. If so, the notion of the curse may need to be qualified. Oil is a good measure of natural resource endowment, because it is a major, "point-source" resource that can be accurately measured and that plays an important role in the world economy. Thus, the first purpose of this thesis is to understand the effect of oil endowments on countries' population growth rates.

Second, understanding how oil endowments impact population growth may be important for understanding economic development. There has been considerable research investigating the connection between a country's population growth rate and its economic development. Some research suggests that a high population growth rate is detrimental to a country's economic development: "the Kelley and Schmidt study [...]"

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<sup>1</sup> This criticism will be discussed further in the Literature Review section.

show[s] a [...] negative relationship between population growth and per capita economic growth for the 1980s” (Kelley and Schmidt, 1994, p. ix). Many countries with oil endowments are also developing countries.<sup>2</sup> Therefore, it makes sense to understand the relationship between oil endowment and population growth in order to understand the pathways through which oil endowments might affect economic development. This second reason may seem similar to the first reason in that the “resource curse” concept also links oil endowments to economic development. This is true to an extent, but the key distinction is that the “resource curse” concept does not identify the population growth rate as the link in the causality chain from oil endowment to economic development, whereas this second reason is specifically concerned with that possibility.

From the results, I find indications that an increase in a country’s oil endowment results in an increase in its population growth rate, an increase in its fertility and birth rates, and a decrease in its mortality rate. To explain these results, I conjecture that an increase in oil endowment results in reduced female labor force participation, which increases the population growth rate. Encouraging results indicate that an increase in oil endowment may indeed reduce female labor force participation. Additionally, I find in a regression that a country’s per capita GDP growth rate decreases with increases in its oil endowment. This is in agreement with the literature supporting the “resource curse”. However, when variations in the population growth rate are controlled for in this same regression, there is no longer such a significant, negative relationship. I also find no significant relationship between aggregate GDP growth and oil endowment. These results affect the interpretation of the “resource curse” concept.

The rest of the thesis is organized as follows. First, the Literature Review section provides a survey of literature regarding the “resource curse” and the causes of population growth, focusing on the role of oil endowments. Second, the Population

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<sup>2</sup> As a rough characterization of the proportion of oil-producing countries that are developing countries, only 8 of the 48 oil-producing countries used in this thesis’ analyses are OECD member countries. The 30 member countries that make up the OECD consist of most of the high-income or upper-middle income countries in the world.

Growth and Oil Endowment section presents the results and methodology regarding the connection between the population growth rate and oil endowments. Likewise, the Fertility, Mortality, and Oil Endowment section then presents the results and methodology regarding the connection between fertility, mortality, and oil endowment. After the basic results of the thesis have been established, the Oil Curse Revisited section investigates the “resource curse” in greater detail using additional results. The Female Labor force Participation section presents and tests a conjecture for explaining why oil endowments have the observed positive effect on the population growth rate. The Conclusion contains a summary of the results, a discussion of the implications of the results, and ideas for future research. Finally, a Reference section contains references and two Appendix sections contain data descriptions and regression results.

## **2. Literature Review**

### **2.1 “Resource Curse” Literature**

The “resource curse” is the concept that large natural resource endowments, particularly oil, slow per capita GDP growth. Sachs and Warner (2001) write that “empirical support for the resource curse is not bulletproof, but it is quite strong.” Several influential papers, including Auty (1990) and Sala-i-Martin and Subramanian (2003), have shown empirical evidence of such a curse. According to Alexeev and Conrad (2005), “There have been different hypothesis about the reasons for this effect of natural resources [...] All empirical literature on the topic, however, concludes that at least in the developing countries, large endowments of certain types of natural resources (“point-source” resources, to use Isham et. al.’s (2003) terminology) have a negative effect on economic growth.” There is a sizable body of scholarly work surrounding the “resource curse”. For example, a Google Scholar™ search of the complete phrases, “resource curse” or “curse of natural resources”, results in 2170 research articles.

In addition to determining its existence, much of the literature is focused on understanding the causes of the “resource curse”. In his book, *The Bottom Billion*, Paul

Collier (2007) summarized some of these causes. One such cause is Dutch Disease: “The resource exports cause the country’s currency to rise in value against other currencies. This makes the country’s other export activities uncompetitive. Yet these other activities might have been the best vehicles for technological progress” (Collier, 2007, p. 39). Another possible cause is that “resource revenues worsen governance” which manifests itself in corruption and policy mismanagement that undermine growth (Collier, 2007, p. 40-52).

The primary regression used to support the curse shows that countries with higher endowments of natural resources, relative to their GDP, have lower average per capita GDP growth over a certain period of time, *ceteris paribus*. This regression uses a measure of per capita GDP growth as the dependent variable, and a measure of oil endowment as the independent variable. One specific example of this regression is given in Sachs and Warner (2001) and is setup in the following way:

$$\Delta Y_{i,1970-1989} = \beta_0 + \sum \beta_i X_i + \alpha_i N_{i,1970} + \varepsilon_i$$

In this regression,  $\Delta Y_{i,1970-1989}$  is the per capita GDP growth rate for a given country from 1970 to 1989.  $N_{i,1970}$  is the export of natural resources, relative to GDP, for a given country in 1970.  $\sum \beta_i X_i$  is a set of explanatory variables that control for geography, institutions, climate, and initial income. Figure 1 shows the negative correlation between per capita GDP growth and natural resources endowment that is observed from this regression.

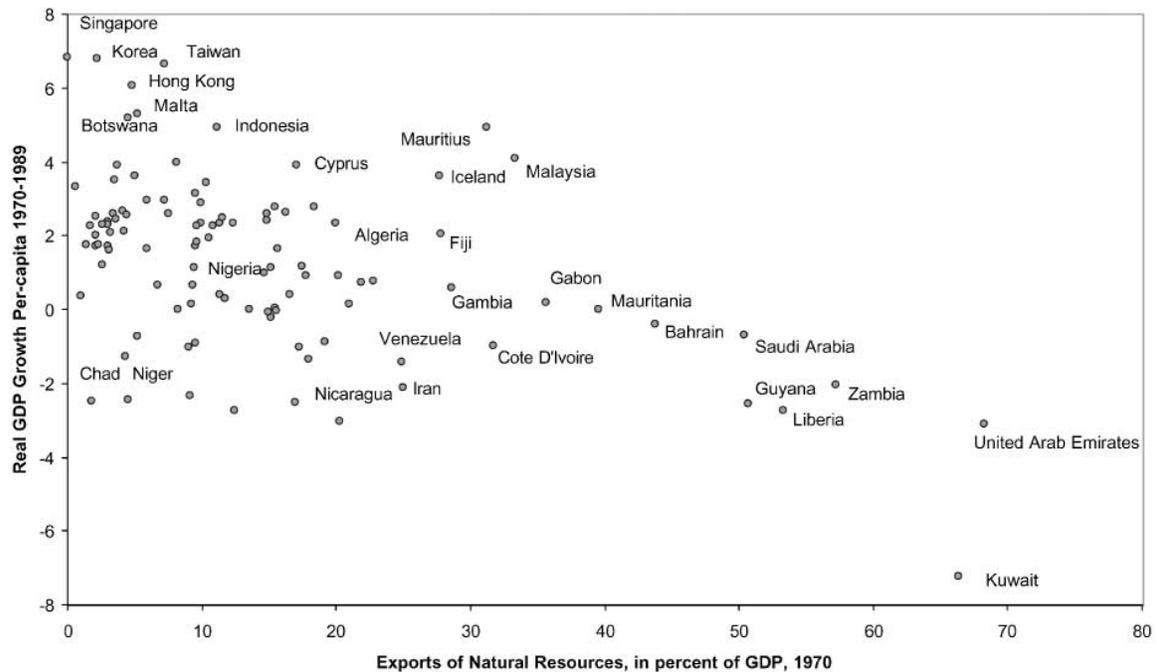


Fig. 1.: A figure from Sachs & Warner (2001) illustrating the “resource curse”.

One criticism of this methodology was put forth by Alexeev and Conrad (2007), who primarily criticized the use of “initial” per capita GDP values in the 1960s and 70s as a control in many of these “resource curse” regressions:

Most of the regressions that estimate the impact of natural resource endowment on growth, institutions, investment, etc., control for “initial” per capita GDP. Note, however, that if the natural resources are “manna from heaven” then per capita GDP increases, whether “initial” or “current,” without affecting other important variables at least in the medium term. Such variables might then look worse in the countries where income has been increased by natural resources relative to other countries with similar income levels (Alexeev and Conrad, 2007).

To investigate the impact of this problem, Alexeev and Conrad (2007) utilized an alternative approach in which they regressed the per capita GDP of each country in Y2000 on its oil endowment while controlling for a set of other explanatory variables, which notably did not include “initial” per capita GDP. From this regression, they concluded that countries well-endowed with natural resources were richer than they

would have been otherwise. This result supported their original criticism of the use of “initial” per capita GDP, and cast doubt on the notion of a curse.

This thesis raises another aspect of the “resource curse” regressions, focusing on the use of per capita GDP growth as the dependent variable. It is plausible to interpret the regression results of Sachs & Warner (2001) and others as a “curse”, if this lower per capita growth rate is purely the result of a lower aggregate GDP growth rate. However, the per capita GDP growth rate may be lower due to a faster population growth rate in the countries with higher natural resource endowments. In turn, this faster population growth could be reflecting either an increase in the birth rate, an increase in the life expectancy, and/or an increase in immigration—changes that are not necessarily bad for the country. If so, the notion of the curse may need to be qualified. This question of whether natural resource endowments affect population growth rates, and its implications for the curse, has not been directly addressed in the literature.

## **2.2 Population Growth Literature**

Work on population growth is divided into understanding the causes of three logical components of population growth: fertility, mortality, and immigration.

With regard to fertility, researchers have investigated a wide-range of models based on cultural, technological, sociological, and economic factors as possible determinants of fertility (Cohen, 1995, p. 46-75). Some cross-country determinants that have been used are per capita income, the infant mortality rate, percent rural, the female labor force participation rate, and per capita energy consumption (Richards, 1983, p. 713). Such determinants have been used to explain different sets of empirical data, but no one determinant or model is considered pre-eminent, because of contradictory observations and lack of applicability to different socioeconomic conditions (Cohen, 1995, p. 46-75). For example, the following is one piece of somewhat contradictory evidence regarding the “percent rural” determinant: “Around 1970, Thailand was judged to have entered the fertility transition [a term that means a steady decline to a lower level of fertility] because its marital fertility had fallen 10

percent below a peak level; the country was then still 85 percent rural. When Chile's fertility transition began in 1964, Chile was less than 30 percent rural" (Cohen, 1995, p. 63). Similarly, some of the contradictory evidence for the infant mortality rate determinant is as follows: "When Chile's fertility transition began in 1964 [...] the infant mortality rate in Chile was 10.3 percent, a high level, but when Taiwan started its fertility transition in 1963, Taiwan's infant mortality rate was 4.9, less than half of Chile's" (Cohen, 1995, p. 63).

One paper by Hunter, Stokes, and Warland (1982) touches specifically on the issue of oil and fertility. This paper found that oil-exporting status, as measured by a dummy variable, tends to increase the country's birth rate, which is one measure of fertility. They found this relationship in two ways. First, they found a positive correlation between a dummy variable for oil-exporting status and the birth rate in a sample that included most of the countries in the world. Second, they found that per capita GNP had a positive effect on birth rate in a sample containing only oil-exporting countries, even though per capita GNP has a negative effect on birth rate in a sample that excluded oil-exporting countries and in a sample containing all countries. To explain their results, the paper put forth the following rationale. First, they contended that for a given country, "unless the rapid increase in income [...] is accompanied by more equitable distributions of modern goods and services, the impact on health, literacy, and fertility is likely to be negligible" (Hunter et al, 1980). Second, the paper suggested that oil-exporting countries constituted a group of countries that have exhibited a rapid increase in income, because many of them achieved high-levels of income in a relatively short amount of time due to oil discovery and export. Third, the paper suggested that this high-level of income did not translate to high social indicator levels among the majority of the population, because it only enriched a small segment of the population. As a result, the paper contended that a lack of reduced fertility, under a condition of increasing per capita GNP in oil-exporting countries, resulted in the observation that the oil-exporting status dummy variable is associated with higher birth rates.

The Hunter et al. (1982) paper has four limitations that are addressed in this thesis. First, additional cross-country statistics for oil and other variables have become available since it was written in 1982, over 27 years ago. The authors of the paper explicitly noted the fact that they had to contend with incomplete and imperfect data for a number of their regressors. Better and larger datasets allow for a more robust study. Second, the paper used a limited set of regressors to predict fertility: per capita GNP, a measure of Quality of Life, and Oil-Exporting Status. The regressions could have benefited from additional control variables and possibly instrumentation. In particular, they did not control for birth rates prior to the time period that they used for their dependent variable. Many oil-exporting countries are predominantly Muslim and are located in the Middle East, but they did not control for religion or geography. The lack of these controls could generate an omitted variable bias. Third, they specifically addressed fertility, rather than the population growth rate. Fourth, the regressor related to oil is a dummy variable, instead of something that indicates the relative importance of oil in a country's economy, such as the quantity of oil produced or discovered. With just a dummy variable, one cannot ascertain the effect of incrementally more versus less oil.

Mortality declines may be another significant cause of population growth. Mortality rates have declined dramatically in less developed countries in the 20<sup>th</sup> century. For example, the life expectancy in Africa increased from age 30 in the 1930s to age 43 by the 1960s (Preston, 1980, p. 290). The explanation for this general decline has focused on two main groups of causes. The first is that the decline in mortality has "been principally a by-product of social and economic development as reflected in private standards of nutrition, housing, clothing, transportation [...] and so on" (Preston, 1980, p. 290). The second is that this decline "was primarily produced by social policy measures [such as vaccination programs] and technical changes [...] that reduced costs of good health" (Preston, 1980, p. 290). There is debate as to which one group of causes has had more impact on mortality declines (Preston, 1980, p. 290).

Finally, immigration can be another cause of population growth. There is better agreement among economists about the causes of immigration than fertility or mortality: “The overwhelming conclusion of almost all migration studies, both descriptive and econometric, is that people migrate primarily for economic reasons” (Todaro, 1980, p. 377).

From this review of the literature on the causes of population growth, it is clear that the relationship between oil endowment and the population growth rate is not well understood, and a more in-depth investigation is needed.

### **3. Population Growth and Oil Endowment**

#### **3.1 Methodology**

The regression used to investigate the effect of an increase in a country’s oil endowment on its population growth is specified as follows:

$$P_{i,1970-2000} = \beta_0 + \sum \beta_i X_i + \alpha_i N_i + \varepsilon_i$$

The dependent variable,  $P_{i,1970-2000}$ , is a measure of population growth.  $N_i$  is a measure of oil endowment for each country and the  $X_i$ ’s stand for other explanatory variables.

The measure of population growth is the log of the population in country  $i$  in 2000 divided by the population of that same country in 1970. The raw population data for this variable was obtained from Maddison (2007).

A log is taken of the population growth variable and also that of all the other non-binary variables in the regressions for two reasons. The first is that the coefficients on the independent variables become elasticity values when this is done. Therefore, each independent variable’s coefficient can be interpreted as the percentage change the variable will have on the dependent variable given a 1% increase in the independent variable, e.g. a 1% increase in oil endowment causes a percent change in the population growth rate equal to the value of the coefficient. The second is that taking logs reduce

the problem and effect of outliers in the data, since the nonlinear nature of logarithms reduces large numbers to a greater extent than smaller numbers.

Two measures of oil endowment are used. The first measure is the log of average per capita value of oil output from 1970 to 2000. Value of oil output is measured as the daily oil output in a given year multiplied by the world price of oil in that year in constant 2007 US Dollars. In this measure, the value of oil output is looked at relative to the population of the country. The second measure, log of average value of oil output as a share of GDP from 1970 to 2000, looks at the value of oil output relative to GDP. Both measures have merit in that they both provide a sense of a country's reliance on oil, which is the objective. Using two measures of oil endowment also creates a natural robustness check, because conclusions about the effect of oil endowment on population growth will not be dependent on one single measurement method. The raw oil output and oil prices data used to calculate the two variables were obtained from the BP Statistical Oil Review (2007).

The set of  $X_i$ 's are control variables included in order to reduce the possibility of omitted variable bias. Population growth rates may vary for reasons unrelated to oil output from 1970 to 2000. One way to control for this possibility is to include the log of population growth from 1960 to 1970 as a variable. However, this control may miss factors that influence the population growth rate from 1970 to 2000 differently than from 1960 to 1970. Therefore, additional control variables are used.

It is plausible that the economic development level of a country may affect the population growth rate. Therefore, the log of per capita GDP in 1970 is used to control for this effect, because per capita GDP is a commonly used indicator of economic development. This variable needs to be instrumented, however, because it may be potentially influenced by the dependent variable (log of population growth from 1970 to 2000). The fact that the per capita GDP is for 1970 and population growth is for after this date does not resolve the potential simultaneity issue, because per capita GDP is correlated across time. For example, the coefficient of correlation between log of per capita GDP in 1970 and log of per capita GDP in 2000 is .832. Three geography-related

exogenous variables are used as instruments to resolve this issue: absolute value of latitude, a dummy variable for countries with a predominantly European population, and a dummy variable for Latin American countries (includes South America). These instruments are likely to be valid, because they meet three general conditions for valid instruments.

First, the instruments should be exogenous with respect to the instrumented variable (log of per capita GDP in 1970). Intuitively, this condition is satisfied, because per capita GDP presumably does not affect a country's latitude, location in Latin America, or status as a country with a predominantly European population.

Second, the instruments should be relatively highly correlated with the instrumented variable, so that they act as an effective predictor. Weak identification tests are a category of tests to check for this condition, and the specific version that I used is called the Kleibergen-Paap rk Wald F statistic<sup>3</sup>. To pass the test, a value of ten or greater is typically required. As shown in Table 1 of Appendix B, these instruments pass the test.

Third, the instruments should not influence the dependent variable except via the instrumented variable. Overidentification tests are a category of tests used to test for this condition, and the specific version that I used is called the Hansen J statistic, where a p-value result that is greater than .1 is typically considered passing.<sup>4</sup> A high p-value means that one cannot reject the null hypothesis that the instruments are correlated with the dependent variable only via the instrumented variable. As shown in Table 1 of Appendix B, the three instruments pass this test. Admittedly, the fact that one cannot reject the null hypothesis does not mean that the null hypothesis is necessarily true. However, it does provide some measure of support for the assumption

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<sup>3</sup> The Kleibergen-Paap rk Wald F statistic is implemented using the `ivreg2` command in Stata®: <http://ideas.repec.org/c/boc/bocode/s425401.html>.

<sup>4</sup> The Hansen J statistic is implemented using the `ivreg2` command in Stata®: <http://ideas.repec.org/c/boc/bocode/s425401.html>.

that the instruments do not influence the dependent variable except via the instrumented variable.<sup>5</sup>

Cultural factors may also influence population growth, particularly through their effect on fertility, so three variables based on religion are used to address this possibility: share of the Muslim population in a country, share of the Protestant population in a country, and share of the Catholic population in a country. The degree of ethnic fractionalization, which is “the probability that two randomly drawn individuals from the population belong to two different groups” has been found to influence a number of cross-country measures including economic growth and the quality of institutions (Alesina, Devleeschauwer, Easterly, Kurlat and Wacziarg (2003)). Therefore, it is included as a control in case it also affects the population growth rate.

### **3.2 Results**

The central conclusion that can be drawn from the results of the regressions is that the population growth rate increases as a result of an increase in the oil endowment. There is a significant, positive correlation at the 1% level between either one of the two measures of oil endowment and population growth. To give a sense of the magnitude of effect, a one percent increase in the average per capita value of oil output from 1970 to 2000 results in a .185% increase in the population growth rate, other things being equal. Likewise, a 1% increase in the average value of oil output as a share of GDP from 1970 to 2000 results in a .401% increase in the population growth rate. The results are included in Table 1 of Appendix B.

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<sup>5</sup>Satisfying this third condition also resolves another issue, which is the possibility that geographic location itself may influence population growth. I assume, however, that geographical location only influences population growth through log of per capita GDP in 1970. Since two of the three instruments are for geographic location (latitude and the Latin America dummy), this assumption is supported by the fact that the instruments pass the Hansen J statistic overidentification test and satisfy the third condition.

## 4. Fertility, Mortality, and Oil Endowment

Now that a positive relationship between the population growth rate and oil endowment has been established, a preliminary attempt is made to understand the intermediate factors determining this relationship. As discussed in Section 1, population growth is commonly broken into fertility, mortality, and immigration components. Thus, a set of regressions are now constructed to look at the effect of oil endowment on fertility and mortality.<sup>6</sup>

### 4.1 Methodology

The following equation is the general form used for all of the regressions used to investigate fertility and mortality:

$$Y_{i,1970-2000} = \beta_0 + \sum \beta_i X_i + \alpha_i N_i + \varepsilon_i$$

$Y_{i,1970-2000}$  represents three different dependent variables that are measures of fertility and mortality. One standard measure of fertility is the crude birth rate, which is the number of live births per 1,000 people in a given year. For the first regression, a cross-country sample of the average of the crude birth rates for each year from 1970 to 2000 is used as the dependent variable. The equivalent of the crude birth rate for mortality is the crude death rate. It is the number of deaths per 1000 people in the population of a country in a given year. For the second regression, a cross-country sample of the average of the crude death rates for each year from 1970 to 2000 is used. Conceptually, the crude birth rate and crude death rate are linked to population growth via a simple relationship:

$$\text{pop. growth rate} = \text{crude birth rate} - \text{crude death rate} + \text{immigration rate}$$

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<sup>6</sup> The effect of oil endowment on immigration is not looked at for lack of appropriate data.

In this relationship, *pop. growth rate* is the population in a given year, and *immigration rate* is a term that accounts for changes due to movement of people in and out of the country.<sup>7</sup>

An additional measure of fertility that is used is the total fertility rate, which, according to the World Development Indicators (2009), “represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates.” This variable provides another perspective on fertility from crude birth rates that more clearly measures individual fertility choices. To illustrate the distinction between these two variables, one can imagine that crude birth rates would be different for two countries with the same total fertility rate if there were a different proportion of females in the two countries or if one country had more females of child-bearing age than the other. For the third regression, a cross-country sample of the average of the total fertility rate for each year from 1970 to 2000 is used as the dependent variable.

The premise for all three regressions is to try to keep them as similar to the population growth regression as possible in terms of the independent regressors used. This strategy is adopted for two reasons. First, the factors that affect population growth are likely to be similar to the factors that affect birth rate, death rate, and fertility rate, because population growth is a function of these three rates. Second, using similar regressors will allow for easy comparison of the regression results. For these reasons, all three regressions use the same two measures of oil endowment,  $N_i$  and the same controls,  $X_i$ 's, as the population growth regression did. There are two exceptions to this, however.

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<sup>7</sup>Note that this equation is only conceptually accurate in the context of this thesis, and is not mathematically accurate. For the equation to be mathematically accurate, the *population growth rate* will need to be measured as the increase in the number of people per 1000 people in a given year. As discussed in Section 3.1, the population growth rate is not measured in this precise way; rather, it is the population in the year 2000 divided by the population in the year 1970. Furthermore, the *immigration rate*, which is not dealt with in this thesis, will need to be the net inflow of people per 1000 people in a given year.

The first exception is that instead of the control, log of population growth from 1960 to 1970, an equivalent version corresponding to the specific dependent variable of each regression is used. Specifically, log of the average of the crude birth rates for each year from 1960 to 1969 is used to control for the possibility of different baseline birth rates in different countries in the crude birth rate regression. Similarly, log of the average of the crude death rates for each year from 1960 to 1969 and log of the average of the total fertility rates for each year from 1960 to 1969 are used as controls for the mortality and total fertility regressions, respectively.

The second exception relates to the way that the economic development level is controlled for in the regressions. In the population growth regression, instrumented per capita GDP in 1970 is used as the control. Unfortunately, this method is problematic for these regressions, because the instruments do not satisfy one of the conditions for instrument validity that was discussed in Section 3.1.

Specifically, the regressions with total fertility rate or crude birth rate do not pass the Kleibergen-Paap rk Wald F statistic (weak identification) test when per capita GDP in 1970 is instrumented by the three variables: absolute value of latitude, a dummy variable for countries with a predominantly European population, and a dummy variable for Latin American countries. These are the same instruments used in the population growth regression in Section 3.1. Because the test checks for sufficient correlation between the instruments and the instrumented variable, one potential way to score higher on the test is to find alternative instruments that have higher correlation values than these to instrument for per capita GDP in 1970. Due to lack of appropriate data and the need to satisfy the other instrument validity conditions, better instruments that pass this test have not been found.

The regression with crude death rate fails the Hansen J statistic overidentification test when per capita GDP in 1970 is instrumented by the same three instruments used in the population growth regression in Section 3.1. One potential way to do better on the test is to find other instruments that only influence the dependent variable (crude death rate) via per capita GDP in 1970. Due to lack of appropriate data

and the need to satisfy the other instrument validity conditions, better instruments that pass this test have not been found.

Two approaches are used to circumvent the fact that valid instruments for per capita GDP in these three regressions have not been found.

The first approach is to use un-instrumented per capita GDP in 1970 instead of instrumented per capita GDP. This is an imperfect solution, however. As described in Section 3.1, a change in the population growth rate may change per capita GDP. This introduces the potential for a simultaneous causality problem (also known as an endogeneity problem) since per capita GDP becomes an endogenous variable in the regression. Using un-instrumented per capita GDP in the fertility and mortality regressions introduces the same potential problem, since the dependent variables, total fertility rate, crude birth rate, and crude death rate, are all determinants of the population growth rate. Nevertheless, the regression results obtained from this approach may still be valuable by giving an indication of possible relationships that can be investigated in a more robust manner in the future.

A second approach is to use log of per worker GDP in 1980 in place of instrumented per capita GDP. Per worker GDP is the GDP of a country in a given year divided by the total employment in the economy. The data for this variable is from the World Development Indicators (2009). It is similar to the real wage level in the sense that if the number of hours an average worker worked is kept constant, a change in the GDP or the total employment would affect per worker GDP in the same way as it affects the real wage level. The potential benefit of using per worker GDP is that, first, it provides a measure of the economic development level of a country while second, it most likely avoiding the simultaneity problem that per capita GDP may have. These two benefits are now discussed in detail.

Specific to the first benefit, while per worker GDP does not measure exactly the same thing as per capita GDP, the idea is that it is measuring something similar enough such that the regression results obtained using per worker GDP can corroborate the results obtained from using un-instrumented per capita GDP, and thus give an additional

indicator of any interesting relationships that are worth investigating further. Per capita GDP and per worker GDP have a high, positive correlation of .96, which indicates the two measures are similar in what they measure.

Specific to the second benefit, unlike per capita GDP, per worker GDP may not be directly affected by a change in the population growth rate. If this is the case, then per worker GDP will not have the same simultaneity concern that is a problem for un-instrumented per capita GDP. While population growth might have some effect on GDP per worker, because it might indirectly affect worker productivity, this influence presumably would be weaker than with respect to per capita GDP where population enters directly in the denominator.

It should also be noted that per worker GDP in 1980 is used instead of per worker GDP in 1970, because 1980 is the first year for which sufficient data is available. The fact that it is 1980 data is not an issue, because the goal is to control for a typical economic development level across the time span of 1970 to 2000.

## **4.2 Results**

The results, which are shown in Table 2-4 of Appendix B, indicate that a larger oil endowment results in an increase in the total fertility rate and a decrease in the crude death rate. This conclusion is supported by significance at the 10% level or below for all the regressions, which used each of the two different oil endowment measures and the two controls for economic development. The results are less conclusive for the crude birth rate. For the two regressions using un-instrumented per capita GDP in 1970 as the control for economic development, there is a positive relationship between larger oil endowments and the crude birth rate at the 10% level significance level or below. While the relationship is still positive, it is not at significant at the 10% level for the two regressions that use per worker GDP in 1980 as the control for economic development.

Indeed, all regressions using per worker GDP result in weaker significance levels than their per capita GDP counterpart. This is most likely due to the fact that there is less data available for per worker GDP than per capita GDP. As a result, the sample sizes

used in per worker GDP regressions are reduced from the 130-140 range to the 90-100 range. All other things equal, a smaller sample size will result in a larger standard error value, which results in a higher p-value.

While the two approaches used to investigate the relationship between fertility, mortality, and oil endowment are imperfect, the results indicate that there may be a positive relationship between fertility and oil endowment and a negative relationship between mortality and oil endowment. This motivates future efforts to find better instruments for per capita GDP and to pursue more robust investigations.

## 5. Oil Curse Revisited

As discussed in the Introduction and the Literature Review, one of the purposes of this thesis is to gain a better interpretation of the “resource curse” concept. A typical regression used to demonstrate the “resource curse concept” is one that is given in Sachs and Warner (2001) and is formulated in the following way:

$$\Delta Y_{i,1970-1989} = \beta_0 + \sum \beta_i X_i + \alpha_i N_{i,1970} + \varepsilon_i$$

In this regression,  $\Delta Y_{i,1970-1989}$  is the per capita GDP growth rate for a given country from 1970 to 1989.  $N_{i,1970}$  is the export of natural resources, relative to GDP, for a given country in 1970.  $\sum \beta_i X_i$  is a set of explanatory variables that control for geography, institutions, and climate. The result of this regression shows that an increase in the export of natural resources decreases the per capita GDP growth rate. A graphical illustration of this relationship is provided in Fig. 1 in Section 2.

The results of Section 3 support the idea that an increase in the oil endowment increases the population growth rate. This raises the possibility that the negative relationship between oil endowment and per capita GDP growth detected in the “resource curse” regression may be partly due to an increase in the population growth rate of the country, rather than being purely due to a decrease in aggregate GDP growth.

To check the applicability of my findings about population growth to the “resource curse” regression, it is important to first replicate the same “resource curse” relationship that was observed by Sachs & Warner (2001) and others, while using a set of explanatory variables that are as identical as possible to those used in the regression that demonstrated the population growth and oil endowment relationship in Section 3. Replicating the “resource curse” relationship will help to show that the observed population growth and oil endowment relationship is not just based on a peculiar choice of explanatory variables that makes it inapplicable to the results of the “resource curse” regressions used by Sachs & Warner (2001) and others.

In addition, it would be interesting to investigate the impact of “excluding” variations in the population growth rate from the per capita GDP growth and oil endowment relationship. This will help to assess the relative importance of changes in the population growth rate to the “resource curse” regression and concept. Two methods are used to investigate this.

First, a regression of aggregate GDP growth, instead of per capita GDP growth, is done on oil endowment. This will show how oil endowment affects the numerator component of per capita GDP growth.

Second, the population growth rate can be explicitly controlled for by inserting it as an independent variable in the per capita GDP growth on oil endowment regression.

## 5.1 Methodology

The following equation illustrates the two regressions used to investigate the effect of oil endowment on per capita GDP growth and on aggregate GDP growth:

$$G_{i,1970-2000} = \beta_0 + \sum \beta_i X_i + \alpha_i N_i + \varepsilon_i$$

In this regression,  $G_{i,1970-2000}$  , is a measure of economic growth,  $N_i$  is a measure of oil endowment for each country and the  $X_i$ 's stand for other explanatory variables.

Two measures of economic growth are used as the dependent variable. The first measures per capita GDP growth by taking the log of the per capita GDP in country  $i$  in 2000 divided by its per capita GDP in 1970. The second measures aggregate GDP growth by taking the log of the aggregate GDP in country  $i$  in 2000 divided by its aggregate GDP in 1970. Note that these two measures are very similar in structure to the measure of the population growth rate used in the regression in Section 3. The same two measures of oil endowment are used here as in the regression in Section 3.

The same set of explanatory variables are used here as in the regression in Section 3, except for two variables. First, instead of using the log of population growth from 1960 to 1970 as a control variable, its analogs are used: the log of per capita GDP growth from 1960 to 1970 is used in the regression where per capita GDP growth is the dependent variable, and the log of aggregate GDP growth from 1960 to 1970 is used in the regression where aggregate GDP growth is the dependent variable.

Second, one version of the per capita GDP growth on oil endowment regression is done with the addition of the variable, log of population growth from 1970-2000, as a control.

## 5.2 Results

The results are shown in Tables 5 and 6 of Appendix B. With regard to per capita GDP growth, the regression results show that as oil endowment increases, per capita GDP growth decreases. This is in agreement with the results reported in the literature that are used to support the “resource curse” concept. As articulated in Section 5.1, this result bolsters the validity of applying the Section 3 result—that population growth is positively related to oil endowment—to the re-interpretation of the “resource curse” concept.

When population growth is controlled for in the per capita GDP growth on oil endowment regression, the previously significant relationship disappears.

With regards to aggregate GDP growth, the results indicate that there is an insignificant relationship between oil endowment and aggregate GDP growth.

Furthermore, the coefficients on the oil endowment measures are positive, which indicate that if anything, an increase in the oil endowment may actually increase aggregate GDP growth, rather than decrease it as expected.

The last two results indicate that population growth may play a role in the “resource curse” relationship. Without the increase of the population growth rate, it seems that the negative relationship between per capita GDP growth and oil endowment would likely not exist.

As discussed in Section 1, these results raise questions about whether the label of “curse” is appropriate for describing the negative, “resource curse” relationship between oil endowments and per capita GDP growth. A substantial part of this negative relationship has now been shown to be due to an increase in the population growth rate of the country, rather than being purely due to a decrease in aggregate GDP growth. As discussed in Section 4, increasing population growth can be caused by increasing fertility, decreasing mortality, or increasing immigration. These are not necessarily bad changes—particularly the decrease in mortality. Indeed, the results of Section 4 indicate that it is distinctly possible for an increase in oil endowments to lower the crude death rate, which is a measure of mortality. Additional implications of the results are included in the Conclusion section.

## **6. Female Labor force Participation**

The empirical evidence generated in the preceding sections make a case for the existence of a positive relationship between oil endowment and the population growth rate. The problem now turns to understanding how this relationship might exist.

It was shown empirically in Section 4 that fertility is likely increased by a larger oil endowment. One conjecture for how this might occur is now explored. It should be stressed that this conjecture is a preliminary investigation intended to spark future research.

## 6.1 Conjecture

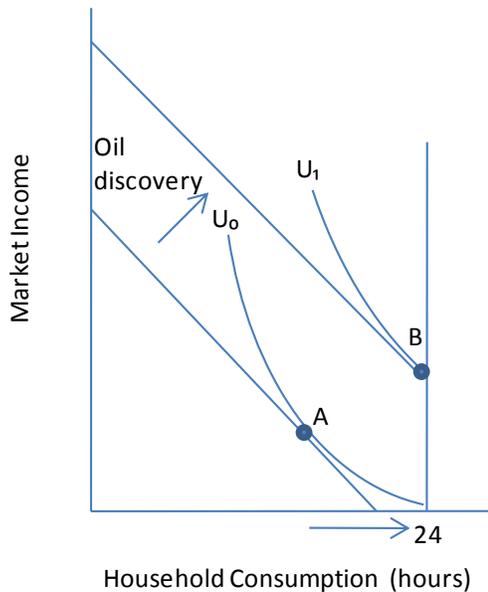


Fig. 2: Effect of oil discovery on Household Consumption.

Fig.2 illustrates the conjecture. Point A is the choice set that an average woman occupies in a given country prior to an oil discovery. The value of the y-axis, *Market Income*, is made up of the following components:

$$\text{Market Income} = w \times (24 - \text{Household Consumption}) + \text{oil wealth}$$

In this equation,  $w$  is the prevailing per-hour wage, 24 is the total number of hours in a given day, *Household Consumption* is the number of non-work hours spent in a given day, and *oil wealth* is the amount of daily income derived from oil. Both *Household Consumption* and *Market Income* are considered normal goods.<sup>8</sup>

When an oil discovery is made, it may be seen as “manna from heaven” and the oil wealth component of *Market Income* increases. The oil discovery causes a parallel, upward shift of the budget constraint, assuming no change in the market wage for labor, such that the optimal choice becomes point B. At point B, *Household Consumption*

<sup>8</sup> Note that the indifference curves do not have to be homothetic, but they will still not intersect as long as the axioms of consumer theory are satisfied.

has increased to 24, which means that the woman no longer works. As a result of the woman no longer working, female labor force participation declines in the country. Note, however, that the *Market Income* at point B is still above that at point A—the increased oil wealth more than makes up for the loss in wage income.<sup>9</sup> While this illustration is made for a single woman, the conjecture can also be extended to a household that has both a husband and a wife. In such a scenario, the joint *Household Consumption* and joint *Market Income* would be increased as a result of an increase in oil wealth.

Child-birth and child-rearing requires both time and money. Children may also be considered a normal good. Thus, due to an increase in both *Household Consumption* and *Market Income* at point B, an accompanying increase in fertility may be observed. Via this mechanism, an increase in the oil endowment as a result of an oil discovery causes female labor force participation to decrease, the fertility rate to increase, and the population growth rate to increase.<sup>10</sup>

A full empirical test of the proposed conjecture is beyond the scope of this thesis. However, one set of regressions is performed in the following section to check for a critical component of the theory: whether female labor force participation decreases as a result of an increase in the oil endowment. In the literature, no research has been found that directly addresses this question.

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<sup>9</sup> Both *Market Income* and *Household Consumption* are higher at point B due to the assumption that both are normal goods.

<sup>10</sup> Instead of increasing the quantity of children that they have, a family may instead choose to increase the quality of their children through better education, better nutrition, or some other human capital investment. Becker (1981) has written extensively on how a family decides between quality and quantity based on the tradeoffs between the costs of increasing one over the other and the return rate on human capital investment. For the purposes of this conjecture, an assumption is made that at least some of the increase in *Market Income* and *Household Consumption* at point B will result in a choice to increase the quantity of children. Note that an increase in the quality of children may still increase the population growth rate, because higher quality children may live longer.

## 6.2 Methodology

To test whether female labor force participation decreases as a result of an increase in the oil endowment, the following regression is used:

$$Femwrate_{1980} = \beta_0 + \sum \beta_i X_i + \alpha_i N_i + \varepsilon_i$$

$Femwrate_{1980}$ , the dependent variable, is the log of the percentage of the female population participating in the work force in 1980. 1980 is the earliest year in which substantial data for this statistic is available.

The variables on the right hand side are identical to those used in the population growth regression in Section 3.1, with two exceptions.

First, the variable, log of population growth from 1960 to 1970, is not included, because it is a control that is specific to the population growth rate. Optimally, a similar control that performs the same function for  $Femwrate_{1980}$  would be desirable. Specifically, the inclusion of a  $Femwrate$  statistic for a time point earlier than 1980 would be valuable in helping to establish that it is the oil endowment that is responsible for any detected variation in  $Femwrate_{1980}$ , rather than pre-existing conditions. Unfortunately, 1980 is the earliest year in which substantial data exists for the  $Femwrate$  statistic. Thus, one has to rely on the other geographical, cultural, and economic development controls.

The second exception stems from the fact that, like the population growth regression, using un-instrumented per capita GDP in 1970 to control for economic development level creates a potential endogeneity problem, because an increase in  $Femwrate_{1980}$  may cause an increase in GDP, which is the term in the denominator of per capita GDP in 1970. The fact that per capita GDP is for 1970 and  $Femwrate_{1980}$  is for after this date does not resolve the endogeneity issue, because  $Femwrate$  is a variable that is highly correlated across time. For example, the coefficient of correlation between  $Femwrate$  in 1980 and  $Femwrate$  in 1990 is .996.

Unfortunately, like the death rate regression in Section 4, using instruments to instrument log of per capita GDP in 1970 causes this regression to fail the Hansen J statistic test. The meaning of this test is discussed in detail in Section 3.1.

In lieu of the availability of better instruments, the same two approaches that were used in Section 4 for the fertility, birth rate, and death rate regressions are used to get around the fact that instrumented per capita GDP in 1970 cannot be used here. Namely, one set of regressions is done with un-instrumented per capita GDP in 1970 as the control and another second set is done with per worker GDP in 1980 as the control. The same reservations discussed in Section 4 with using these two approaches apply to their application in these female labor force participation regressions.

### **6.3 Results**

The results, which are shown in Table 7 of Appendix B, generally indicate that an increase in a country's oil endowment results in a decrease in its female labor force participation. This indication is supported by significance at the 10% level or below for all the regressions, except for one. In the regression using per capita value of oil output as the oil endowment measure and per worker GDP in 1980 as the control, the significance is too weak to be within the 10% level, although the coefficient value on the oil endowment measure still indicates the same negative relationship that all the other regressions show.

Indeed, all regressions using per worker GDP result in weaker significance levels than their un-instrumented per capita GDP counterpart. This is most likely due to the fact that there is less data available for per worker GDP than per capita GDP. As a result, the sample sizes used in per worker GDP regressions are reduced from the 130-140 range to the 90-100 range. All other things equal, a smaller sample size will result in a larger standard error value, which results in a higher p-value.

While the two approaches used to investigate the relationship between female labor force participation and oil endowment are imperfect, the results motivate future

efforts to find better instruments for per capita GDP and to pursue more robust investigations.

Furthermore, the results offer preliminary support for the conjecture, but much still needs to be done to fully investigate the conjecture's empirical implications. In particular, it would be interesting to see whether a decrease in female labor force participation causes an increase in fertility and population growth.

## **7. Conclusion**

I find empirical indications that an increase in a country's oil endowment results in an increase in its population growth rate. Therefore, as explained in Section 1, a change in a country's oil endowment may have an effect on its economic development via the oil endowment's effect on the population growth rate.

In this thesis, measures for oil endowment have been based on oil output. A natural extension would be to use oil reserves as the basis for additional measures of oil endowment. Furthermore, the "resource curse" refers to all "point-source" resources. Therefore, the impact of natural gas, coal, diamond, and other "point-source" resource endowments on the population growth rate may also be explored. The regressions in this thesis have also been purely spatial, cross-country studies. An alternative, event-based or time-series approach may be pursued instead. For example, it would be interesting to look at the impact of a discrete oil discovery event on a specific country or region.

An increase in oil endowment also seems to result in an increase in the fertility rate, an increase in the birth rate, and a decrease in the mortality rate. These secondary results make sense and are valuable in that they help to explain why the population growth rate increases when oil endowment increases. For the future, the robustness of these results would be improved if better instruments were found to instrument per capita GDP, which is the standard control for economic development level. It will also be valuable to investigate how the immigration rate is affected by oil endowments, since it is also a determinant of the population growth rate.

In one regression, the per capita GDP growth rate is shown to be negatively correlated with increasing oil endowment. This is in agreement with the results reported in the literature that are used to support the “resource curse” concept. However, there no longer seems to be such a negative relationship when a control for variations in the population growth rate is included in this same regression. Furthermore, there does not seem to be a significant relationship between aggregate GDP growth and oil endowment.

These two results, along with the result that the population growth rate increases with oil endowment, suggest that the negative, “resource curse” relationship between per capita GDP growth and oil endowment is partially due to an increase in the population growth rate, and is not purely due to a decrease in aggregate GDP growth. Since population growth, especially as a result of decreased mortality rates, is not necessarily bad, the use of the word, “curse” in describing this “resource curse” relationship may be inappropriate. There may be a debate about whether population growth is good or bad, and its relative importance to economic growth. However, given the findings, the word, “curse” may no longer be describing the empirical results objectively ahead of these normative, policy decisions. The policy implications of the results may be worth investigating in the future.

It would also be interesting to investigate whether and how the current theories that try to explain the “resource curse” accommodate the results. In the Dutch Disease and governance causes described by Collier (2007), the rationale for the decrease of per capita GDP growth as a result of an increase in oil endowment seems to also apply to aggregate GDP growth. However, the results suggest that these two measures of growth actually respond differently to oil endowment increases--with per capita growth decreasing (when population growth is not controlled), but aggregate growth not being significantly affected.

To explain the positive population growth and oil endowment relationship that has been found, I conjecture that an increase in the oil endowment results in reduced female labor force participation, which increases the population growth rate.

Encouraging empirical results indicate that an increase in oil endowment may indeed reduce female labor force participation. However, like the fertility and mortality results, the robustness of this result would be improved if better instruments were found to instrument per capita GDP. Additionally, more empirical research needs to be done to establish whether a decrease in female labor force participation results in increased fertility and population growth.

This conjecture is part of a category of plausible mechanisms whereby the wealth effect resulting from an increase in the oil endowment may be channeled towards an investment in human capital. Such investments can be a rational and efficient portfolio response to increases in wealth. That is, a resource discovery changes the portfolio balance of an economy, and thus using the wealth created by this discovery to invest in other types of capital, including human capital, may be rational. In the future, it may be fruitful to investigate the effect of oil endowments on health and education expenditures, which can be thought of as investments in human capital.

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## Appendix A: Data Descriptions & Summary Statistics

Variable	Description and Source
Per Capita Value of Oil Output 1970-2000	Natural log of one plus the average of the value of oil output divided by population for each year from 1970 to 2000. Value of oil output is measured as daily oil output in a given year in 1000s of barrels multiplied by the world price of oil in that year (constant 2007 US Dollars). Note that some countries did not start producing oil until after 1970. Oil output and price data from BP Statistical Oil Review (2007). Population data from Maddison (2007).
Value of Oil Output as GDP share 1970-2000	Natural log of one plus the average of the value of oil output divided by GDP for each year from 1970 to 2000. Value of oil output is measured as daily oil output in a given year in 1000s of barrels multiplied by the world price of oil in that year (constant 2007 US Dollars). Note that some countries did not start producing oil until after 1970. Oil output and price data from BP Statistical Oil Review (2007). GDP data from Maddison (2007).
Population Growth 1970-2000	Natural log of the population in 2000 divided by the population in 1970. Population data from Maddison (2007).
Birth Rate 1970-2000	Natural log of the average of the number of live births per 1,000 people in the population of a country in each year from 1970 to 2000. Data from World Development Indicators (2009).
Death Rate 1970-2000	Natural log of the average of the number of deaths per 1,000 people in the population of a country in each year from 1970 to 2000. Data from World Development Indicators (2009).
Fertility Rate 1970-2000	Natural log of the average of the total fertility rate of a country in each year from 1970 to 2000. Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates in that country. Data from World Development Indicators (2009).

Per Capita GDP Growth 1970-2000	Natural log of the per capita GDP in 2000 divided by the per capita GDP in 1970. Population and GDP data from Maddison (2007).
GDP Growth 1970-2000	Natural log of the GDP in 2000 divided by the GDP in 1970. GDP data from Maddison (2007).
Female Labor Participation 1980	Natural log of the percentage of the female population participating in the work force in 1980. Data from World Development Indicators (2009).
Per Capita GDP 1970	Natural log of per capita GDP in 1970. GDP and population data from Maddison (2007).
Per Worker GDP 1980	Natural log of per worker GDP in 1980. Per worker GDP Data from World Development Indicators (2009).
GDP Growth 1960-70	Natural Log of the GDP in 1970 divided by the GDP in 1960. GDP data from Maddison (2007).
Per Capita GDP Growth 1960-70	Natural log of the per capita GDP in 1970 divided by the per capita GDP in 1960. Population and GDP data from Maddison (2007).
Population Growth 1960-70	Natural log of the population in 1970 divided by the population in 1960. Population data from Maddison (2007).
Birth Rate 1960-69	Natural log of the average of the number of live births per 1,000 people in the population of a country in each year from 1960 to 1969. Data from World Development Indicators (2009).
Death Rate 1960-69	Natural log of the average of the number of deaths per 1,000 people in the population of a country in each year from 1960 to 1969. Data from World Development Indicators (2009).
Fertility Rate 1960-69	Natural log of the average of the total fertility rate of a country in each year from 1960 to 1969. Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with current age-specific fertility rates in that country. Data from World Development Indicators (2009).
Muslim	Share of Muslim population in a country. Source is La Porta, et al. (1999). The number for Lithuania is from Iwaskiw (1995).

Catholic	Share of Catholic population in a country. Source is La Porta, et al. (1999). The number for Lithuania is from Iwaskiw (1995).
Protestant	Share of Protestant population in a country. Source is La Porta, et al. (1999). The number for Lithuania is from Iwaskiw (1995).
Ethnic Fractionalization	Average of five different indices of ethnic fractionalization, which is the probability of two random people in a country not belonging to the same ethnolinguistic group or not speaking the same language. Source is Alesina et al. (2003)
Latitude	Absolute value of latitude for a country. Data values combined from two sources: Gallup et. al. (2001) and Sala-i-Martin et. al. (2004).
Latin America	Dummy variable for Latin American countries (includes South America). Source: common knowledge & world maps.
Europe	Dummy variable for countries with a predominantly European population. Source: Sala-i-Martin, et. al. (2004).

Variable	Mean	Skewness	Std Dev	Min	Max	Obs
Birth Rate 1960-69	3.55	-0.94	0.40	2.54	4.08	186
Birth Rate 1970-2000	3.29	-0.45	0.47	2.35	4.03	198
Catholic	33.22	0.69	36.26	0.00	99.10	200
Death Rate 1960-69	2.61	0.00	0.45	1.28	3.47	186
Death Rate 1970-2000	2.28	0.22	0.42	1.10	3.26	198
Ethnic Fractionalization	0.44	0.01	0.26	0.00	0.93	188
Europe	0.22	1.35	0.42	0.00	1.00	217
Female Labor Participation 1980	3.87	-1.09	0.45	2.22	4.52	183

Fertility Rate 1960-69	1.61	-0.92	0.42	0.61	2.13	186
Fertility Rate 1970-2000	1.30	-0.27	0.50	0.36	2.09	198
GDP Growth 1960-70	0.53	2.08	0.26	0.06	2.01	138
GDP Growth 1970-2000	0.84	0.04	0.65	-0.85	2.90	152
Latin America	0.18	1.64	0.39	0.00	1.00	217
Latitude	0.29	0.37	0.19	0.00	0.72	173
Muslim	21.65	1.41	35.07	0.00	99.90	200
Per Capita GDP 1970	0.98	0.20	1.01	-0.80	3.50	152
Per Capita GDP Growth 1960-70	0.29	1.85	0.25	-0.15	1.61	138
Per Capita GDP Growth 1960-70	0.24	-0.13	0.65	-1.63	1.89	152
Per Capita Value of Oil Output 1970-2000	0.24	3.83	0.72	0.00	4.21	220
Per Worker GDP 1980	8.27	-0.19	1.09	6.31	10.29	101
Population Growth 1960-70	0.23	1.96	0.14	-0.10	0.94	213
Population Growth 1970-2000	0.56	0.73	0.37	-0.17	2.25	213
Protestant	14.16	1.97	22.17	0.00	97.80	197
Value of Oil Output as GDP share 1970-2000	0.08	4.10	0.27	0.00	1.57	214

## Appendix B: Regression Results

Table 1: Effect of Oil Endowment on Population Growth

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Dependent variable: Population Growth 1970-2000

Variable	(1)	(2)
Per Capita Value of Oil Output 1970-2000	.185*** (.036)	
Value of Oil Output as GDP share 1970-2000		.401*** (.091)
Per Capita GDP 1970 (Instrumented)	-.233*** (.028)	-.211*** (.030)
Muslim	.002*** (.001)	.002*** (.001)
Catholic	.002*** (.001)	.001*** (.001)
Protestant	.002** (.001)	.003*** (.001)
Ethnic Fractionalization	.046 (.069)	.034 (.071)
Population Growth 1960-70	1.251*** (.215)	1.394*** (.231)
Sample size	142	138
Centered-R-squared	.738	.734
P-value for Kleibergen-Paap rk LM statistic	.000	.000
Kleibergen-Paap rk Wald F statistic	40.033	42.167
P-value for Hansen J statistic	.842	.910

Notes:

Robust standard errors are in parentheses.

Constant term not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant

Instruments for Per Capita GDP 1970: Latitude,  
Latin America, Europe.

Centered-R-squared is similar to R-squared, and is a  
statistic provided in instrumented variable regressions.

Table 2: Effect of Oil Endowment on Fertility Rate

Dependent variable: Fertility Rate 1970-2000				
Variable	(1)	(2)	(3)	(4)
Per Capita Value of Oil Output 1970-2000	.082*** (.026)		.069** (.029)	
Value of Oil Output as GDP share 1970-2000		.224*** (.055)		.181** (.071)
Per Capita GDP 1970	-.196*** (.029)	-.196*** (.027)		
Per Worker GDP 1980			-.183*** (.035)	-.175*** (.032)
Muslim	.002*** (.001)	.002*** (.001)	.003*** (.001)	.003*** (.001)
Catholic	.002** (.001)	.002*** (.001)	.002*** (.001)	.002** (.001)
Protestant	.002*** (.001)	.003*** (.001)	.002** (.001)	.002** (.001)
Ethnic Fractionalization	.350*** (.080)	.331*** (.078)	.267*** (.095)	.272*** (.092)
Latitude	-.008 (.197)	-.008 (.189)	.061 (.241)	.069 (.238)
Latin America	-.052 (.054)	-.038 (.055)	-.109* (.058)	-.089 (.061)
Europe	-.012 (.056)	-.028 (.059)	-.089 (.099)	-.078 (.099)
Fertility Rate 1960-69	.614*** (.090)	.596*** (.090)	.565*** (.103)	.573*** (.103)
Sample size	141	137	97	97
R-squared	.895	.897	.911	.912
Adj. R-squared	.887	.889	.901	.901

Notes:

Robust standard errors are in parentheses. Constant term is not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant

Table 3: Effect of Oil Endowment on Birth Rate

Dependent variable: Birth Rate 1970-2000				
Variable	(1)	(2)	(3)	(4)
Per Capita Value of Oil Output 1970-2000	.036* (.0190)		.029 (.020)	
Value of Oil Output as GDP share 1970-2000		.099** (.044)		.072 (.049)
Per Capita GDP 1970	-.125*** (.023)	-.128*** (.022)		
Per Worker GDP 1980			-.125*** (.029)	-.121*** (.026)
Muslim	.001** (.000)	.001** (.000)	.001** (.001)	.001* (.001)
Catholic	.001** (.001)	.001** (.001)	.002*** (.001)	.002*** (.001)
Protestant	.002*** (.001)	.002*** (.001)	.002*** (.001)	.002*** (.001)
Ethnic Fractionalization	.229*** (.054)	.226*** (.054)	.190*** (.068)	.193*** (.067)
Latitude	-.059 (.132)	-.060 (.130)	.066 (.166)	.067 (.166)
Latin America	-.036 (.043)	-.030 (.044)	-.073 (.048)	-.066 (.050)
Europe	.007 (.047)	-.008 (.050)	-.065 (.078)	-.061 (.079)
Birth Rate 1960-69	.823*** (.079)	.798*** (.083)	.752*** (.085)	.754*** (.085)
Sample size	138	136	97	97
R-squared	.931	.932	.940	.940
Adj. R-squared	.926	.927	.933	.933

Notes:

Robust standard errors are in parentheses. Constant term is not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant

Table 4: Effect of Oil Endowment on Death Rate

Dependent variable: Death Rate 1970-2000				
Variable	(1)	(2)	(3)	(4)
Per Capita Value of Oil Output 1970-2000	-.098*** (.031)		-.080** (.034)	
Value of Oil Output as GDP share 1970-2000		-.230** (.085)		-.166* (.098)
Per Capita GDP 1970	-.035 (.037)	-.049 (.037)		
Per Worker GDP 1980			-.056 (.042)	-.074* (.042)
Muslim	-.003*** (.001)	-.003*** (.001)	-.003** (.001)	-.003** (.001)
Catholic	-.001* (.001)	-.001* (.001)	-.002 (.001)	-.001 (.001)
Protestant	.001 (.001)	.001 (.001)	.001 (.001)	.001 (.001)
Ethnic Fractionalization	.244*** (.092)	.253*** (.094)	.181* (.100)	.167 (.101)
Latitude	.137 (.214)	.126 (.223)	-.121 (.235)	.139 (.248)
Latin America	-.026 (.059)	-.033 (.058)	-.005 (.070)	-.020 (.072)
Europe	.312*** (.083)	.346*** (.086)	.346*** (.116)	.344*** (.119)
Death Rate 1960-69	.822*** (.072)	.827*** (.074)	.790*** (.096)	.785*** (.098)
Sample size	138	136	97	97
R-squared	.781	.780	.778	.773
Adj. R-squared	.763	.762	.752	.746

Notes:

Robust standard errors are in parentheses. Constant term is not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant

Table 5: Effect of Oil Endowment on Per Capita GDP Growth

Dependent variable: Per Capita GDP Growth 1970-2000				
Variable	(1)	(2)	(2)	(2)
Per Capita Value of Oil Output 1970-2000	-.145*		-.048	
	(.077)		(.127)	
Value of Oil Output as GDP share 1970-2000		-.515***		-.407
		(.171)		(.258)
Per Capita GDP 1970 (Instrumented)	-.050	-.075	-.150	-.122
	(.104)	(.094)	(.142)	(.115)
Population Growth 1970-2000			-.269	-.135
			(.274)	(.246)
Muslim	-.004***	-.003**	-.004**	-.003**
	(.001)	(.001)	(.002)	(.002)
Catholic	-.003**	-.003*	-.003*	-.003
	(.002)	(.002)	(.002)	(.002)
Protestant	-.005*	-.004*	-.004*	-.004
	(.002)	(.002)	(.002)	(.002)
Ethnic Fractionalization	-1.142***	-1.093***	-1.132***	-1.096***
	(.221)	(.217)	(.227)	(.222)
Per Capita GDP Growth 1960-70	.332	.478**	.368	.482*
	(.271)	(.240)	(.287)	(.248)
Sample size	129	129	129	129
Centered-R-squared	.408	.435	.399	.426
P-value for Kleibergen-Paap rk LM statistic	.000	.000	.000	.000
Kleibergen-Paap rk Wald F statistic	22.075	24.397	11.290	13.134
P-value for Hansen J statistic	.697	.697	.579	.599

Notes:

Robust standard errors are in parentheses.

Constant term not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant

Instruments for Per Capita GDP 1970: Latitude, Latin America, Europe.

Centered-R-squared is similar to R-squared, and is a statistic provided in instrumented variable regressions.

Table 6: Effect of Oil Endowment on GDP Growth

Dependent variable: GDP Growth 1970-2000		
Variable	(1)	(2)
Per Capita Value of Oil Output 1970-2000	.128 (.089)	
Value of Oil Output as GDP share 1970-2000		.005 (.237)
Per Capita GDP 1970 (Instrumented)	-.364*** (.108)	-.350*** (.104)
Muslim	-.003 (.002)	-.001 (.002)
Catholic	-.002 (.002)	-.001 (.002)
Protestant	-.002 (.003)	-.002 (.003)
Ethnic Fractionalization	-1.058*** (.240)	-1.013*** (.240)
GDP Growth1960-70	.638** (.321)	.791** (.310)
Sample size	129	129
Centered-R-squared	.138	.123
P-value for Kleibergen-Paap rk LM statistic	.000	.000
Kleibergen-Paap rk Wald F statistic	28.836	30.869
P-value for Hansen J statistic	.499	.435

Notes:

Robust standard errors are in parentheses.

Constant term not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant

Instruments for Per Capita GDP 1970: Latitude,  
Latin America, Europe.

Centered-R-squared is similar to R-squared, and is a  
statistic provided in instrumented variable regressions.

Table 7: Effect of Oil Endowment on Female Labor Participation

Dependent variable: Female Labor Participation 1980				
Variable	(1)	(2)	(3)	(4)
Per Capita Value of Oil Output 1970-2000	-.152*** (.050)		-.069 (.046)	
Value of Oil Output as GDP share 1970-2000		-.347*** (.132)		-.223* (.124)
Per Capita GDP 1970	-.106** (.043)	-.129*** (.042)		
Per Worker GDP 1980			-.194*** (.044)	-.192*** (.041)
Muslim	-.006*** (.001)	-.006*** (.001)	-.009*** (.002)	-.009*** (.002)
Catholic	-.004*** (.001)	-.003*** (.001)	-.005*** (.001)	-.004*** (.001)
Protestant	.003** (.001)	.003*** (.001)	.004*** (.001)	.004*** (.001)
Ethnic Fractionalization	.368*** (.133)	.381*** (.129)	.285* (.158)	.288* (.153)
Latitude	.033 (.235)	-.075 (.235)	.200 (.279)	.173 (.276)
Latin America	-.169** (.080)	-.202*** (.078)	-.127 (.088)	-.155* (.089)
Europe	.210** (.099)	.225** (.096)	.176 (.120)	.162 (.118)
Sample size	140	136	97	97
R-squared	.574	.618	.725	.731
Adj. R-squared	.545	.591	.697	.703

Notes:

Robust standard errors are in parentheses. Constant term is not shown.

\*10% significant, \*\*5% significant, \*\*\*1% significant