Modelling Natural Resources, Oil and Economic Growth in Africa

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Abstract. Using panel data from 1980 to 2010 on 34 sub-Saharan African countries, this paper examines whether institutionalised authority, which is a proxy for state authority, can change the negative relationship between natural resources and economic growth. The key finding is that, institutionalised authority can alter the negative relationship that exists between natural resources and economic growth. We also model the relationship between the oil revenue (fuel exports) and economic growth, and how institutionalised authority can alter this relationship as well.

Key words: Economic Growth; Natural Resources; Oil; Institutions; Dutch Disease; Sub-Saharan Africa

JEL classification: C33, O43, P52, Q28, Q33, Q43

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Section 1: Introduction:

Many research papers have been written in order to analyse the effect of natural resources on economic growth. These researches have used aggregate natural resources and in many cases, primary exports as a proxy for natural resources in doing this analysis. This paper seeks to decompose the natural resources in sub-Saharan Africa and make use of two main resources; ores and metal exports, and fuel exports. This research uses data from 1980 to 2010 on all the 48 sub-Saharan Africa countries as recognized by the World Bank and the United nations. Any sub-Saharan Africa that is not included in this research is either not recognized by the aforementioned bodies above or came into existence after 2010, like South Sudan.

The effect of energy resource in the countries with abundant natural resources will be analysed in this paper. This is to see if the energy resources worsen the seemingly negative relationship between natural resource and economic growth or they reduce the negativity. Then more crucially in this paper, we will analyse the effect of institutionalised authority (a proxy for freedom or state authority) in all these relationships. In doing this, there will be an international perspective where a theoretical overview will be done on the effect of natural resources on the economic growth of countries outside the Sub Saharan Africa (SSA) region. This is to see if the natural resource curse and the Dutch disease are worse or peculiar in the SSA countries are or it is same or even worse on the broader international perspective.

Section 2: The contribution of this paper

First of all, this research seeks to establish and analyse the impact institutionalised authority has on the relationship between natural resources and economic growth of sub-Saharan African countries. In establishing that the resource curse is well and prevalent in the sub-Saharan region, this paper also examines the effect of oil revenue on economic growth in the sub region. After the analysis, it can be established that, the Dutch disease is indeed also present in sub-Saharan Africa. This means that, the oil revenue is an enforcer of the negative relationship between natural resource and economic growth (referred to as the natural resource curse). It will become clear at the end of this paper that, institutionalised authority can positively alter the role natural resources play in economic growth of sub-Saharan African countries.

In establishing the regression model to use in order to analyse the relationship among growth, natural resource and institutionalised democracy, this paper makes use of the linear growth regression model which has become the standard empirical literature on this subject as used by researchers like Mankiw, Romer, et al (1992), Sachs and Warner (1997), Sala-i-Martin and Subramanian (2003), and Ilmi (2007). Therefore, the empirical linear growth models that will be used in this paper consist of two sets of equations. The first set look at the relationship between natural resources and economic growth, and how institutionalised authority affect this relationship. The second set of models look at the relationship between the oil revenue (fuel exports) and economic growth, and how institutionalised authority can alter this relationship as well. The expectations from these set of models is that, natural resources have negative impact on economic growth, but institutionalised authority can positively affect this negative relationship. SSA countries have been mentioned uncountable number of times when discussions of the Dutch disease are done. Some researchers even hold the view that, SSA countries are the worst culprit caught in this menace. However, the role of freedom, institutionalised or state authority, in matters of resource management seems to be lacking in research.

In most SSA countries, many groups, in addition to the state, lay claim to the ownership and management of natural resources in their jurisdiction. There are countless number of rebel groups ranging from the Lord's Resistance Army (LRA) and the M23 (militia) in the Democratic Republic of Congo to the Movement for the Emancipation of the Niger Delta (MEND) in Nigeria. These militant groups believe that, they could better manage the natural resources than the state authorities who supposedly spend most of the revenue derived from these resources on bureaucracy and its unnecessary apparatus.

This paper will look at the role that the state authority plays in the natural resource curse syndrome. This research seeks to analyse if the use of a united and institutionalised authority can alter this negative relationship which apparently exists between natural resources and economic growth.

This paper is therefore, adding three main new dimensions to the existing literature on this matter; to check the severity of both the natural resource curse and the oil-induced Dutch disease on economic growth. We investigate if the inclusion of the oil resource reduces the negative impact of natural resources on economic growth or it worsens the natural resource curse. Then finally, this paper will look at the impact of institutionalised authority on the relationship between economic growth and natural resource, and also its effect on the relationship between economic growth and oil revenue.

Many of these factors that have been empirically proven to be associated with the existence of the natural resource abundance and the Dutch disease is found in most SSA countries. Therefore, the countries with these factors that threaten economic growth are likely to have slow growth, with or without natural resource. Therefore, analyzing data on resource-rich (and oil-rich) countries in the SSA zone and their resource-poor counterparts also in the SSA zone and comparing the performance of their economic growth holding other factors constant will tell a better story than what has already been done. This paper will therefore pitch the growth rates of the SSA countries against each other. This means that, both sets of SSA countries will be taken into consideration; resource-rich and resource-poor ones. Using the same time period, from 1980 to 2010, we will see if the resource-poor ones are indeed performing better than the resource-rich ones.

Section 3: Data and software

3.1 Data

This paper makes use of data from two main sources; the World Bank, and the Center for Systemic Peace. However, in many instances, data is sought and crosscheck from the central bank, statistical offices, and other relevant institutions in these sub- Saharan African countries. The data on GDP growth, manufacturing growth, population growth, external debt, ores and metal exports (which is a representative of natural resources and herein after referred to as natural resources), fuel export, Life expectancy, and Tax Revenue, come from the World Bank. However, polity (the proxy for freedom) comes from the Center for Systemic Peace. This center provides living data resources on 167 countries that are independent and have population not less than 500,000 as at 2012. The terms oil, petroleum, and fuel exports shall be used loosely and shall mean the same thing.

Throughout this paper, some few terms are used loosely and interchangeably. Polity, polity2, institutionalised authority, state authority, and central authority shall mean same and are used loosely and interchangeably. Economic growth, economic development and manufacturing growth shall mean same and are used loosely and interchangeably. Black gold, oil revenue, oil exports, energy resource, and fuel exports shall mean same and are also used loosely and interchangeably. GDP and economic growth are also used loosely and interchangeably as well.

Data preparation sometimes referred to as data preprocessing is the process of manipulating data into a form suitable for further analysis and processing (Spector, 2008; Williams, 2011). It is one of the most important steps in data analysis that ensures data integrity and quality (Kalbfleisch & Prentice, 2011). The process is often described as tedious and time consuming because it involves several different tasks which often cannot be automated. Some of these tasks include editing, coding and tabulation. It could also involve dealing with cleaning, aggregation variables and records selection as well as transformation of data.

In this study, the focus was on selecting variables that have major impact on economic growth specifically for the sub-Saharan Africa region. Some of these variables are *population growth, external debts, tax revenue, fuel exports, life expectancy* among others. Firstly, data were collected from the World Bank, institutions in the sub-Saharan African countries under consideration, and the center for systemic peace from 12th February to 14th March to construct the final data set. The data was then prepared to form a panel data from 1980 to 2010 and saved in a comma separated value (csv) format. A panel data also referred to as longitudinal or cross-sectional time-series data is one in which the behavior of entities are observed across time. These entities may be individuals, countries, regions or companies. The entities in this study were made of 49 sub-Saharan African countries.

3.2 Software

The data preparation, cleaning, transformation and the analysis were all performed using the R programming language. R is free open source software with rich and comprehensive statistical and graphical programming packages (Maindonald, 2007; Ihaka & Gentleman, 1996). R is also unique as a statistical software tool because of its expansive sets of packages for solving almost all statistical problems. In this study, the following packages were handy in the preparation as well as the analysis stages.

car - *Companion to Applied Regression*
pastecs - *Package for Analysis of Space-Time Ecological Series*
plm - *Linear Models for Panel Data*
gdata - *Various R programming tools for data manipulation*
foreign - *Read data stored by Minitab, dBase, SAS, SPSS, Stata,etc*
lmtest - *Testing Linear Regression Models*

The main package used was *plm* which was used in running both random and fixed effects on the data sets. The same package was also useful in deciding between whether to employ random or fixed effects on the models by running the *Hausman test.*

Section 4: Model

4.1 Model equations

The Resource Curse: Natural Resource, Institutionalised Authority, and Economic Growth

The following regression seeks to estimate the relationship between the natural resources, institutionalised democracy, and economic growth of 34 Sub-Saharan African countries.

$$Growth_{it} = \beta_0 + \beta_1 Natu_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \beta_7 Polity_{it} + \beta_8 Natu_{it} \times Polity_{it} + \mu_{it}$$

As a standard practice in using panel data, i refers to the countries while t relates to time.

Growth relates to the manufacturing growth, which is a proxy for real non-oil GDP growth.

Natu refers to natural resources. This is the aggregate of fuels, ores and metal exports.

Pop refers to population growth which is the percentage of the rate of growth from the previous year to the current year.

*Ext r*efers to external debts, which is a percentage of Gross National Income (GNI).

Imports refer to imports of goods and services, a percentage of GDP.

*Educ r*efers to total public spending on education, a percentage of GDP.

Life refers to life expectancy, the total number of years a person is expected to live if the current mortality conditions at the time of that person's birth remain same throughout.

Polity is the proxy for institutionalised democracy.

The interaction term between natural resource and institutionalised authority in the equation is to enable us address the core question this paper seeks to answer- does institutionalised authority affect the relationship between natural resource and economic growth, and how?

Under this set of model, there are two other equations. The first one is to estimate an equation for the relationship between natural resource and economic growth, with the assumption of non-existence of institutionalised democracy. Therefore, the polity variable was not included in this equation at all:

$$Growth_{it} = \beta_0 + \beta_1 Natu_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \mu_{it}$$

The second equation under this model is an equation that makes room for the existence of institutionalised democracy, but with no interaction between institutionalised authority and natural resource.

$$Growth_{it} = \beta_0 + \beta_1 Natu_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \beta_7 Polity_{it} + \mu_{it}$$

This is to see the influence of natural resource on economic growth in countries with institutionalised authority but this resource is not fully managed by the institutionalised authority. Example is the Democratic Republic of Congo.

The Dutch Disease: Oil Revenue, Institutionalised Authority, and Economic Growth

This is the second model which focuses on the oil resource, which is also a major resource on the sub-Saharan African sub region.

$$Growth_{it} = \beta_0 + \beta_1 Oil_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \beta_7 Polity_{it} + \beta_8 Oil_{it} \times Polity_{it} + \mu_{it}$$

Oil refers to the oil resource, represented by fuel exports. All other variables in this equation remain same as explained in the first model for natural resource. There is an interaction term in this equation as well. This is also to answer the fundamental question of whether institutionalised authority can positively affect the relationship between the oil resource and economic growth.

In this model, there are two sub equations as well. The first equation is to estimate the relationship between oil resource and economic growth without including the institutionalised authority variable in the equation. This is to see how oil resource affects economic growth in sub-Saharan African countries that do not have institutionalised authority (not necessarily elections).

$$Growth_{it} = \beta_0 + \beta_1 Oil_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \mu_{it}$$

The second sub equation under this model is the equation estimating the relationship between the oil resource and economic growth, which includes institutionalised democracy, but no interaction between this variable and oil revenue. This is to see the influence of oil on economic growth in countries with institutionalised authority but where these resources are not totally managed by state authorities.

$$Growth_{it} = \beta_0 + \beta_1 Oil_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \beta_7 Polity_{it} + \mu_{it}$$

4.2 Econometrics Issues

In conducting this research on the 34 sub-Saharan African countries, this paper acknowledges that many limitations exist. The first and major problem in analyzing the relationship between natural resources and economic is the problem of reverse causality, that is, the issue of cause and effects. Thus, natural resources and institutionalised authority affect economic growth. However, these two factors could also be affected by the level of economic growth or development in a country. Example is the contrasting relationship between the effect of oil resource on economic growth in Norway and Nigeria. Many schools of thought believe that, if Nigeria's level of economic growth was like that of Norway when both countries discovered oil, the impact of the oil resource could have been positive on the economy of Nigeria as well, just like Norway.

The second problem to look out for is the problem of omitted variable bias. However, the Ramsey Resett test showed a p-value of 0.0002677. This means that the model do not have any serious omitted variable bias problem.

There are other limitations which include but not limited to measurement error. The acknowledgement of this problem necessitated the inclusion of an error term in the models.

There is also likelihood of the problem of endogeneity, where explanatory variables might be correlated with the error. This problem is solved by using five years lagged values of the independent variables as instrumental variables. This ensures that the model avoids the problem of endogeneity since error terms are not correlated with the lag of independent variables. Therefore, the explanatory variables used in the regressions are five years lagged values.

To make sure that this model does not suffer from heterogeneity problems, many assumptions were made. Three main estimation models are used; pooled OLS, Fixed Effect (FE), and Random Effect (RE) models. In formulating the equation for the panel data, this paper makes use of a constant term, α_0 :

$$Growth_{it} = \alpha_0 + \beta_1 Natu_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \beta_7 Polity_{it} + \beta_8 Natu_{it} \times Polity_{it} + \mu_{it} \quad (a)$$

Including time and country effects in our model, we make use of pooled OLS and Random Effect models. In these models, $\mu_{it} = c_i + d_t + \psi_{it}$

Where c_i is the country-specific effect, d_t is the time effect, and the ψ_{it} is the white noise.

$$Growth_{it} = \rho_{it} + \beta_1 Natu_{it} + \beta_2 Pop_{it} + \beta_3 Life_{it} + \beta_4 Ext_{it} + \beta_5 Imports_{it} + \beta_6 Educ_{it} + \beta_7 Polity_{it} + \beta_8 Natu_{it} \times Polity_{it} + \psi_{it} \quad (b)$$

With time and country effects for the Fixed Effect model, $\rho_{it} = \alpha_0 + c_i + d_t$.

Assumption Underlying the three models; pooled OLS, Random Effect, and Fixed Effect (Park, 2005)

For the pooled OLS model, the assumption is that, the effects of the explanatory variables and the intercepts shall be same for all countries.

The Random Effect model works under the assumption that error variance structure ($\mu_{it} = c_i + d_t + \psi_{it}$) is affected by time and country-specific effects.

The Fixed Effect model on the other hand analyses the impact of the time and country-specific effects on the intercept.

In summary, this paper makes use of all the three estimation models (pooled OLS, Random Effect, and Fixed Effect models). The hypothesis under consideration is that, there is a negative relationship between natural resources economic growth, but institutionalised authority can change the nature of this relationship.

Section 5: EMPIRICAL RESULTS

5.1 Results

The key results from the panel data analysis of the relationship between natural resources and economic growth in sub-Saharan African countries are discussed here. The dependent variable is the manufacturing growth, which is a proxy for real non-oil GDP growth, and a good indicator of economic growth. At the heart of this research is how institutionalised authority can be used to change the negative relationship between natural resources and economic growth. The institutionalised authority is represented by polity2. This variable is the aggregate of two indicators; Institutionalised Democracy and Institutionalised Autocracy. Institutionalised Democracy index is an additive eleven-point scale which ranges from zero to ten (0 -10); the higher the index, the higher the level of Institutionalised democracy. The Institutionalised Autocracy is also an eleven-point additive scale ranging from zero to ten (0 -10); the higher this value, the severity of the institutionalised autocracy. The polity2 variable is therefore, the subtraction of the institutionalised autocracy index from that of the institutionalised democracy. This mathematical operation leaves the polity2 index in the range of positive ten (+10) and negatives ten (-10). A positive value for polity2 means there is Institutionalised democracy in that country at that time; and the higher the positive value, the stronger the Institutionalised democracy. In a similar vein, a negative value for polity2 implies that, there is institutionalised autocracy in that country at that particular point in time; a higher negative value means that country is strongly autocratic. Therefore, the institutionalised autocracy for a country with a value of negative ten is worse and severe than for a country with wild autocracy of say, negative one (Center for Systemic Peace, 2013).

From the regression outputs, the coefficient of natural resource is significant and negative for three equations in the pooled OLS regressions. However, the coefficient of the interactive term of natural resource and polity2 is significant and positive. This proves that, indeed there is resource curse in sub-Saharan Africa but with institutionalised authority, this curse can be converted into a blessing;

as shown in the regression (See Appendix B). To explain this in details, the impact of the polity2 variable is very important in this research. So in answering the core question in this paper, a set of regressions is carried out to see if institutionalised authority can alter the negative relationship between natural resource and economic growth. First, the polity2 variable is included in the model without interacting it with any other variable. In this circumstance, the polity2 variable is negative and significant in all the estimation models.

Table 4: Estimation Results, including polity2 variable but no interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	5.9432186	1.6277207	3.6513	0.000275 ***
Natural.resource	-0.0367959	0.0076839	-4.7887	1.943e-06 ***
Population.growth	-1.4518097	0.1867099	-7.7758	1.923e-14 ***
Life.expectancy.at.birth	0.1358164	0.0317226	4.2814	2.043e-05 ***
External.Debt	-0.0054900	0.0018129	-3.0284	0.002524 **
Imports	0.0472989	0.0092087	5.1363	3.390e-07 ***
Education	0.4838312	0.0709976	6.8148	1.663e-11 ***
polity2	-0.2208250	0.0340650	-6.4825	1.439e-10 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.22507 Adj. R-Squared : 0.22321

This means that, institutionalised authority on its own have negative relationship on economic growth. This can be explained by the fact that, institutionalised authority comes with institutions, elections, transitions, and other forms of bureaucracies. As the cliché goes 'democracy is very

expensive'. This implies that, institutionalised authority as a variable does not improve the economy. Again, the institutionalised authority can be an autocratic one. Even in this case where there is likely to be very little or no institutions, no elections, and less bureaucracy, autocracy is characterized by less limitations on executive power, and sheer display of profligate expenditure without due process. So it comes as no surprise that, institutionalised authority on its own has a negative relationship with economic growth. However, and more importantly, the interaction between polity2 and natural resource shows a positive and significant coefficient.

Table 5: Estimation Results, including the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	3.7624627	1.6582243	2.2690	0.023491 *
Natural.resource	-0.0247770	0.0079162	-3.1299	0.001801 **
Population.growth	-1.4761727	0.1842325	-8.0126	3.236e-15 ***
Life.expectancy.at.birth	0.1733871	0.0320958	5.4022	8.300e-08 ***
External.Debt	-0.0052699	0.0017887	-2.9461	0.003295 **
Imports	0.0501735	0.0091001	5.5135	4.518e-08 ***
Education	0.4756806	0.0700506	6.7905	1.953e-11 ***
polity2	-0.3190944	0.0384419	-8.3007	3.478e-16 ***
Natural.resource:polity2	0.0074580	0.0014171	5.2628	1.749e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.24676 Adj. R-Squared : 0.24447

This means that, institutionalised authority can alter the relationship between natural resource and economic growth from negative to positive. Specifically, one additional unit of natural resource introduced into an economy reduces economic growth by 0.0248 units. However, with the interaction with polity2, natural resource has positive effect on economic growth and for one additional unit of natural resource into the economy, economic growth improves by an additional 0.0075 units.

The regression also shows the effects of other independent variables used in the model are in conformity with expectations as to how they affect economic growth. Population growth has negative effect on economic growth. As it has been one of the plights of sub-Saharan African countries, increase in population growth has 'coincided' with worsening economic fortunes. External debt also has negative impact on economic growth. As expatiated in the previous chapter, one of the major challenges facing sub-Saharan African countries is their high level of external debts and its associated consequences. However, public spending on education has positive effect on economic growth. Thus, expenditure on education is a good investment in the productivity of people and the economy at large. Spending on education therefore, has a positive relationship with economic growth. The higher the expenditure by governments on education, the better it is for the economy, as evident in the results in this paper.

The Dutch Disease Hypothesis; is oil a minimizer or a multiplier?

The negative relationship between natural resource and economic growth has become evident in the estimations used in this paper. To see how the fuel component also reacts to economic growth, the results also prove similar to that of the natural resource; as depicted in the table below.

Table 6: Estimation Results using Fuel Exports with the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	4.6814819	1.6466324	2.8431	0.004563 **
Fuel.exports	-0.0312563	0.0103794	-3.0114	0.002669 **
Population.growth	-1.5016667	0.1867825	-8.0397	2.631e-15 ***
Life.expectancy.at.birth	0.1573258	0.0322780	4.8741	1.278e-06 ***
External.Debt	-0.0052404	0.0018087	-2.8973	0.003849 **
Imports	0.0467792	0.0092152	5.0763	4.619e-07 ***
Education	0.4827046	0.0708896	6.8092	1.726e-11 ***
polity2	-0.2623366	0.0360403	-7.2790	6.983e-13 ***
Fuel.exports:polity2	0.0046812	0.0018584	2.5190	0.011930 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.2283 Adj. R-Squared : 0.22619

From the above estimates, it can be seen that the fuel exports has a negative relationship with economic growth. Specifically, an additional increase of one unit of fuel exports will cause economic growth to decline by 0.0313. Recall that, with the same conditions and variables, natural resource causes economic growth to decline by 0.0248. This means that, oil revenue causes more havoc to economic growth than the much broader group of natural resource. This paper can therefore, conclude that, oil revenue reinforces the resource curse syndrome.

When fuel export is interacted with polity2, the impact on economic growth becomes positive. In actual terms, the economy grows by 0.0047 units per every additional increase in fuel exports. This means that, oil revenue can become a blessing when countries have good institutionalised authority.

5.2 Robustness

Using the pooled OLS for empirical analysis, the assumption is that, the intercepts are the same for all the sub-Saharan African countries under consideration, and therefore all these countries shall react to changes in economic growth the same way.

However, other assumptions are further made to control for unobservable heterogeneity and to ensure the robustness of the results. A different assumption here is that, changes to economic growth are not the same for all the sub-Saharan African countries. With this assumption, it becomes necessary to use Fixed Effect and Random Effect models. The main empirical findings are discussed below.

To check if the resource curse syndrome really exists in sub-Saharan Africa, the regression models are done with and without the interactive term. The first two regressions are done without the interaction term. The first regressions completely exclude the polity2 variable. Under this circumstance, the coefficient of natural resource is negative for both estimation models, but it is only significant under the Fixed Effect model, and not significant in the Random Effect model. The second regression which includes the polity2 variable but with no interaction between this variable and the natural resource variable, the coefficient of natural resource is negative and significant in both estimation models. This outcome is in line with the resource curse syndrome; natural resource indeed has negative impact on economic growth. Therefore, ceteris paribus, resource-rich countries in sub-Saharan Africa are likely to have slower economic growth over a long period of time than their resource-poor counterparts. Finally, when the interactive term of polity2 and natural resource is included in these two models, the impact of natural resource is still negative, but with lower negativity in both models. For the Random Effect model, the coefficient reduces from 0.0343 to 0.0024. This means that, without polity2, one additional unit of natural resource introduced into an economy reduces the economic growth by 0.0343 units. However, with the interaction between natural resource and polity2, one additional unit of natural resource introduced into an economy reduces the economic growth by only 0.0024 units. It is obvious from this that, even though polity2 could not change the impact of the natural resource from negative to

positive on economic growth, it still has a very significant positive effect on natural resource's impact on economic growth by reducing the negative impact drastically. The output from the Fixed Effect model also gave a similar result. Here, polity2 reduces the negative impact from 0.0338 units to 0.0027 units. Even though these two models gave very similar results, the Hausman test was done to find out which of these two models is better for this particular research

The Hausman test

This test is used to make a choice between Random Effect and Fixed Effect models. The null hypothesis for this test is that, Random Effect model is the preferred model. Whiles the alternate hypothesis is that, Fixed Effect is the preferred one. After running this test, the p-value was 2.2e-16 which is less than 0.05. Therefore, the null hypothesis is rejected and hence, Fixed Effect model becomes the preferred model.

Also, to deal with heteroskedasticity and serial correlation problems, this paper used robust covariance matrix to account for it.

Section 6: CONCLUSION

This paper investigates the hypothesis that natural resources have negative impact on economic growth. The influence of oil revenue is also analysed in this paper. It follows suit that oil revenue has negative impact on economic growth as well. What is new in this part is that, the negative impact of the oil revenue is more devastating than the broader group of natural resources. This indeed implies that, oil revenue is a maximiser in the natural resource curse syndrome. Data from 1980 to 2010 on the 34 sub-Saharan African countries analysed in this paper showed that, institutionalised authority vested in the state, no matter how weak and inefficient it is, is better than having several groups attempting to be the right managers of these resources.

It is worthy of note to acknowledge that, this research has some weaknesses. The data covers the period between 1980 and 2010 on 34 of the 48 sub-Saharan African countries. Data availability and reliability makes it difficult to include several years preceding the 1980s. This research concentrated on the linear relationship between natural resource and economic growth and how institutionalised authority can alter this relationship. Further research could be done to see the nonlinear relationship existing among these variables.

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Appendix

Appendix A

List of Sample Countries

	Country name	Country Code		Country name	Country code
1	Benin	BEN	18	Liberia	LBR
2	Botswana	BWA	19	Madagascar	MDG
3	Burkina Faso	BFA	20	Malawi	MWI
4	Burundi	BDI	21	Mali	MLI
5	Cameroon	CMR	22	Mauritania	MRT
6	Central African Republic	CAF	23	Mauritius	MUS
7	Chad	TCD	24	Niger	NER
8	Congo, Dem. Rep.	ZAR	25	Nigeria	NGA
9	Congo, Rep.	COG	26	Rwanda	RWA
10	Cote d'Ivoire	CIV	27	Senegal	SEN
11	Ethiopia	ETH	28	Sierra Leone	SLE
12	Gabon	GAB	29	South Africa	ZAF
13	Gambia, The	GMB	30	Sudan	SDN
14	Ghana	GHA	31	Swaziland	SWZ

15	Guinea-Bissau	GNB	32	Togo	TGO
16	Kenya	KEN	33	Zambia	ZMB
17	Lesotho	LSO	34	Zimbabwe	ZWE

Appendix B

Descriptive Statistics

	Obs	Mean	Std. Dev.	Min	Max
GDP growth	1053	3.22	7.37	-51.03	106.28
Manufacturing growth	861	3.82	12.01	-54.01	177.72
Manufacturing, value added	997	11.50	7.18	0.24	45.67
Population growth	1054.00	2.60	1.15	-7.60	10.26
Life expectancy	1054.00	52.13	6.77	26.76	72.97
External debt	1021	97.22	114.58	2.16	1380.77
Imports	1041	39.54	24.07	2.98	157.87
Education	1054	1.94	2.95	0.00	44.33
Polity2	1054	-1.19	6.15	-10.00	10.00

Appendix C

Pooled OLS

Table C1: Estimation using Natural resource with no polity2

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	8.6002911	1.6084358	5.3470	1.117e-07 ***
Natural.resource	-0.0370985	0.0078456	-4.7286	2.598e-06 ***
Population.growth	-1.2921929	0.1889761	-6.8379	1.425e-11 ***
Life.expectancy.at.birth	0.0860022	0.0314258	2.7367	0.006321 **
External.Debt	-0.0058123	0.0018503	-3.1412	0.001734 **
Imports	0.0456162	0.0093989	4.8534	1.415e-06 ***
Education	0.4219393	0.0718340	5.8738	5.859e-09 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.19125 Adj. R-Squared : 0.18987

Table C2: Estimation with polity2, without interaction term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	5.9432186	1.6277207	3.6513	0.000275 ***
Natural.resource	-0.0367959	0.0076839	-4.7887	1.943e-06 ***
Population.growth	-1.4518097	0.1867099	-7.7758	1.923e-14 ***
Life.expectancy.at.birth	0.1358164	0.0317226	4.2814	2.043e-05 ***
External.Debt	-0.0054900	0.0018129	-3.0284	0.002524 **
Imports	0.0472989	0.0092087	5.1363	3.390e-07 ***
Education	0.4838312	0.0709976	6.8148	1.663e-11 ***
polity2	-0.2208250	0.0340650	-6.4825	1.439e-10 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.22507 Adj. R-Squared : 0.22321

Table C3: Estimate of natural resource with interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	3.7624627	1.6582243	2.2690	0.023491 *
Natural.resource	-0.0247770	0.0079162	-3.1299	0.001801 **
Population.growth	-1.4761727	0.1842325	-8.0126	3.236e-15 ***
Life.expectancy.at.birth	0.1733871	0.0320958	5.4022	8.300e-08 ***
External.Debt	-0.0052699	0.0017887	-2.9461	0.003295 **
Imports	0.0501735	0.0091001	5.5135	4.518e-08 ***
Education	0.4756806	0.0700506	6.7905	1.953e-11 ***
polity2	-0.3190944	0.0384419	-8.3007	3.478e-16 ***
Natural.resource:polity2	0.0074580	0.0014171	5.2628	1.749e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.24676 Adj. R-Squared : 0.24447

Random Effect (RE) Model Estimations

Table C4: Estimation using Natural resource with no polity2

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	15.1217424	1.6268112	9.2953	< 2.2e-16 ***
Natural.resource	-0.0306350	0.0045818	-6.6863	3.871e-11 ***
Population.growth	-0.2849655	0.1033724	-2.7567	0.005949 **
Life.expectancy.at.birth	-0.0435879	0.0264384	-1.6487	0.099544 .
External.Debt	0.0021229	0.0012455	1.7045	0.088615 .
Imports	-0.0186442	0.0084072	-2.2176	0.026812 *
Education	0.1455668	0.0349873	4.1606	3.458e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.088085 Adj. R-Squared : 0.08745

Table C5: Estimations using Natural resource with polity2, but no interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	13.8236775	1.6137300	8.5663	< 2.2e-16 ***
Natural.resource	-0.0278906	0.0046028	-6.0594	1.958e-09 ***
Population.growth	-0.3161258	0.1029521	-3.0706	0.002196 **
Life.expectancy.at.birth	-0.0264744	0.0265449	-0.9973	0.318847
External.Debt	0.0027124	0.0012461	2.1766	0.029752 *
Imports	-0.0123273	0.0084631	-1.4566	0.145554
Education	0.1650594	0.0350740	4.7060	2.896e-06 ***
polity2	-0.0843093	0.0200896	-4.1967	2.959e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.10434 Adj. R-Squared : 0.10348

Table C6: Estimations using Natural resource with the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	13.65428199	1.50712381	9.0598	< 2.2e-16 ***
Natural.resource	-0.03426705	0.00500422	-6.8476	1.337e-11 ***
Population.growth	-0.34790130	0.10420003	-3.3388	0.0008738 ***
Life.expectancy.at.birth	-0.02126279	0.02670905	-0.7961	0.4261764
External.Debt	0.00253132	0.00125651	2.0146	0.0442276 *
Imports	-0.01015775	0.00848390	-1.1973	0.2314857
Education	0.16660554	0.03558663	4.6817	3.253e-06 ***
polity2	-0.05547663	0.02246981	-2.4689	0.0137242 *
Natural.resource:polity2	-0.00244858	0.00075552	-3.2409	0.0012323 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.11371 Adj. R-Squared : 0.11265

Fixed Effect (FE) Models

Table C7: Estimation using Natural resource with no polity2

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
Natural.resource	-0.0300044	0.0045597	-6.5804	7.822e-11 ***
Population.growth	-0.2570960	0.1029336	-2.4977	0.012672 *
Life.expectancy.at.birth	-0.0499185	0.0265094	-1.8830	0.060005 .
External.Debt	0.0024249	0.0012451	1.9476	0.051768 .
Imports	-0.0223740	0.0084651	-2.6431	0.008353 **
Education	0.1404103	0.0347326	4.0426	5.723e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.089684 Adj. R-Squared : 0.08599

Source: Author's computations

Table C8: Estimations using Natural resource with polity2, but no interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
Natural.resource	-0.0272569	0.0045721	-5.9615	3.545e-09 ***
Population.growth	-0.2836600	0.1022917	-2.7730	0.005664 **
Life.expectancy.at.birth	-0.0341524	0.0265741	-1.2852	0.199051
External.Debt	0.0030433	0.0012441	2.4461	0.014625 *
Imports	-0.0164377	0.0085209	-1.9291	0.054021 .
Education	0.1585705	0.0347334	4.5654	5.656e-06 ***
polity2	-0.0812560	0.0199597	-4.0710	5.079e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.10562 Adj. R-Squared : 0.10116

Table C9: Estimations using Natural resource with the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
Natural.resource	-0.0337520	0.0048836	-6.9114	8.910e-12 ***
Population.growth	-0.2940257	0.1016715	-2.8919	0.0039183 **
Life.expectancy.at.birth	-0.0336551	0.0264029	-1.2747	0.2027431
External.Debt	0.0031156	0.0012362	2.5202	0.0118965 *
Imports	-0.0171091	0.0084679	-2.0205	0.0436217 *
Education	0.1549494	0.0345236	4.4882	8.083e-06 ***
polity2	-0.0476157	0.0218969	-2.1745	0.0299163 *
Natural.resource:polity2	-0.0026593	0.0007340	-3.6230	0.0003069 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.11808 Adj. R-Squared : 0.11298

Appendix D

Fuel Exports Estimations

Pooled OLS

Table D1: Estimation using Fuel Exports with no polity2

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	8.1356463	1.6156636	5.0355	5.687e-07 ***
Fuel.exports	-0.0379806	0.0095778	-3.9655	7.866e-05 ***
Population.growth	-1.3141608	0.1898012	-6.9239	8.015e-12 ***
Life.expectancy.at.birth	0.0909979	0.0317370	2.8673	0.004231 **
External.Debt	-0.0055929	0.0018553	-3.0146	0.002641 **
Imports	0.0453017	0.0094535	4.7920	1.911e-06 ***
Education	0.4228059	0.0721259	5.8621	6.274e-09 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.18578 Adj. R-Squared : 0.18444

Table D2: Estimation using Fuel Exports with polity2, but no interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	5.2948954	1.6330401	3.2424	0.001226 **
Fuel.exports	-0.0425658	0.0093841	-4.5360	6.457e-06 ***
Population.growth	-1.4868904	0.1872078	-7.9425	5.505e-15 ***
Life.expectancy.at.birth	0.1458277	0.0320422	4.5511	6.018e-06 ***
External.Debt	-0.0052758	0.0018137	-2.9089	0.003710 **
Imports	0.0465432	0.0092402	5.0370	5.644e-07 ***
Education	0.4852676	0.0710787	6.8272	1.531e-11 ***
polity2	-0.2329403	0.0341932	-6.8125	1.688e-11 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.22321 Adj. R-Squared : 0.22137

Table D3: Estimation using Fuel Exports with the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	4.6814819	1.6466324	2.8431	0.004563 **
Fuel.exports	-0.0312563	0.0103794	-3.0114	0.002669 **
Population.growth	-1.5016667	0.1867825	-8.0397	2.631e-15 ***
Life.expectancy.at.birth	0.1573258	0.0322780	4.8741	1.278e-06 ***
External.Debt	-0.0052404	0.0018087	-2.8973	0.003849 **
Imports	0.0467792	0.0092152	5.0763	4.619e-07 ***
Education	0.4827046	0.0708896	6.8092	1.726e-11 ***
polity2	-0.2623366	0.0360403	-7.2790	6.983e-13 ***
Fuel.exports:polity2	0.0046812	0.0018584	2.5190	0.011930 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.2283 Adj. R-Squared : 0.22619

Random Effect (RE) Model Estimations

Table D4: Estimation using Fuel Exports with no polity2

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	15.0197102	1.6500878	9.1024	< 2.2e-16 ***
Fuel.exports	-0.0053337	0.0060443	-0.8824	0.377756
Population.growth	-0.2444216	0.1057599	-2.3111	0.021038 *
Life.expectancy.at.birth	-0.0534683	0.0270291	-1.9782	0.048193 *
External.Debt	0.0036318	0.0012539	2.8965	0.003859 **
Imports	-0.0199145	0.0086028	-2.3149	0.020828 *
Education	0.1447215	0.0358337	4.0387	5.802e-05 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.046521 Adj. R-Squared : 0.046186

Table D5: Estimation using Fuel Exports with polity2, but no interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	13.4652405	1.6266818	8.2777	4.160e-16 ***
Fuel.exports	-0.0037042	0.0059983	-0.6175	0.5370223
Population.growth	-0.2856604	0.1050403	-2.7195	0.0066551 **
Life.expectancy.at.birth	-0.0319359	0.0270685	-1.1798	0.2383643
External.Debt	0.0041857	0.0012473	3.3557	0.0008226 ***
Imports	-0.0121858	0.0086302	-1.4120	0.1582739
Education	0.1681960	0.0358039	4.6977	3.013e-06 ***
polity2	-0.1015209	0.0203161	-4.9971	6.912e-07 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.070513 Adj. R-Squared : 0.069932

Table D6: Estimation using Fuel Exports with the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	13.38538534	1.60848921	8.3217	2.949e-16 ***
Fuel.exports	-0.00100359	0.00669289	-0.1499	0.880837
Population.growth	-0.28855612	0.10527630	-2.7409	0.006240 **
Life.expectancy.at.birth	-0.03068656	0.02711501	-1.1317	0.258035
External.Debt	0.00414727	0.00124964	3.3188	0.000938 ***
Imports	-0.01189281	0.00863918	-1.3766	0.168952
Education	0.16845202	0.03589753	4.6926	3.089e-06 ***
polity2	-0.10743694	0.02119989	-5.0678	4.825e-07 ***
Fuel.exports:polity2	0.00090348	0.00094647	0.9546	0.340027

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.071356 Adj. R-Squared : 0.070695

Fixed Effect (FE) Model Estimations

Table D7: Estimation using Fuel Exports without polity2

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
Fuel.exports	-0.0042420	0.0060143	-0.7053	0.4807858
Population.growth	-0.2139024	0.1052113	-2.0331	0.0423283 *
Life.expectancy.at.birth	-0.0602573	0.0270856	-2.2247	0.0263405 *
External.Debt	0.0039594	0.0012520	3.1625	0.0016148 **
Imports	-0.0240315	0.0086600	-2.7750	0.0056308 **
Education	0.1388355	0.0355389	3.9066	0.0001004 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.047854 Adj. R-Squared : 0.045883

Table D8: Estimation using Fuel Exports with polity2, but no interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
Fuel.exports	-0.0024781	0.0059529	-0.4163	0.6773001
Population.growth	-0.2494271	0.1042007	-2.3937	0.0168759 *
Life.expectancy.at.birth	-0.0403124	0.0270703	-1.4892	0.1367804
External.Debt	0.0045561	0.0012430	3.6655	0.0002608 ***
Imports	-0.0167443	0.0086853	-1.9279	0.0541721 .
Education	0.1607307	0.0353971	4.5408	6.341e-06 ***
polity2	-0.0983112	0.0201500	-4.8790	1.254e-06 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.071617 Adj. R-Squared : 0.068593

Table D9: Estimation using Fuel Exports with the interactive term

Coefficients :

	Estimate	Std. Error	t-value	Pr(>|t|)
Fuel.exports	0.00028983	0.00662849	0.0437	0.9651329
Population.growth	-0.24901654	0.10420710	-2.3896	0.0170638 *
Life.expectancy.at.birth	-0.03986149	0.02707590	-1.4722	0.1413021
External.Debt	0.00455022	0.00124304	3.6606	0.0002659 ***
Imports	-0.01685774	0.00868653	-1.9407	0.0525999 .
Education	0.16032855	0.03540150	4.5289	6.702e-06 ***
polity2	-0.10383482	0.02097377	-4.9507	8.780e-07 ***
Fuel.exports:polity2	0.00088622	0.00093324	0.9496	0.3425561

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-Squared : 0.072517 Adj. R-Squared : 0.06938

Table D10: Fixed Effects Using Least Squares Dummy Variable Model

Estimation using natural resource with interactive term

Coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
Natural.resource	-0.033752	0.004884	-6.911	8.91e-12 ***
Population.growth	-0.294026	0.101671	-2.892	0.003918 **
Life.expectancy.at.birth	-0.033655	0.026403	-1.275	0.202743
External.Debt	0.003116	0.001236	2.520	0.011896 *
Imports	-0.017109	0.008468	-2.020	0.043622 *
Education	0.154949	0.034524	4.488	8.08e-06 ***
polity2	-0.047616	0.021897	-2.175	0.029916 *
Natural.resource:polity2	-0.002659	0.000734	-3.623	0.000307***

Table D11: Hausman Test

Hausman Test

data: Growth ~ Natural.resource + Population.growth + Life.expectancy.at.birth + ...

chisq = 181.0171, df = 8, p-value < 2.2e-16

alternative hypothesis: one model is inconsistent

Since the p-value is less than 0.05, we choose fixed effect

Table D12: F test (fixed.time, fixed)

F test for individual effects

data: Growth ~ Natural.resource + Population.growth + Life.expectancy.at.birth + ...

F = 3.1516, df1 = 30, df2 = 899, p-value = 4.189e-08

alternative hypothesis: significant effects

Since p-value is less than 0.05, time.fixed effect is the preferred model

Table D13: The Breusch-Pagan LM test (fixed.time, fixed)

Lagrange Multiplier Test - time effects (Breusch-Pagan)

data: Growth ~ Natural.resource + Population.growth + Life.expectancy.at.birth + ...

chisq = 5.1395, df = 1, p-value = 0.02339

alternative hypothesis: significant effects

Since this number is less than 0.05, again the time.fixed effect model is the preferred

Table D14: Test for Heteroskedasticity

Breusch-Pagan test

data: Growth ~ Natural.resource + Population.growth + Life.expectancy.at.birth + External.Debt + Imports + Education + polity2 + (polity2 * Natural.resource) + factor(Country.Name)

BP = 1041.651, df = 41, p-value < 2.2e-16

Since the p-value is less than 0.05, there is heteroskedasticity

Table D15: Controlling for heteroskedasticity: Random Effects

Heteroskedasticity consistent coefficients

t test of coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	10.4950159	3.7922538	2.7675	0.005761 **
Natural.resource	-0.0250740	0.0185740	-1.3499	0.177360
Population.growth	-0.5281812	0.2229125	-2.3695	0.018017 *
Life.expectancy.at.birth	0.0225955	0.0783906	0.2882	0.773225
External.Debt	-0.0002750	0.0019423	-0.1416	0.887440
Imports	0.0109746	0.0134128	0.8182	0.413443
Education	0.2101202	0.0472636	4.4457	9.814e-06 ***
polity2	0.0171472	0.0574317	0.2986	0.765337
Natural.resource:polity2	-0.0022039	0.0023206	-0.9497	0.342507

Table D14: The following shows the HC standard errors of the coefficients

	(Intercept)	Natural.resource	Population.growth	Life.expectancy.at.birth
HC0	3.792254	0.01857402	0.2229125	0.07839057
HC1	3.870785	0.01895866	0.2275286	0.08001391
HC2	3.878269	0.01899719	0.2339777	0.08047631
HC3	3.966430	0.01943099	0.2458230	0.08264738
HC4	3.889516	0.01907150	0.2571320	0.08185785

	Natural.resource:polity2	External.Debt	Imports	Education
HC0	0.002320603	0.001942302	0.01341279	0.04726358
HC1	0.002368659	0.001982524	0.01369054	0.04824233
HC2	0.002376919	0.001984615	0.01376611	0.05049254
HC3	0.002434791	0.002028422	0.01413439	0.05484967
HC4	0.002391668	0.001989044	0.01400623	0.06759935

Note that the standard errors have reduced drastically after correcting for heteroskedasticity.

Table D15: Controlling for heteroskedasticity: Fixed Effects

Heteroskedasticity consistent coefficients

t test of coefficients:

	Estimate	Std. Error	t value	Pr(>|t|)
Natural.resource	-0.02476543	0.01973551	-1.2549	0.209853
Population.growth	-0.46773936	0.20597945	-2.2708	0.023395 *
Life.expectancy.at.birth	0.00797526	0.07814743	0.1021	0.918737
External.Debt	0.00075126	0.00195794	0.3837	0.701290
Imports	0.00165505	0.01473445	0.1123	0.910590
Education	0.19315666	0.04353935	4.4364	1.028e-05***
polity2	0.03142987	0.05382239	0.5840	0.559397
Natural.reosurce:polity2	-0.00254985	0.00246674	-1.0337	0.301558

Table D16: The following shows the HC standard errors of the coefficients

	Natural.resource	Population.growth	Life.expectancy.at.birth	Imports
HC0	0.01973551	0.2059794	0.07814743	0.01473445
HC1	0.02013340	0.2101322	0.07972298	0.01503152
HC2	0.02018670	0.2155877	0.08020953	0.01519001
HC3	0.02064929	0.2258712	0.08235934	0.01566853
HC4	0.02028246	0.2358599	0.08172691	0.01567253

	Natural.resource:polity2	External.Debt	Polity2
HC0	0.002466740	0.001957937	0.05382239
HC1	0.002516473	0.001997412	0.05490751
HC2	0.002527140	0.002006146	0.05527323
HC3	0.002589209	0.002056562	0.05681604
HC4	0.002545451	0.002038845	0.05679317

Note that the standard errors have reduced drastically after correcting for heteroskedacsticity.

Table D17: Testing for unit roots/stationarity

Augmented Dickey-Fuller Test

Dickey-Fuller = -9.8505, Lag order = 2, p-value = 0.01

alternative hypothesis: stationary

There is no unit root problem so the data used is stationary. The p-value is the same for all the variables