Is it true that Good Institutions Alleviate the Resource Curse? A Re-assessment of Existing OLS Cross Country Evidence

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Abstract

The paper tests the hypothesis that the effect of resources on growth is conditional on the quality of institutions, by further building on Mehlum, Moene, and Torvik's (2006b) influential work. Advances are made by re-testing the hypothesis, using: (a) a dataset of up to 53 countries over the period 1984-2003; and (b) a resource abundance indicator that focuses on non-renewable resources alone rather than the ones commonly used in the literature that include renewable resources, which are inappropriate. The empirical results of the paper confirm the hypothesis that resource rich economies are not destined to be cursed if they have good institutions.

Keywords: World economic growth, resource curse, institutions

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1. Introduction

Contrary to conventional theory, a growing body of evidence suggests that economies with abundant natural resources perform badly in terms of economic growth relative to their resource poor counterparts—the so-called *resource curse* hypothesis. However, this general hypothesis is not robust. It clearly fails to account for the differing experiences of resource abundant economies. For instance, the theory, applied generally, offers no explanation as to why economies like Botswana and Norway have exceptional growth, while Saudi Arabia and Nigeria have stagnated. Prompted by these experiences, the paper investigates the circumstances under which the curse is more or less likely to exist. In particular, the paper finds evidence that the major reason for the diverging experiences is the differences in the quality of institutions across countries.

The research paper is related to the influential work of Mehlum, Moene and Torvik (2006b) and Boschini, Petterson and Roine (2007) in the sense that it hypothesis that a good institutional setting abates the resource curse. The paper tests the robustness of these previous results to variations in the measure of natural resource abundance and data used.[2] The main objective is to estimate a single cross-country growth regression using Ordinary Least Squares (OLS) methods, the new data and measure of natural resource abundance.[3]

To foreshadow the conclusions of the analysis, results based on the OLS cross-country methods provided in the paper are similar to those of existing literature in the sense that economies with

[2] A non-renewable rather than a renewable resource indicator is used because the former is more useful since it is more related to the issue of sustainability, the key concern of the resource curse.

[3] The dataset used here is different from influential work of Mehlum et al. (2006b) who uses Sachs and Warner's (1995;1997) dataset for 1975-1998 and Boschini et al. (2007), who uses a fresh dataset for 1965-1990. Furthermore, a natural resource abundance indicator different from Sachs and Warner's that the previous studies have tended to use is adopted here.

good institutions are not resource cursed. Furthermore, the use of a flow measure of resource abundance rather than the World Bank's stock measure does not fundamentally change these conclusions.

The paper begins by exploring the stylised facts underlying the empirical analysis in Section 2. Next, a basic model used for analysis in the paper is specified in Section 3. Section 4 presents the OLS cross-country economic growth results, as well as the issues of concern, namely, omitted variables, measurement error and endogeneity. One of the major concerns in the literature is the inadequacy of using a natural resource indicator that is a flow rather than a stock measure. Section 5 presents results from using a latter measure. Finally, a conclusion to the paper is given in Section 6.

2. The Sample

In order to test the generality of the conclusions regarding the conditionality on institutional quality of the resource curse, up to 53 countries with different levels of development, natural resource abundance and institutional quality are included in the sample.[4] Wherever possible, the paper ensures that the same set of countries is maintained. This is intended to take into account the view that comparing coefficients across regressions based on different samples is questionable (Hoover and Perez, 2004). The countries were selected on the basis of having available data for the variables of interest. Annual data are obtained for the period between 1984 and 2003. The period is also chosen based on the availability of a comprehensive set of data for the economies under study. On this basis, Table 1 below contains a list of countries used to test the paper's hypotheses.

[4] It could have been good to have used Sachs and Warner's (1995; 1997) original dataset, maybe even the time period, for the current data setting. However, due to data limitations the current one is adopted. A use of a different dataset is desirable because it is viewed as a test of sensitivity of the result to different data sets.

Table 1 List of Countries in the Sample (by Institutional Quality: Averaged 1984-2003)

Country	Institutional quality	Resource abundance	Real GDP/capita Growth
Finland	1.00	5.33	2.15
Sweden	1.00	40.03	1.70
Denmark	1.00	83.56	1.90
Netherlands	0.99	164.68	2.25
Iceland	0.99	37.74	1.65
Canada	0.99	681.23	2.05
New Zealand	0.98	126.06	1.40
Norway	0.96	1147.03	2.60
Australia	0.93	480.49	2.25
USA	0.91	329.93	2.15
Bahrain	0.65	3184.14	1.73
Malaysia	0.65	264.92	3.58
Botswana	0.65	39.55	5.44
Chile	0.64	231.71	-0.18
South Africa	0.64	119.31	-0.18
Oman	0.60	2488.93	2.11
Brazil	0.58	62.17	1.03
China	0.57	29.53	8.75
Saudi Arabia	0.57	2957.60	-0.95
Morocco	0.57	8.98	1.83
Trinidad and Tobago	0.56	1071.98	1.20
Jordan	0.56	11.90	-0.01
India	0.54	11.37	3.73
Ecuador	0.54	197.74	0.60
Papua New Guinea	0.53	182.93	0.64
Tunisia	0.53	81.05	2.48
Madagascar	0.53	0.01	-1.03
Iran	0.52	395.75	0.87
United Arab Emirates	0.52	5157.65	-2.16
Venezuela	0.51	838.77	-1.01
Dominican Republic	0.51	14.73	2.09
Mexico	0.49	244.63	0.91
Zimbabwe	0.47	16.92	-1.17
Guinea	0.47	23.58	0.99
Egypt	0.47	57.93	2.21
Cameroon	0.46	74.04	-0.95
Senegal	0.44	0.93	0.14
Jamaica	0.44	52.17	1.49
Ghana	0.44	3.35	1.99
Algeria	0.43	355.83	0.07
Gabon	0.42	747.21	-1.04
Niger	0.41	0.19	-1.41
Zambia	0.40	25.63	-1.09
Suriname	0.40	160.40	0.18
Peru	0.40	63.80	0.60
Guyana	0.36	51.66	1.95
Sierra Leone	0.35	63.53	3.55
Indonesia	0.34	63.53	3.55

Togo	0.32	2.35	-0.39
Bolivia	0.32	50.03	0.49
Nigeria	0.32	116.99	0.91
Sudan	0.27	7.43	1.99
Congo Rep.	0.12	210.46	-1.72

3. Some Stylised Facts

Table 2 shows a sample correlation matrix for the variables that are used in the paper (a summary of the description of the data used is presented in the section that follows, i.e., Section 3). The data used to produce the table are annual averages over the period 1984 to 2003.

Table 2 Sample Correlation Matrix for Period 1984-2003

	Resource abundance	Institutional quality	GDP/ capita Growth	Investment	Openness	Initial GDP/capita
Resource abundance	1.00					
Institutional quality	0.07 (0.60)	1.00				
GDP/capita Growth	-0.21 (0.14)	0.35 (0.01)*	1.00			
Investment	0.12 (0.37)	0.14 (0.33)	0.47 (0.00)*	1.00		
Openness	0.34 (0.01)*	0.00 (0.99)	0.01 (0.97)	0.38 (0.01)*	1.00	
Initial GDP/capita	0.50 (0.00)*	0.75 (0.00)*	0.01 (0.93)	0.12 (0.38)	0.11 (0.42)	1.00

p-values are given in parenthesis. *Statistical significance at conventional levels (1%, 5% and 10%).

The correlation between natural resource abundance and institutional quality is low and insignificant. This suggests that the argument that natural resource abundance has played a pivotal role in shaping institutions historically is unlikely to hold in the current context.[5] This is consistent with claims in the existing literature (e.g., Acemoglu, Johnson and Robinson, 2001)

[5] Of course, the correlation matrices do not say anything about the direction of causality and do not control for other relationships, so any conclusions based on these correlations is only preliminary.

that the "extractive" states that colonial masters established were dependent on settler mortality risk. For instance, assuming two countries, A and B, that have the same resource endowment, but A with a higher mortality risk than B. A is likely to be an extractive state, i.e., a state that passes resources to the metropole. Hence, the institutions would not be conducive to investment or even the promotion of private property rights. Conversely, B would be a "neo-European" colony set up to promote private property rights and this arrangement was generally the case either for the US, Australia or New Zealand colonies. Sokoloff and Engerman (2000) contradict this viewpoint by suggesting that the poor institutions in Latin American countries are attributed to the initial conditions that prevailed during European colonisation. Specifically, the production of grains allowed fairly small farms in North America and Canada, compared to the wheat production in Latin America that allowed ownership of masses of land. As a result, the elite opposed democracy and made policies that presented limited opportunities, fearing that the poor majority might demand a redistribution of land, income and rents (Sokoloff and Engerman, 2000). [6]

There is a moderate, positive, statistically significant relationship between initial income and natural resource abundance. This may suggest that initially, natural resource abundance may help promote growth. However, in the long run, it is possible that the negative effect outweighs the positive effect. There is a highly positive and statistically significant relationship between institutional quality and initial Gross Domestic Product (GDP).

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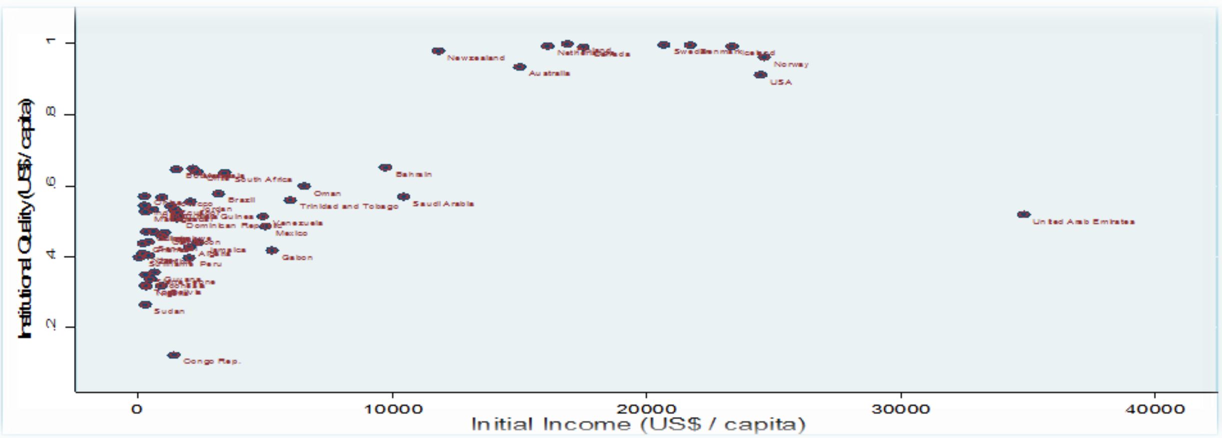
[6] As much as institutions play a critical role in explaining the growth divergences, the macroeconomic policies adopted by governments are also important. For instance, although Jamaica and Barbados have maintained more or less the same quality of institutions, Barbados has outperformed Jamaica mainly because of differences in macroeconomic decisions (Henry and Miller, 2009).

To further investigate the high correlation between initial GDP and institutional quality and initial GDP and natural resource abundance, scatter plots of these variables are given in Figure 1 and Figure 2, respectively.

Figure 1 show that high (low) values of initial income are associated with high (low) values of institutional quality, confirming the results of the sample correlation matrix of Table 2.

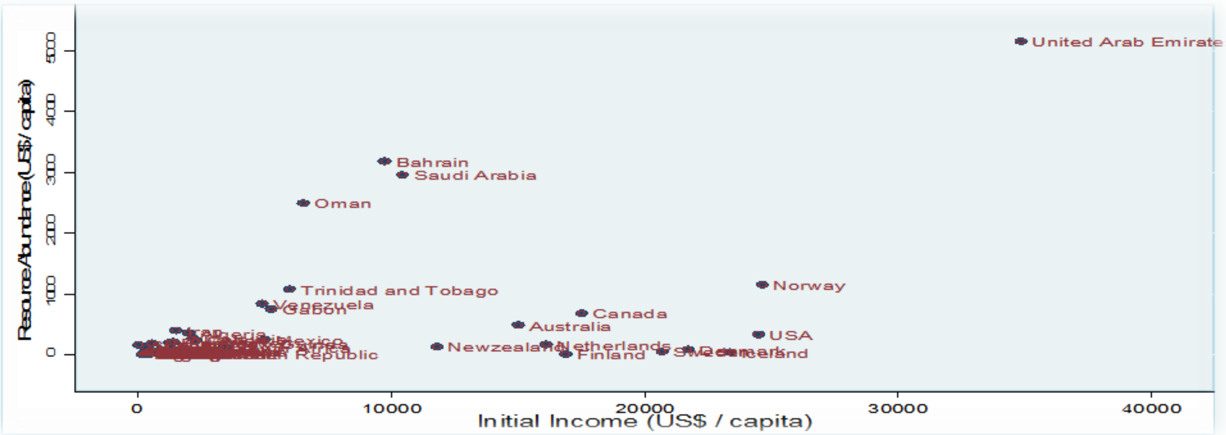
Figure 1 *Plot of Institutional Quality and Initial Income*



Source: Author's calculation based on data used in the paper.

The scatter plot of initial income and natural resource abundance in Figure 2 gives unclear results in terms of establishing the positive association between the two (as depicted in Table 2), particularly once the United Arab Emirates outlier is discounted.

Figure 2 *Plot of Resource Abundance and Initial Income*



Source: Author's calculation based on data used in the paper.

4. The Basic Model

A specification similar to Mehlum et al. (2006b) and Boschini et al. (2007), based on the earlier work of Sala-i-Martin (1997), is used to ensure that the approach to the analysis is comparable to the benchmark in the literature. Of course, there is often concern that the conclusions reached in such growth studies depend on the combination of explanatory variables used (Hoover and Perez, 2004). Studies such as that of Levine and Renelt (1992) have found that almost any assortment of variables (except for investment and openness) is "fragile" to changes in the "conditioning information set".[7] In turn, the supporters of extreme-bounds analysis maintain that finding that a variable is "fragile" does not refute that it may be an actual determinant of the explained variable. Noting this possibility, the approach of Sala-i-Martin's (1997) is still

[7] The differences in the results could be attributed to the strictness of the variant of Leamer's (1983, 1985) extreme bound test that Levine and Renelt (1992) use for determining robustness of explanatory variables for growth models.

followed in this paper to provide a specification that is comparable to existing literature on the conditionality on the institutional quality of the resource curse.

Besides natural resource abundance, initial output level and institutional quality, the independent variables in the model include an interaction term between institutional quality and natural resource abundance. The term is intended to capture the potential differences between the effects of natural resource abundance on economic growth in the presence of differing institutional settings. The set of variables that act as conditioning variables include investment, openness to trade, and two regional dummies for Africa and Latin America, respectively. The dependent variable is real per capita GDP growth.

The cross-country growth model for country *i*, for *i* = 1, 2…53 is given as:

$$g_i = \alpha Y_{i,t-1} + \beta_1 NR_i + \beta_2 (NR_i \times INSTQ_i) + \beta_3 INSTQ_i + \phi X' + \varepsilon_i \qquad (1)$$

where: g_i is real per capita GDP growth, $Y_{i,t-1}$ is the level of income per capita in the last period, NR_i is natural resource abundance, $INSTQ_i$ is institutional quality indicator, $NR_i \times INSTQ_i$ is the interaction term, X′ is the set of control variables. ε_i is a white noise error term. A summary of the definition of the variables used in the paper is given in Table 3.

Table 3 *Summary of Variables, Description and Sources*

Variable name & expected sign	Description	Definition	Source
Resource abundance (-)	Natural resource rents (US$ per capita)	Non-renewable resource rents per capita. Sum of mineral, forestry and energy resources, excluding forestry rents.	(Rambaldi et al., 2005; World Bank, 2006a).
Natural capital	Natural capital (US$ per capita)	The sum of agricultural croplands, pastureland, timber, non-timber forest benefits, protected areas, energy resources and mineral resources. The bank uses a social rate of 4% p.a. as the discount rate to calculate a country's wealth as the net present value of sustainable consumption from the year 2000 to 2025.	World Bank (1997; 2006).
INVESTMENT (+)	Gross capital formation (% GDP)	Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation. Data are in constant 2000 U.S. dollars.	WDI database.
Openness (+/-)	Trade (% GDP)	Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product.	WDI database.
Growth	GDP per capita growth (annual %)	Annual percentage growth rate of GDP per capita based on constant local currency. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	WDI database.
Institutional quality (+)		It is calculated from Political Risk Services (PRS)' survey based data-International Country Risk Guide (ICRG) and is an unweighted average of six-point scales: rule of law, corruption in government and bureaucratic quality, and ranges from 0(bad institutions) to 1(good institutions).	Generated based on Knack's (2000) definition. Data from Political Risk Services.
Lattitude		Latitudinal distance from the equator, in absolute degrees terms	Treisman (2000, 2007)
Latin (-)	Regional dummy	Latin=1 Latin countries = 0 otherwise	Coding based on World Bank's country

			classifications.
Africa (-)	Regional dummy	Africa = 1 African countries = 0 otherwise	Coding based on World Bank's country classifications
Initial income level (-)	Initial income level	Gross domestic product divided by midyear population. GDP per capita (Constant 2000 US$).	WDI database
Interaction (+)	Interaction term	Product of natural resource abundance and institutional indicator	Generated

WDI= World Development indicators.

The partial growth impact of a marginal increase in natural resource abundance is (for simplicity, the subscripts are excluded):

$$\frac{\partial g}{\partial NR} = \beta_1 + \beta_2 (INSTQ)$$

The resource curse hypothesis implies that $\beta_1 < 0$.

The view that good institutions remedy the resource curse implies that $\beta_2 > 0$.

Note that to ensure that good institutions not only lessen the resource curse, but eradicate it, it is required that,

$$\frac{\partial g}{\partial NR} = \beta_1 + \beta_2 (INSTQ) \geq 0 .$$

Thus, the institutional threshold for not having the resource curse is given by $-\frac{\beta_1}{\beta_2}$.; i.e.,

$$-\frac{\beta_1}{\beta_2} \geq INSTQ$$

5. Regression Results

The results for the single cross-country OLS estimation are presented in Table 4. The table presents five specifications; regression (1) includes all the variables, as well as the regional dummies, regression (2) excludes the regional dummies, the specification for regression (3) is the same as in regression (2) but it is for non-African economies, regression (4) and (5) are similar to regressions (1) and (2), respectively, but differ in that the variable "openness" is excluded.

Table 4 Cross Country OLS Growth Results

Variable	(1)	(2)	(3)[b]	(4)	(5)
Initial income level	-0.0001 (0.04)*	-0.0001 (0.04)*	-0.0001 (0.09)*	-0.0001 (0.05)*	-0.0001 (0.05)*
Resource abundance	-0.002 (0.02)*	-0.003 (0.02)*	-0.002 (0.03)*	-0.003 (0.02)*	-0.002 (0.01)*
Interaction term	0.004 (0.01)*	0.004 (0.01)*	0.003 (0.02)*	0.004 (0.01)*	
Institutional quality	3.38 (0.11)	4.37 (0.03)*	3.46 (0.08)*	4.45 (0.03)*	3.60 (0.10)*
Openness	-0.01 (0.29)	-0.01 (0.37)	-0.01 (0.37)		
Investment	0.17 (0.01)*	0.19 (0.01)*	0.21 (0.05)*	0.17 (0.01)*	0.16 (0.01)*
Latin	-0.74 (0.39)				-0.43 (0.54)
Africa	-1.03 (0.15)				-0.90 (0.16)
Constant	-2.46 (0.20)	-4.07 (0.01)*	-3.70 (0.09)*	-4.23 (0.01)*	-2.92 (0.12)
F-test for joint significance (*p*-value)[a]	0.00	0.00	0.00	0.00	0.00
R^2	0.52	0.49	0.52	0.48	0.50
Countries	53	53	33	53	53

Dependent variable is real GDP per capita growth. *Statistical significance at conventional levels of significance (1%, 5% and 10%). [a]The null hypothesis is that there is overall significance in the regression/model. [b]Excludes African countries. The figures in parentheses are the *p*-values.

Based on regression (1) of Table 4, the cross-country OLS growth regression results are consistent with previous studies (with particular reference to Boschini et al., 2007; Mehlum et al., 2006b). The coefficient on natural resource abundance has a negative sign, while the one for the interacted term has a positive sign. For both the resource abundance and interacted term, the results are robust to different specifications. Interestingly, even the magnitudes stay fairly stable. It is worth noting that even though all the other explanatory variables have the expected signs, openness has an unexpected (negative) sign, albeit being statistically insignificant consistently across regressions (1) to (3). When it is dropped from the regression, the results presented in regression (5) are very similar to those of regression specification (1).[8] The statistical insignificance of openness may be a signal that this indicator affects economic growth indirectly through the rate of investment (as outlined in Hoeffler, 2001). Hence, the inclusion of investment and openness in the same regression equation may explain the insignificance of this variable. However, this explanation may not be valid because when investment is dropped from the equation, openness maintains the same negative and statistically insignificant result. Therefore, the negative sign may be reflecting Rodriguez and Rodrik's (1999) argument that an ambiguous relationship may exist between trade openness and economic growth. An increase in exports improves foreign exchange essential for purchasing imported capital goods (especially for small economies) thus developing a market for domestic products. However, if imports mainly consist of consumption goods, economic growth could be reduced through a reduction in investment.

To factor in the assertion that the resource curse is likely to be an "African phenomena" (Boschini et al., 2007; Mehlum et al., 2006b), regression (3) excludes all African economies in the sample. However, the conclusions remain the same; implying that the results are not driven by the inclusion of African countries.

The partial growth impact of a marginal increase in resource abundance (holding all other variables constant) implied by regression (1), for instance, is:

$$\frac{\partial(growth)}{\partial(resource)} = \text{-0.002+0.004(institutional quality)}$$

[8] The results remain unchanged not just in terms of conclusion, but also in terms of the sign and magnitude of the variables of interest.

The regression results indicate that the institutional threshold of not having the resource curse is $-\frac{\beta_1}{\beta_2}$ = 0.5.

The 0.5 threshold implies that above this institutional quality level, the partial contribution of natural resource abundance to growth is higher for a high resource endowed country than for a low endowed one, whereas the reverse holds below the institutional threshold.[9] In short, countries with institutional quality above 0.5 are not going to be resource cursed.

Using Table 5 below, the average impact of a unit-standard deviation increase in natural resource abundance on economic growth for a country with average institutional level, which is 0.57 for the sample used, is:

$$952.25 * (-0.002 + (0.004 * 0.57)) = 0.27$$

The result implies that, *ceteris paribus*, for a country with average institutional quality, a one standard deviation increase in natural resource abundance is expected to increase the annual growth rate by 0.27 per cent. Despite the apparent attractiveness of these results, they may be misleading due to possible issues of endogeneity, omitted variables and outliers. These issues are investigated below.

Table 5 Cross Country Summary Statistics Data

Variable	Observations	Mean	Std. Dev.	Min	Max
Initial income level	53	5898.30	8396.43	45.23	34845.57
Growth	53	1.20	1.95	-2.16	8.75
Investment	53	20.22	5.31	7.06	32.63
Openness	53	69.53	35.71	18.74	186.04
Resource abundance	53	429.79	952.25	0.01	5157.65
Institutional Quality	53	0.57	0.22	0.12	1.00

Source: Author's calculations based on WDI data.

[9] To recap, institutional quality ranges between 0 for bad quality and 1 for good quality.

6. Issues Expected to Arise from Applying OLS to Cross Sectional Data

A key issue as far as the OLS cross-country analysis is concerned is that unobserved country-specific effects are ignored. In addition, there is only one time period, implying that the country specific term and explanatory variables are assumed uncorrelated. The estimation of this relationship using OLS is likely to be biased upwards. This is because in a typical growth model, both the explanatory variables and the country-specific term are related–the *omitted variables* problem. Moreover, there are likely to be issues of endogeneity and simultaneity bias. Also of concern, and related to the omitted variable bias, is the possibility of a mis-specified functional form. For instance, the relationship may not be linear or some variables that need to be included in the regression equation are not. Therefore, the estimation of a typical growth model requires that these issues be addressed. In view of these concerns, this section discusses the issue of the appropriateness of the model specified. Apart from the model specification issues, the other problem concerns the natural resource abundance indicator used.

6.1 Model Specification

Even though the problems of omitted variables, measurement error and endogeneity may arise for different reasons, their remedy is the same: instrumental variable estimation (Baum, 2006). This is because the difference between omitted variables and simultaneity is not clear-cut, since both problems can concurrently appear in the same equation (Wooldridge, 2009).

6.2 Omitted Variables

A concern with the previous analysis is that there might be an omitted variable problem. Omitting a relevant variable may lead to a correlation between some explanatory variables and the error term, thus leading to biased and inconsistent OLS estimates. For instance, it is possible that the relationships in question are non-linear, hence the missing variable may be a quadratic term, and so to explore this possibility, Ramsey's Regression Specification Error Test (RESET) is used. To recap, the growth equation, excluding subscripts, is:

$$g = \beta_1 NR + \beta_2 (INSTQ \times NR) + \beta_3 INSTQ + \phi X' + \varepsilon \qquad (2)$$

The RESET uncovers potential general types of functional form misspecification by including polynomials in the fitted values of the OLS to equation (2). Let $\hat{y}$ be the OLS fitted values of estimating equation (2), then the expanded equation is:

$$g = \beta_1 NR + \beta_2 (INSTQ \times NR) + \beta_3 INSTQ + \phi X' + \delta_1 \hat{y}^2 + \varepsilon \qquad (3)$$

Equation (3) is used to determine whether equation (2) has left out some important nonlinearities, therefore $\hat{y}^2$ represents the nonlinear functions of the explanatory variables. Any assortment of powers of $\hat{y}$ series could be added to fix this problem. The option of including powers more than two is not pursued for two reasons. First, the price of including additional quadratics is a complication in the interpretation of the model. Second, the RESET, and related theory, does not provide an answer as to why the functional form is misspecified (Wooldridge, 2009). The RESET is just an *F*-statistic for testing the following hypotheses:

Ho: there is no misspecification OR the model has no omitted variables ($\delta_1 = 0$)

H1: the model is misspecified ($\delta_1 \neq 0$)

The RESET specification test for the basic model suggests a clear rejection of the null hypothesis. A test for the basic model with all the variables, including the regional dummies, suggests a rejection of the null hypothesis (*p*–value = .01). Similarly, the exclusion of the regional dummies suggests the same conclusion (*p*–value = .02). Next, the square of resource abundance interacted with institutional quality is included and the result does not change (*p*–

value = .02). The exclusion of regional dummies in one instance and the inclusion of the square of resource abundance in the other each gives a *p*–value = .01. The results do not suggest whether the model is linear or non-linear, but it is clear that both specifications are not appropriate, or there may be some omitted variables. The question is which variables are missing? The major shortcoming with the Ramsey's specification test is its failure to give guidance on what to do if the model is rejected (Wooldridge, 2009).[10] The results here suggest that the commonly used model is not robust to the use of different samples, period nor a natural resource indicator that concerns itself with the non-renewable resources. The results are used nonetheless to highlight the non-generality (empirically) of the conditionality of the resource curse.

6.3 Measurement Error and Endogeneity

As far as empirical work is concerned, it is quite common to have to deal with a measurement error or an error-in-variable (Baum, 2006). This problem occurs when theory informs a researcher of an inclusion of a variable that cannot be accurately measured. For instance, it is difficult to capture resource abundance as a stock variable, forcing the paper to utilise a flow variable instead; and the latter may just be measuring resource dependence rather than abundance. Therefore, some observable magnitude cannot be observed or captured. The failure to capture this magnitude implies that the actual behavioural response has been misread. The measurement error affects the OLS regression model in a similar fashion as endogeneity of at least one of the regressors (Baum, 2006).

[10] The results here suggest that the specification of the model commonly used in this line of literature is not robust to the use of a different sample, period nor a natural resource indicator that concerns itself with non-renewable resources.

Endogeneity arises when an explanatory variable defies the "zero-conditional-mean assumption $E[\varepsilon / X] = 0$: that is, if the variable is correlated with the error term, it is endogenous" (Baum, 2006, p. 132). Mathematically, the previously mentioned measurement error and endogeneity tend to have similar effects on an OLS regression model. Previous literature uses instrumental variables estimators, especially the Two Stage Least Squares (2SLS) to deal with these issues. While Mehlum et al. (2006b) appreciate that there might be reverse causality between institutional quality and economic growth, they do not seek to address the problem. However, Boschini et al. (2007) carries out a *Regression-based Hausman Endogeneity Test* and fail to reject the null hypothesis that institutions, natural resource abundance and the interacted term are exogenous. Even so, they still decided to test the sensitivity of their results to an instrumental variable estimation: the 2SLS, while treating institutional quality and the interaction term as endogenous variables. They used a country's latitude and the fraction of the population speaking any European language to instrument institutional quality, and used an interaction of resource abundance with these variables as instruments for the interaction term. In the research presented in this paper, the variable latitude is used to instrument institutions and latitude interacted with resource abundance for the interacted term. The exogeneity tests reveal that endogeneity is not a problem, implying that there is some confidence in the initial OLS results of Table 4.[11]

[11] In spite of this, an instrumental variable estimation (2SLS) was carried out on the understanding that 2SLS is expected to be less efficient than the OLS when explanatory variables are exogenous (as is the case in the paper). Indeed, the 2SLS gives less precise measure. However, the 2SLS results (available upon request from the author) are fundamentally similar to those obtained under OLS.

6.4 Other Issues

6.4.1 Outliers

Another concern with the OLS model is the possibility of it being influenced by outliers. OLS is prone to outliers because it minimises the sum of squares of residuals, implying that large positive and/or negative residuals are weighted more in the least squares minimisation problem. To determine the robustness of the results to potential outliers, Belsley, Kuh and Welsch's (1980) Difference in FIT Standardised (DFITS) Statistic is used. The test is useful in giving leverage; leverage is used to identify observations which have a large impact on results from fitting regression models (Baum, 2006).[12] That is, it gives the change in the predicted value for a point, calculated when the point is omitted from the regression. The statistic is given as:

$$DFITS_j = r_j \sqrt{\frac{h_j}{1-h_j}}$$

where: h_j is the leverage of a point and r_j represents a standardised residual defined as:

$$r_j = \frac{e_j}{s_j \sqrt{1-h_j}}$$

where: $e_j = \hat{y}_j - \hat{y}_j(j)$ are prediction for the *j*th observation with and without the *j*th observation included in the regression. s_j is the root mean squared error of the regression without the *j*th observation. Observations that satisfy the cut-off value of $|DFITS_j| > 2\sqrt{\frac{K}{N}}$, are considered as highly influential, i.e., outliers. [13] This makes sense because high values of the numerator (which in this case is the leverage, h_j), and the residual (which, in turn, influences r_j) will inflate the DFITS.

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[12] An outlier is data that has leverage.

[13] K is the number of explanatory variables and N is the number of observations.

The DFITS cut-off criterion identified the following four countries as outliers: United Arab Emirates, China, Sudan and Papua New Guinea. Consequently, the OLS country regressions were repeated without these countries. Table 6 presents the amended results. Regression (9) includes all explanatory variables as well as regional dummies. On the other hand, regression (10) excludes the dummies.

Table 6 Cross Country OLS Results for Regressions Excluding Outliers and Developed Countries, Respectively

Variable	(9)[b]	(10)[b]	(11)[c]	(12)[c]
Initial income level	-0.0001 (0.03)*	-0.0001 (0.05)*	0.0001 (0.58)	0.00003 (0.88)
Resource abundance	-0.003 (0.01)*	-0.003 (0.01)*	-0.01 (0.05)*	-0.01 (0.11)
Interaction term	0.005 (0.00)*	0.005 (0.01)*	0.01 (0.05)*	0.01 (0.09)*
Institutional quality	4.81 (0.03)*	5.18 (0.01)*	2.75 (0.41)	3.61 (0.28)
Openness	-0.001 (0.82)	-0.002 (0.74)	-0.02 (0.17)	-0.01 (0.28)
Investment	0.15 (0.00)*	0.17 (0.00)*	0.20 (0.01)*	0.22 (0.01)*
Latin	0.04 (0.96)		-1.16 (0.22)	
Africa	-0.64 (0.35)		-1.09 (0.13)	
Constant	-3.70 (0.04)*	-4.59 (0.00)*	-2.18 (0.33)	-3.97 (0.03)*
F-test for joint significance (*p*-value)[a]	0.00	0.00	0.00	0.00
R^2	0.51	0.53	0.56	0.52
Countries	49	49	43	43

Dependent variable is real GDP per capita growth. [b]Excludes United Arab Emirates, China, Sudan and Papua New Guinea. The figures in parentheses are the *p*-values. *Statistical significance at conventional levels of significance (1%, 5% and 10%). [a]The null hypothesis is that there is overall significance in the regression/model. [c]Excludes Finland, Sweden, Denmark, Netherlands, Iceland, Canada, New Zealand, Norway, Australia and USA.

The results suggest that the inclusion of outliers is not driving the main results in Table 4 in the sense that institutional quality still significantly determines whether abundant natural resources are harmful to economic growth or not. However, the regression results of equation (9) indicate that the institutional threshold of not having the resource curse increases to 0.6. A Wald test reveals that there is a statistically significant difference between the new and old threshold.[14] The 0.6 threshold implies that the partial contribution of resource abundance is higher for a high resource endowed country than a lesser endowed one, whereas the reverse holds below the institutional threshold. In short, only economies with institutional quality of at least 0.6 will not be resource cursed.

6.4.2 Are Developed Countries Driving the Results?

It is possible that developed economies drive the results given their typically superior institutions (Figure 1 highlights this). All of the developed countries in the sample have superior institutions and some (like Norway, Canada) have a substantial level of resource endowment. A combination of these factors may be behind the positive sign of the interaction term. Therefore, Table 6 also presents OLS regression results (11) for a regression with regional dummies for all developing economies, whilst regression (12) is a more parsimonious presentation that excludes these dummies.

The results in Table 6 indicate that the positive sign of the interaction term in the previous results is not driven by the developed economies with their good institutions and, in some cases, high endowment of the resource. Generally, the results suggest that developed countries are not driving the results presented earlier regarding the conditionality on institutional quality of the

[14] The null hypothesis for the test is that the ratio of the coefficient of resource abundance and the interaction between resource abundance and institutional quality is equivalent to 0.5. This is tested against an alternative hypothesis that the ratio is not equal to 0.5. The resulting *F*-statistic is 691.08, with a *p*-value of .00, hence a rejection of the null hypothesis.

resource curse. However, the new threshold of 1, presented in regression (11), implies that only economies with the highest attainable institutional quality will escape the curse.[15]

6.5 The Natural Resource Abundance Indicator

Is the resource indicator chosen appropriate for the research developed in this paper? To investigate, the World Bank's natural capital stock *measure of resource abundance* rather than the often used flow variable is used. Of the 53 countries that form the core sample, it is only possible to obtain data for the World Bank's natural capital for 48.[16] Table 7 contains OLS cross-country growth results utilising this alternative measure.

Table 7 Cross Country OLS Growth Results Using a Stock Variable

Variable	(13)	(14)	(15)	(16)
Initial income level	-0.0001 (0.00)*	-0.0001 (0.00)*	-0.0001 (0.00)*	-0.0001 (0.00)*
Natural Capital	-0.0002 (0.01)*	-0.0002 (0.03)*	-0.0002 (0.01)*	-0.0001 (0.03)*
Interaction term	0.0002 (0.04)*	0.0001 (0.10)*	0.0002 (0.04)*	0.0001 (0.09)*
Institutional quality	4.50 (0.01)*	5.57 (0.00)*	4.84 (0.00)*	5.83 (0.00)*
Openness	-0.01 (0.35)	-0.01 (0.37)		
Investment	0.21 (0.00)*	0.23 (0.00)*	0.20 (0.00)*	0.21 (0.00)*
Latin	-0.19 (0.81)		0.11 (0.86)	
Africa	-1.10 (0.11)		-0.97 (0.12)	
Constant	-3.37 (0.04)*	-5.02 (0.00)*	-3.90 (0.01)*	-5.29 (0.00)*

[15] The Wald test results in an *F*-statistic of 740.35, with a *p*-value of .00; therefore, the threshold here is statistically different from 0.5.

[16] Consistent with Brunnschweiler (2008), the average of the only two available years (i.e., 1994 and 2000) is used. This decision was made for two main reasons. Firstly, the use of an average is not harmful since the individual indicators are highly and significantly correlated with averaged natural capital. Secondly, the average is intended to reduce the potential measurement and price fluctuation that may arise in the calculations (Brunnschweiler, 2008).

F-test for joint significance (*p*-value)[a]	0.00	0.00	0.00	0.00
R^2	0.65	0.61	0.64	0.60
Countries	48	48	48	48

Dependent variable is real GDP per capita growth. The figures in parentheses are the *p*-values. *Statistical significance at conventional levels of significance (1%, 5% and 10%). [a]The null hypothesis is that there is overall significance in the regression/model. Regressions exclude the following: Bahrain, Oman, Sudan, Iceland and USA because of data limitations.

The regression results of equation (13) in Table 7 indicate that the institutional threshold for not having the resource curse increases to 1.[17] The threshold of 1 implies that for economies with the highest attainable institutional quality, the partial contribution of natural resources is higher for a high resource endowed country than a low endowed one, whereas the reverse holds for everyone else.[18] The threshold is the same as the one for when developed economies are excluded in regressions (11) and (12), respectively, of Table 6.

Finally, to summarise, Table 8 gives the marginal growth effects of a unit standard deviation change in resource for various levels of institutional quality.

Table 8 Summary of Marginal Effects of Natural Resource Abundance for Different Levels of Institutions

Type of institution	Full sample (53 countries) FLOW resource indicator	STOCK resource indicator (48 countries)	No outliers (49 countries) FLOW resource indicator	Developing Countries (43) FLOW resource Indicator
Bad institutions	-1.45	-1.95	-2.27	-8.35
Average institutions	0.27	-0.95	-0.14	-4.09
Good institutions	1.90	0.00	1.89	0.00

Source: Author's calculations based on the OLS cross country results.
Notes: Bad institutions = institutional quality of 0.12. Average institutions = institutional quality of 0.57. Good institutions = institutional quality of 1.

Generally,

$$\Delta growth = SDresource \times (\hat{\beta}_{resource} + \hat{\beta}_{instq} \times Instq)$$

where: *SDresource* is the resource standard deviation and *Instq* is a country's institutional level.

[17] The Wald test result is an *F*-statistic of 67.53, with a *p*-value of .00.
[18] Then again, since by using natural capital the sample ended up with 48 countries instead of 53 used in Table 4, due to data availability, the differences may be stemming from the differences in coverage.

The minimum institutional quality level for the cross sectional sample is for Congo at 0.12 while the maximum is for Finland, Sweden and Denmark at 1.[19] A unit standard deviation increase in natural resource abundance will always have a negative effect on economic growth for economies with bad institutions, but becomes a blessing as the institutional quality improves. The cross-country results of Table 4 are the only ones that show that both economies with average and good institutions will not be resource cursed. All other variants of the initial specification, namely exclusion of outliers and developing countries, as well as the use of a stock variable, show that only those economies with good institutions (the very best for the last two instances) will escape the resource curse. This implies that the initial OLS results are sensitive to these variants and may give misleading results in terms of the institutional threshold that matters for the resource curse. Generally, however, regardless of the specification used, one can still conclude that the resource curse diminishes with institutional quality improvement.

7. Conclusion

The paper re-tested the contemporary hypothesis that the resource curse is conditional on good institutions. To achieve this, an OLS cross-country regression was applied to a fresh dataset for 1984-2003, while using a natural resource indicator that focuses solely on non-renewable resources, rather than the inappropriate universally used one, which also includes renewable resources. The regression results are similar to those found in the existing literature in the sense that economies with good institutions will escape the resource curse. Therefore, the results are not driven by the use of a different sample, period nor a natural resource indicator that concerns itself with non-renewable resources.

[19] Table 5 gives summary statistics of the data for the cross section data used here.

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