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A Study on the Impact of Natural Resources Endowment on Economic Growth: Empirical Evidence from Mali

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Abstract

Slow growth has been the case in many Sub-Saharan Africa (SSA) countries in the 1980s and 1990s. The natural resources export of most SSA countries in the 1990s to early 2000s has been a curse rather than blessing. This situation is the case for the economy of Mali; the revenues from natural resources export have been mixed and largely attributed to weak government management of the natural resources endowment, institutional and administrative bottlenecks in the natural resources sector. Given the role of natural resources export on growth, this study investigates the impact of natural resources endowment on economic growth in Mali from 1990-2013, using the Error Correction Model (ECM) regression technique. This study shows that natural resources export has a positive impact on growth in Mali. However, the interaction of natural resources export and corruption impact negatively on economic growth in Mali. The policy implication is that, there is need for the country to improve on the management of natural resources revenues by putting in place effective and robust policy measures to lessen and/or possibly eliminate corruption in the public domain. This study contributes to current literature by providing an econometric understanding of relationships in natural resources endowment and growth for SSA countries. This understanding is important for academics, policy makers and development organizations that are assisting with the growth process of Africa in shaping the future stability of natural resources infrastructure and economic growth in the region.

Key words: Natural Resources Endowment, Natural Resources Export, Corruption, Error Correction Model, Economic Growth, Mali and Sub-Saharan Africa

Introduction

The relationship between natural resources endowment and economic growth has been of great concern in the past decades and has attracted a lot of attention in recent times. It has been observed by many researchers, policy makers and development organizations that the possession of valuable natural resources does not necessarily translate to growth. The question is, the determination of the causal pattern between natural resources endowment and growth has important implications for policy-makers and development organizations decision about the appropriate growth and development polices to adopt. The fact that strong correlation do exist between natural resources endowment and economic growth has been well documented in the economic development literature. However, the possession of natural resources endowment such as oil, diamonds or other minerals have left many countries with low per capita income and poor quality of life (Auty, 2001).

Africa is endowed with significant amounts of mineral resources and is ranked second in quantity of world reserves of bauxite, chromite, cobalt, industrial diamond, manganese, phosphate rock, platinum-group metals, soda ash, vermiculite and zirconium. The region is also a major world producer of these minerals.

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For example in 2010, Africa's portion of diamond, chromite, gold and uranium were 57 per cent; 48 per cent 19 per cent; and 19 percent, respectively. The region is also known as relevant player in world production of coal, oil and gas. In 2010, Africa recorded a total share of 12.2 per cent of the world oil production. These resources play a critical role in the region as they account for a substantial share of exports. Therefore, mineral resource exports play a crucial role to merchandise exports in most African countries (Jeffry, 2011).

The general economic understanding and theory implies that significant revenues from natural resources should generate wealth, improves economic growth and reduces poverty. However, existing studies have produced mixed and conflicting results, viewing natural resources as both a curse and blessing. The issue now is, can natural resource rich countries appear to have sound economic growth than resource poor countries? The Africa region is faced with abundance of natural resources ranging from diamonds, gold, iron ore, crude oil, aluminum, uranium, bauxite, manganese, tine and columbite etc. The discovery of natural resources in Africa aims at boosting economic activities and improving livelihood for the citizens in the region, yet much evidence suggests the opposite in region (Stevens, 2008). However, the East Asian economies like Japan, Korea, Taiwan, Singapore and Hong Kong have attained western-level standards of living even with rocky islands (or peninsulas) with nearly no natural resources endowment. As noted by (Jeffry, 2011), the concept that natural resource riches are a curse rather than a blessing may sound paradoxical and has led to a wide ranging literature on the subject matter of natural resources endowment.

Looking at Africa's economic situations, the level of poverty in the region with abundant of natural resources, one will be forced to think natural resources as a curse to the region. This is likely to hold true, proponents of the resource curse literature have made the point that the possession of oil, natural gas, or other valuable mineral deposits does not necessarily confer economic growth. For instance, many African countries such as Angola, Sierra Leone, Nigeria, Sudan and the Congo are rich in oil, diamonds, or other minerals, but their population continues to face with low per capita income and low quality of life (Collier and Goderis, 2007).

The discovery of mineral and petroleum resources in Africa has in one way or the other played a critical role in influencing the political economy of these countries. Countries such as The Gambia and Burkina Faso can hardly boast of any substantial amount of mineral resources. However, many African States have one or many other forms of mineral resources. Diamond, Gold, Bauxite, iron ore, and recently crude oil are all part of Sierra Leone's endowment of mineral resources. Guinea is among the top five bauxite producers in the world, whilst Ghana is rich with deposit of gold, and recently discovered crude oil in commercial quantities. Nigeria has been producing substantial quantity of crude oil for the past decades. An interesting question one would, however, like to ask is whether the presence or discovery of natural resources in Africa has significantly impacted on the economies of these countries?

Over the past two decades, a good number of researchers have observed a link between natural resource discovery and the outbreak of civil conflicts (Swanson 2002). In the case of Africa, the civil wars in Sierra Leone and Liberia that left over half million people dead, provides perhaps a good example of military political entrepreneurship driven by natural resource exploitation. With respect to human casualties, the war that ripped apart the Democratic Republic of Congo (DRC) remained to be the worst in recent times, resulting in over four million deaths, and is perhaps the greatest example of a resource-fuelled war. Similar civil conflicts have taken place in countries like Nigeria, Cote d'Ivoire and Guinea Bissau. In Cote d'Ivoire, natural resources have been a major factor in financing the conflict; both the government and the rebels have used these resources to their advantage (Philippe, 2003). The question that one needs to ask at this juncture is that, why are natural resource abundance economies prone to poor economic performance? Some of the key reasons that a good number of economists have attempted to advance, includes issues ranging from the Dutch disease phenomenon, increased rent seeking behavior, corruption and unnecessary formalities, closed economic policies, and sometimes limited skills of labour-based learning and education. Theses cenarios are the case for Mali, the country's mineral sector is rich and dominated by gold mining, and is the third largest gold producer in the Africa region. Other mineral resources include bauxite, iron ore, diamond, limestone, manganese, nickel, petroleum, phosphates, tin, and uranium. Mali's petroleum potential is promising and research and exploration are stepping up.

The country has the potential also to provide a strategic transport route for oil and gas exports, and there is the possibility of connecting the Taoudeni basin to the European market through Algeria. In spite of the just conclude political crisis in Mali, the mining sector continues to flourish with very little restraint on investors. According to a report by the Extractive Industry Transparency Initiative (EITI) of 2009, Mali's mineral sector is still dominated by gold mining, and thus, making Mali still the third largest gold producer in Africa. In 2009, gold exports from Mali alone amounted to more than 80% of the country's export earnings and equivalently 8% of its Gross Domestic Product (Mali's Poverty Reduction Strategy Paper, 2009).

Despite improvements in the management of the country's natural resources sector to accelerate growth. However, the sector still exhibits some level of inefficiency, thinness, corruption and weak level of regulatory control. These have impacted negatively on the economic growth of the country. It is more imperative to gather theoretical and empirical ideas at a time when the nation has set its sight on growth and development. The natural resources sector is one key area for growth and development (Mali's Poverty Reduction Strategy Paper, 2009).

Therefore, to generate empirical evidence on the impact of natural resource abundance in the economy of Mali, the following questions are worth being raised: (i) can the presence of abundant natural resources has causal link with corruption in Mali?; (ii) can natural resource abundance accelerate growth in Mali? The attempt to provide answers to these questions constituted the key problem of this study.

Now that growth promotion in the management of natural resources endowment is being actively supported by the IMF, World bank, and other international institutions including the Government, all these effects requires research to find out how the growth in the natural resources sector would impact on the economic growth. The Mali economy provides a good test laboratory. Reliable and a long term time series data is available for Mali that allows for an econometric analysis to make reasonable conclusions of relationships in natural resources endowment and economic growth. Studies thus, far have looked at some of the key determinants to sustained economic growth, but studies on how natural resources endowment can impact on the economic growth of developing country like Mali are scant.

Despite the introduction of the IMF and World Bank programs, growth in Mali has been bad. To address these issues, this study therefore, endeavors to carry out a systematic examination on the extent to which natural resources endowment has affected growth in Mali. Specifically, the study seeks to; (i) empirically determine the effect of natural resources endowment including natural resources restraint variables (control variable) on economic growth in Mali; (ii) examining the direction of causality between natural resources endowment and economic growth; (iii) determining the interactive impact of natural resources export and corruption on economic growth in Mali (iv) providing policy recommendations to academics, policy makers and development organizations in shaping the future stability of natural resources and hence economic growth. These specific characteristics of Mali's growth process offer us the test case to investigate the impact of natural resources endowment on growth in Mali, and are one of the motivations of this study.

Therefore, we propose the following hypotheses that can be tested. This is because hypotheses are statements that can be proven or disproven. Hence, we test the Null hypothesis against the alternative hypothesis thus;

Null Hypothesis $(\mathbf{H_0})$: There exist positive correlation between natural resources endowment and economic growth in Mali.

Alternative Hypothesis $(\mathbf{H_1})$: There exist negative correlation between natural resources endowment and economic growth in Mali.

$\mathbf{H_2}$**:** Causal relationship exists between natural resources endowment and economic growth in Mali.

Alternative Hypothesis $(\mathbf{H_3})$: Causal relationship does not exist between natural resources endowment and economic growth Mali.

The attempts to provide logical explanations on the above issues constitute major challenges of the current study. Data on natural resources export, corruption index, government effectiveness, human capital, inflation, openness to trade and real gross domestic product were collected from the International Financial Statistics, the World Bank, over the period 1990-2013. The Ordinary Least Square (OLS) regression estimation with the aid of the Error Correction Model (ECM) technique is applied in the study. The Pair-wise correlation matrices are also applied to test the first hypothesis. Granger Causality test is employed to test the second hypothesis. Econometric-view software is applied in the analysis.

This study contributes to the literature in the following ways: First, studies on the interactive impact of natural resources and corruption on growth are limited. This study incorporates the interactive impact of natural resources endowment and corruption non growth in Mali. Second, the study investigates the impact of natural resources restraints (control variables) on economic growth in Mali. Finally, the study provides an econometric understanding of relationships in natural resources endowment and growth. This study therefore, fills these gaps by focusing on role of strong institutions and sound growth policies (such as government effectiveness, corruption, human capital, inflation and openness to trade).

Primary weakness of the study is the limited availability of data. Analysis is therefore, restricted to a smaller number of variables than desired because of these restrictions. However, reasonable data is available for the purpose of this research. The rest of this paper is organized as follows: section 2 is literature review, followed by section 3, theoretical model and estimation procedure, section 4 is result and discussion. Finally, section 5 presents the conclusion.

2. Literature Review

This aspect examines existing understanding theoretically and empirically in the perspective of developing and developed countries and to review a broader literature strand on the relationship between natural resources endowment and economic growth. This connection is very critical and relevant to undertake an empirical study on the relationship between natural resources endowment and economic growth.

2.1 Theoretical Literature

This section presents the theoretical underpinnings on the relationship between natural resources endowment and the "Dutch disease", natural resources endowment and price volatility, natural resources endowment, and conflict. Finally, between natural resources endowment, corruption and institutions.

2.1.1 Natural Resources Endowment and Dutch Disease

The link between natural resources endowment and the Dutch disease has been widely argued in the economic paradigm that economies that exceedingly dependent on natural resources are characterized with both blessing and curse. For instance, (Gelb, 1988) puts forward various arguments on the link between natural resource abundance economies and growth on the grounds of the popular idea known as the "Dutch disease", which is based in the understanding that an economy can be classified into three main sectors namely; the tradeable natural resource sector, the tradeable non-resource (manufacturing) sector and the non-traded sector. Proponents of the Dutch disease argued that economies with vast natural resource sectors may generate increasing demand for the non-tradable goods. As a result, there is uneven re-allocation of labour and capital from the tradable manufacturing sector to the natural resource sector, and subsequently reduces activities in the manufacturing sector. This in turn can increase dependence on natural resources. This situation can expose resource dependent economies to commodity price volatility.

The "Dutch disease may also give rise to protection policies for affected lagging sector industries as well as extensive corruption in the public sector.

As (Polterovich and Popov, 2006) observed that, corruption in the public domain in the presence of resource abundance may give rise for the government not to effectively pursuing prudent macroeconomic, social and industrial policies and hence, affects economic growth.

However, a major limitation of the argument put forward by proponents of the "Dutch disease" is that, they failed to take into account the fact that in many economies, the natural resources and the manufacturing sectors are dependent on one another. As most manufactured products contain natural resources as inputs, and at the same time, the extraction of these natural resources involves the use of manufactured products such as machinery and refining plants.

2.1.2 Natural Resources Endowment and Price Volatility

Natural resources dependent countries are frequently faced with booms and busts as a result of fluctuations in the prices of raw materials in the world market and consequently, affect export revenues, which in turn can triggers exchange rate volatility. The resulting exchange rate volatility can harm export, foreign investment and hence reduces economic growth. Proponents of the resource curse argue that a country that exhibits heavy dependence on natural resources abundance are more likely to face lower growth rate than those without. Primary commodity exporters can be hurt from reduced terms of trade, which would broaden the gap between the rich industrial countries and the poor resource exporting countries, this idea is sometime known as immiserizing growth. The core of the immiserizing theory is that, as open economy expands its productive capacity through economic growth and/or technological progress can have the tendency to be worst off due to deterioration in the terms of trade and thus, reduces economic growth (Bulte et al., 2005).

2.1.3 Natural Resources Endowment and Conflict

The link between conflict and the extraction of natural resources still remains unclear, however, resource- rich countries seem to be more inclined to conflict than the resource-poor countries. Humphreys (2005) observed that if a country's Gross Domestic Product (GDP) accounts from a significant proportion of natural resource extraction such as metal ores, oil and gas, the risk of conflict is very high. Several studies have attempted to document the link between natural resource abundance and civil conflict. For instance, (Rohner, 2006) have identified various sources via which resource -rich countries can be vulnerable to conflicts. Export of natural resources can offer prospects for rebellion during conflict and so can finance the escalation and sustainability of the rebellion. Natural resources like diamond and oil afford high possibility for the financing of rebellion through such actions like kidnapping and ransoming of oil workers, tapping of pipelines and theft of oil, extortion rackets against oil companies or illicit mining and smuggling of diamonds.

Most government of resource-rich countries is highly motivated to hold on to power through vote-buying, voter terrorization and other forms of electoral deception. Lack of accountability and transparency in the management of natural resources by such governments has the tendency of triggering rebellions/civil conflicts that may have hostile consequences to the economy resources and are highly likely to be inspired by the wish to loot rather than the pursuance of any political cause. Indeed, this loot seeking behavior of rebel recruits is highly rampant during the lawless conditions that prevail during conflict than during peacetime. The most quoted examples are those of the diamond-financed rebellions in Sierra Leone and Angola. In Nigeria too, particularly in the Southern oil rich State of Delta, armed criminals have been notorious in financing their operations through kidnapping oil foreign workers in exchange for offers of ransoms (Collier and Goderis, 2007).

2.1.4 Natural Resources Endowment Corruption and Institutions

The fact that resource-poor countries sometimes outperform resource-rich countries is nothing new in economic history. However, experience seems to show that, it is not so much the presence of natural resources per se that hurts growth but rather the failure of public authorities to meet the policy challenge posed by natural resource abundance, and to address problems that surrounds institutional and market failures.

The negative link between resource abundance and economic growth can be explained by the value of institutions in a country. That is, developing nations with excessive abundance of natural resources are not doomed to failure or poor economic performance, if they have solid institutions.

According to (Bulte and Damania, 2008), countries with strong institutions to protect against civil conflict are less likely to be trapped by the curse of natural resources. For instance, (Acemoglu et al., 2003),observed that the African nation of Botswana has successfully escaped the resource curse by providing property rights, political checks and balances, health care, education and investments in infrastructure. By comparison, neighboring countries such as the Democratic Republic of Congo and Sierra Leone with weaker institutions and high resource extraction have had their economies dwindling.(Robinson et al., 2006), highlighted issues of rent seeking behavior under political corruption and fragile institutions, large revenues from natural resources enable governments to appease dissent and dodge accountability, thereby protecting them from pressures for institutional reforms, and that countries without such institutions are highly likely to suffer from a political resource curse, and thus, may increase their tendencies towards implementing inefficient activities via rent-seeking motivations and corruption.

2.2 Empirical Evidence

The second part examines the empirical literature on the established relationships between natural resources endowment and economic growth. A separate review of theories as against empirics will enhance our better understanding of the subject matter by separating views from reality. Whilst theories are mere expressions of our opinions about the reality, empirics confirm those opinions with what obtains in real life. As such, a separation of theories from empirics is fundamental in a classical scientific research. To this end, available evidences are presented on the relationship between natural resources endowment and the "Dutch disease", natural resources endowment and price volatility, natural resources endowment and conflict and natural resources endowment, corruption and institutions.

2.2.1 Natural Resources Endowment and Dutch Disease

Gelb (1988) provides influential empirical cross-country study of the Dutch disease phenomenon, where the effect of windfall on oil exporters was evaluated for a group of oil exporting countries, most of whom have spent large amounts of the windfall they achieved in the wake of the 1973 oil boom. He finds that Ecuador, Iran, Nigeria and Trinidad and Tobago went through the Dutch disease, as a result of decline in Agriculture, over the first and second oil booms of 1972–81, while Algeria, Indonesia and Venezuela went through a strengthening of their non-oil tradable. However, all countries in the study do not exhibit Dutch disease in the manufacturing sector. A possible explanation for the missing Dutch disease was that these sectors were initially too small, and that price controls and subsidies by the government combined with vigorous promotion of the sector kept them from being adversely affected. Services, however, did expand dramatically as a share of output in GDP. However, Sachs and Warner (1995), in their initial paper advanced a model of the Dutch disease to explain why a resource curse may be present in resource-rich nations. This seminal paper which is hugely influential ignites the debate on the effect of natural resources on economic growth, using cross country data from 1970 to 1989. Sachs and Warner examined the impact of natural resources on economic growth. They used primary product exports as a percentage of GDP. Their findings suggest that, after controlling for a number of factors, natural resources have a negative impact on economic growth. According to them, the likely effects of the Dutch disease on the manufacturing sector can be the cause of the negative impact.

Many researchers on the link between natural resources abundance and the Dutch disease have arrive at a similar conclusion that natural resource abundance economies have the potential to grow less rapid than those without. For example, (Ding and Field, 2012) estimated two different models using the World Bank data to investigate the effect of natural resource dependence and natural resource endowment on growth. The result of their findings indicate that natural dependence has a statistically negatively effect on growth, and natural resources endowment has a statistically positive effect on growth. However, when a three-equation recursive model was included with endogenous human capital and allowing for endogeneity in a resource dependence sector, the effects of natural resources on growth are found not to be statistically significant.

Although the Dutch disease literature has a lengthy theoretical pedigree, it appears to be the empirically least important mechanism. For example, (Spatafora and Warner, 2001) examined 18 oil exporting developing countries covering a period running from the mid-1960s until the 1980s. They found that Dutch disease effects are strikingly absent. A major problem with this study is that they tend to predict a monotonic effect of resources on development that is not always consistent with the cross-country evidence.

2.2.2 Natural Resources Endowment and Price Volatility

The study by (Sala-i-Martin and Subramanian,2003) find no evidence of natural resource curse in Nigeria due to volatility of crude oil price. This study highlighted issues that are all too common in analyzing the impact of oil prices on macroeconomic variables in oil-exporters, which is the importance of knowing the type of spending, and not only the quantity. (Spatafora and Warner, 2001) finds a positive link between terms of trade shocks in oil-exporting countries and their real exchange rate as well as public spending. They find that the reaction of public spending to shocks was stronger than that of private spending. However, they could not find evidence of natural resource curse. Using 1994 World Bank resource stocks data (Brunnschweiler and Bulte, 2008), found that export dependence does not affect growth and find a positive impact of per capita wealth on growth, they however, suggest that this impact is not significant after dealing with several statistical issues, andopined that, ignoring the commodity price volatility channel may lead to erroneous conclusion, that there is no effect of natural resources on growth.

2.2.3 Natural Resources Endowment and Conflict

On the relationship between resource abundance and civil conflict, Collier and Hoeffler (2001) find that the chance of a civil conflict is on average 0.5 percent in a country with limited natural resources, while approximately on average is 23 percent in a country where natural resources account for 26 percent of GDP. They further noted that, for a good number of countries, including Iraq, Nigeria, Sierra Leone, Venezuela, former Zaire, Zambia, and many others, the abundance in natural resources like oil or mineral wealth has not effectively translated into economic and social well-being for the majority of its population.(Boschini et al., 2007), for example, following Sachs and Warner's initial paper, studied the different categories of resources and point out their differing effects upon growth. Their findings indicate that "point source" resources such as minerals have a negative effect upon economic growth than "diffuse" natural resources such as rice and wheat. (Addison and Murshed, 2012), finds that abundant point resources are often associated with higher risk of conflict. This is because "point source" resources are more likely to attract appropriation and rent seeking. Point resources cannot be moved and, therefore, cannot escape expropriation. They are taxed more heavily and are more subject to expropriation with a more inelastic supply.

2.2.4 Natural Resources Endowment Corruption and Institutions

Ward (2004) examined the relationship between institutional infrastructure and economic growth across 43 countries over 1975–1990, by using a neoclassical growth framework; they integrate a broad set of institutional variables used as proxy for the overall institutional infrastructure of an economy. The results from this study indicate that security of property rights, size of government is the most significant factors that explain variations in economic growth.

(Hammond, 2012), carried out a study which investigates the existence of resource curse in Nigeria, and examines issues of corruption, level of science and technology, policy implementation and infrastructural development, institutions and transparency among others. The result of the regressions showed that corruption/weak institution, poor level of technology have direct and significant impact on the resource curse in Nigeria.

On balance, literature survey reveals that numerous studies have looked at the link between natural resources endowment and economic growth. Results of these studies are mostly inconclusive. The contradictory conclusions emerging from previous empirical studies constitute also one of the motivations for the present study. Furthermore, the above studies are dominated by panel data approach, which attached relevance on cross country differences and can sometimes suffer from measurement error and consequently, result to imprecise inferences.

In order to understand the relationship between endowment of resource and economic growth, studies that are related to single country are needed. Therefore, this study aims to narrow the gap in the literature by employing time series data (country – specific study) to examine the impact of natural resources endowment on economic growth in Mali.

The main contribution of this study is to determine the interactive impact of natural resources endowment (natural resources export) and corruption on economic growth in Mali by applying time series econometric techniques.

3. Theoretical Framework and Estimation Procedure

In the work of Lucas (1988) which has provided a useful survey of literature in applied growth accounting exercise. It focuses more explicitly on the measured effects of education and training in the form of higher output or sales rather than earnings. Growth accounting literature has a long pedigree, which can be traced back to Solow (1957). In essence, the model assumes a Cobb-Douglas production function of the endogenous growth models. On discussing the growth models, we then pursue a significant portion of the literature on development and maintained that, the extent of natural resources endowment in an economy is an important determinant of its real growth rate.

Here, the analysis heavily draws from the contributions of the “endogenous growth literature” by Romer (1986) and Lucas (1988). One of the many insights of this literature is that natural resources generally influence equilibrium growth rates. In such, the model is described as the general framework for growth. The model compares the prospects for growth in an environment with and without natural resources endowment. The conclusion reached, however, is that, the presence of natural resources endowment can improve the prospects for growth. This conclusion lends support for further use of econometric techniques capable of capturing the link between natural resources endowment and growth.

3.1 The Growth Model

Growth accounting literature has a long pedigree, which can be traced back to Solow (1957). In essence, the model assumes a Cobb-Douglas Production function of the form:

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} M_t^{\delta} \quad (1)$$

Where Y_t the gross is output, K_t is physical capital, L_t is the labour stock (employment) and M_t is materials and intermediate inputs. A_t is efficiency level , α, β and δ are factor shares so that the higher is A_t for any given values of the inputs, the higher is output. The unit of measurement of the inputs affects the level of A_t. This can be avoided by writing equation (1) in growth form by taking total derivative with respect to time (t) yields:

$$\Delta Y_t = \Delta A_t + \alpha \Delta K_t + \beta \Delta L_t + \delta \Delta M_t \quad (2)$$

Where the symbol (Δ) in each of the variable reflects the growth rates, ΔA_t is the rate of change in total factor productivity, if we solve for ΔA_t in equation (2) yields:

$$\Delta A_t = \Delta Y_t - \left(\alpha \Delta K_t + \beta \Delta L_t + \delta \Delta M_t \right) \quad (3)$$

This equation implies that ΔA_t represents the output growth that cannot be accounted for by changes in the growth of physical inputs. Hence ΔA_t could be described as the residual factor.

The growth accounting model poses potential weaknesses such as the many assumptions imposing on the inputs rather than testing them empirically. It is the case that the rate of change of each input is weighted by the share of that input within the total. While human capital has a significant role to play in explainingoutput growth in the model. The measurement of this human capital is usually a complex mix of educational, demographical and labour market variables. Nonetheless, the model is still useful for exploring the links between human capital and economic growth.

The weaknesses of the growth accounting exercise paved the way for the neoclassical growth theory of the (Solow, 1957) model which considers labour and technology to grow over time, and could be explained thus: $Y_{i,t}$ = total output, $L_{i,t} = L_{i,0}e^{n_{i,t}}$ total labour which grows at a rate of n_i .The output per worker $y_{i,t}$ will be total output ($Y_{i,t}$) divides by total labour ($L_{i,t}$).Therefore, $y_{i,t} = Y_{i,t} / L_{i,t}$, If $A_{i,t} = A_{i,0}e^{g_{i,t}}$ the labour augmenting technological progress that grows at a rate of g_i . The efficiency unit of labour is total labour $(L_{i,t})$ multiplies by labour augmented technological progress $(A_{i,t})$.

Therefore efficiency unit of labour $(L_{i,t}A_{i,t})$, which is the amount of labour at time t measured in terms of labour efficiency at time zero. If labour efficiency grows at a rate of $(n_i + g_i)$ then $L_{i,t}A_{i,t} = L_{i,0}e^{n_{i,t}}A_{i,0}e^{g_{i,t}} = L_{i,0}A_{i,0}e^{(n_i+g_i)t}$ dividing total output $Y_{i,t}$ by the efficiency unit of labour $(L_{i,t}A_{i,t})$ which gives the output by efficiency unit of labour $y_{i,t}^{E}$.

Thus, $y_{i,t}^{E} = Y_{i,t} / L_{i,t}A_{i,t}$,this implies that in general, as long as there is some kind of technical change output per capita,$y_{i,t}$ will grow even if the economy is in equilibrium. In contrast, output per efficiency unit of labour, which divides total output by a term that grows at the rate of technology change, could be stable (not grow) in equilibrium. This framework is useful to have a measure of output that nets out exogenous improvement in technology and converges to a constant in equilibrium.

However, numerous studies have been carried out to find long-run- growth path, the earliest studies were conducted by (Solow, 1957)based on the neoclassical theory. In their analysis, per capita income is determined by the growth of population, which is a proxy for the growth rate of the labour force and the growth rate of investment. However, technological progress is not captured in the model as it assumes diminishing marginal return to capital which is the cornerstone to convergence or catch up hypothesis. Therefore, the neoclassical growth model in the Solow (1957) sense implies that the average annual rate of economic growth per worker from time zero (0) to time (t) of country (i), denoted by (γ_i) equals:

$$\gamma_i = g_i + \varphi_i \left[\log\left(y_{i,0}\right) - \log\left(y^E_{i,\infty}\right) - \log\left(A_{i,0}\right) \right] \quad (4)$$

Where g_i the rate of labour augmenting technological progress, $y_{i,0}$ is income per worker at time zero, $y^E_{i,\infty}$ is the steady state value on income per efficiency unit of labour and $A_{i,0}$ is the initial efficiency unit of labour at time zero, $\varphi_i = -\frac{1}{t}\left(1 - e^{-\theta_{i,t}}\right)$ where $\theta_i > 0$,the speed of convergence. Equation (4) can be decomposed as:

$$\gamma_i = g_i + \varphi_i \left[\log\left(y_{i,0} / A_{i,0}\right) - \log\left(y^E_{i,\infty}\right) \right] \quad (5)$$

But, $\log\left(y_{i,0} / A_{i,0}\right) = \log\left(y^E_{i,0}\right)$

Therefore equation (5) becomes :

$$\gamma_i = g_i + \varphi_i \left[\log\left(y^E_{i,0}\right) - \log\left(y^E_{i,\infty}\right) \right] \quad (6)$$

Equation (6) implies that growth models are assumed to be exogenous (g_i) plus the difference between the initial value of output per efficiency unit of labour $\left(y^E_{i,0}\right)$ and the long run equilibrium value of output per efficiency unit of labour $\left(y^E_{i,\infty}\right)$.

In general, if $\left(y^E_{i,0}\right) < \left(y^E_{i,\infty}\right)$ then the $\log\left(y^E_{i,0}\right) < \log\left(y^E_{i,\infty}\right)$,this shows that countries for which $\left(y^E_{i,0}\right)$ is far below $\left(y^E_{i,\infty}\right)$ will have higher rates of economic growth than countries with $\left(y^E_{i,\infty}\right)$ close to their $\left(y^E_{i,\infty}\right)$. Thuseverything else equal poor countries should have higher rates of economic growth and will tend to catch up to better off countries. Finally, φ_i measures the speed or rate of convergence of economic growth, and the steady state then becomes smaller overtime and eventually goes to zero. Hence, in the long-run, the term $\varphi_i \left[\log\left(y^E_{i,0}\right) - \log\left(y^E_{i,\infty}\right) \right]$ is zero. Therefore, $\gamma_i = g_i$ (which is the rate of technological progress)

The neoclassical model also assumes that the growth rates of physical and human capital are determined by country specific savings rates. Therefore, the two kinds of capital $S_{K,i}$ and $S_{R,i}$ respectively depreciates so that their changes over time will result to:

$$K^*_{i,t} = S_{K,i} Y_{i,t} - \delta K_{i,t} \ \ and \ \ R^*_{R,i} = S_{R,i} Y_{i,t} - \delta R_{i,t} \quad (7)$$

Where δ is the depreciation rates and assumed to be the same for all countries, and saving rates are allowed to vary by country and capital type, but not vary over time and are not determined by any optimizing behaviour. This assumption will enable us to obtain estimates for $\left(y^E_{i,\infty}\right)$ and $\left(A_{i,0}\right)$. Thus, $\left(y^E_{i,\infty}\right)$ the steady state level of income per efficiency unit of labour now becomes;

$$y_{i,\infty}^{E}=\left(\frac{S_{K,i}^{\alpha}S_{R,i}^{\beta}}{\left(n_i+g+\delta\right)^{\alpha+\beta}}\right)^{\frac{1}{1-\alpha-\beta}} \tag{8}$$

α,β are the factor shares, n_i the country specific population growth, taking natural logs in equation(5) and substituting for $\log\left(y_{i,\infty}^{E}\right)$ in equation (8) yields;

$$\gamma_i = g_i + \varphi_i \log\left(y_{i,0}\right) + \varphi_i\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\log\left(n_i+g+\delta\right) - \varphi_i\left(\frac{\alpha}{1-\alpha-\beta}\right)\log\left(S_{k,i}\right) - \varphi_i\left(\frac{\beta}{1-\alpha-\beta}\right)\log\left(S_{R,i}\right) - \varphi_i\log\left(A_{i,0}\right) + \mu_i \tag{9}$$

Mankiw et al, (1992) noted that the only country specific term not observe in equation (9) is $\left(A_{i,0}\right)$ .Therefore, $\log\left(A_{i,0}\right)=\log\left(A_0\right)+e_i$, where e_i is country specific random shock that is not connected with $n_i, S_{K,i}$ and $S_{R,i}$,with the restrictions, equation (9) becomes :

$$\gamma_i = g_i + \varphi_i \log\left(y_{i,0}\right) + \varphi_i\left(\frac{\alpha+\beta}{1-\alpha-\beta}\right)\log\left(n_i+g+\delta\right) - \varphi_i\left(\frac{\alpha}{1-\alpha-\beta}\right)\log\left(S_{k,i}\right) - \varphi_i\left(\frac{\beta}{1-\alpha-\beta}\right)\log\left(S_{R,i}\right) - \varphi_i\log\left(A_{i,0}\right) + \varepsilon_i \tag{10}$$

Where $\varepsilon_i=\mu_i-\varphi_i$. Therefore, equation (10) provides the theoretical foundation for estimating the determinants of economic growth which is the basis of the regression of Mankiw et. al. (1992).

However, recent growth theories demised the (Solow, 1957) model in favor of the endogenous growth model that assumes constant and increasing return to scale. The different implications of the exogenous and endogenous growth models have led to renewed theoretical as well as empirical work in recent years. One of the major concerns has been the issue of convergence noting that, there seems to be in broad consensus that long term growth is negatively associated with inflation and civil unrest, but positively correlated with government effectiveness in managing the economy, human capital development and undistorted foreign exchange markets (Fischer, 1993).

3.2 Estimation Procedure

In this aspect, we aim at applying econometric techniques that are capable of capturing the impact of natural resources endowment on economic growth in the economy of Mali. Such econometric techniques are discussed below.

3.2.1 Summary Statistics and Correlation Matrices

The summary statistics captures the mean and standard deviation of the data distribution and the pair-wise correlation matrices is applied to test for the existence of correlation between natural resources endowment and growth, and to also determine the existence of multi-co linearity among the variables.

3.2.2 Unit Root Tests

When using time series annual economic data, it is important to note that most time series data are non-stationary which implies that the mean, variance and covariance of each variable is time variant otherwise the series is stationary. Hence using the OLS technique may imply that the result obtained would be spurious in the sense that the variables may seem to have causation when there is no causation and the regression is meaningless. However, to overcome this notion, time series data requires being de-trended in a regression analysis. Thus we apply the idea of differencing for stationary at certain level or order, co-integration between non-stationary series require both series to be of the same order of integration. If a series is level stationary, we denote I (0) and stationary at first difference, we denote I (1), the series is integrated of first order. In general an I(d) process is a series that is stationary after differencing d-times (Hendry and Richard, 1983).

We test for unit root of the series using the Augmented Dickey-Fuller(ADF) unit root test and the Phillip-Perron (PP) unit root test. The ADF is a test of the null hypothesis that the series are non-stationary I(1) against the alternative hypothesis that the series are- stationaryI(0). The Philip-Perron (PP) test is alsoapplied, which makes no assumption about the heteroskedascity and auto-correlated disturbances and suffers less from distribution issues and also adjust for the problem of endogeneity of the regressors. The ADF and PP tests have the same null hypothesis that unit root exist. Dickey and Fuller (1979) and (Phillips and Perron, 1988) The Augmented Dickey Fuller (ADF) test regression of a unit root is given by

$$\Delta x_t = \mu + \beta t + \delta x_{t-1} + \ldots \sum \delta_i \Delta x_{t-1} + \delta_m \Delta x_{t-m} + \mu_t \quad (11)$$

$$\Delta x_t = \mu + \delta x_{t-1} + \ldots \sum \delta_i \Delta x_{t-1} + \delta_m \Delta x_{t-m} + \mu_t \quad (12)$$

Equation (11) contains a trend term, while equation (12) does not contain a trend time, and the lag terms are introduced in the model as additional repressors to account for heteroskedasticity and auto-correlation. But for the Phillip Perron, the lag m, is omitted to adjust for the standard error in order to correct for auto-correlation, heteroskedascity and problem of endogeniety. Thus, the PP test equation is specified as:

$$\Delta x_t = \mu + \beta t + \delta x_{t-1} + \ldots \sum \delta_i \Delta x_{t-1} + \delta_m \Delta x_{t-m} + \mu_t \quad (13)$$

The inclusion of the time trend in both unit root tests in equations (11) and (13) explains the importance attached to trended series but can be dropped if found to be insignificance, However, dropping it requires caution, one needs to think twice and thrice before dropping it. Hence we consider including the time trend in the unit tests regressions. We carry the tests under the condition that:

Null Hypothesis $H_0 : \delta = 0$, the series has a unit root (non-stationary) that is I(1) against the Alternative Hypothesis $H_1 : \delta < 0$ the series has no unit root (Stationary) that is I(0), if the calculated value of the tests statistic is lessthan the critical value at 0.05 of one tailed test, we reject H_0 and accept H_1. That is the series is I (0), stationary otherwise the series is I(1), non-stationary.

3.2.3 Co-integration Test

It is important to note that, if the series is stationary at differencing, conclusion made regarding information about the variables in the regression can only be valid for short run dynamics, while in the long run considerable and useful information would have been lost. To overcome this problem, we test whether the dependent variable exhibit long run equilibrium-relationship with the explanatory variables or are co-integrated using the Co-integrating Regression Augmented Dickey–Fuller (CRADF) test. This test uses residuals form of a co-integration regression, we estimate the model using OLS estimation by minimizes the sum of the squares residuals, Engel and Granger in Econometrical (1987) considers this test as one of the preferred test of co-integration and became known as Co-integration Regression Augmented Dickey Fuller (CRADF) test. The Co-integration Augmented Dickey Fuller (CRADF) test regression equation is given by

$$\Delta e_t = \alpha_1 e_{t-1} + \delta_1 \Delta e_{t-2} + \cdots + \delta_m \Delta e_{t-m} + \mu_t \quad (14)$$

From equation (14) Δe terms are included to eliminate any autocorrelation so that $\mu_t \sim \text{IID}\left(0, \delta^2\right)$, notice that there is no constant in the regression. A constant can be included in either the co-integrating regression or the CRADF but not both. With a constant in the co-integrating regression equation, the residuals have zero mean, we do not expect the residuals to have a deterministic trend and so linear trend is not included.(Engel and Mackinnon, 1991), we carry the CRADF test thus:

$$\text{H}_0\text{:}\alpha_1 = 0 \text{ and } \text{e}_\text{t} \text{ are I}(1)\text{, the series are not co-integrated}$$
$$\text{H}_1\text{: }\alpha_1 < 0 \text{ and } \text{e}_\text{t} \text{ are I}(0)\text{, the series are co-integrated}$$

The test statistics under the null has no standard distribution, if the calculated value of the test statistic is less than the critical value then the null hypothesis of no co-integration is rejected; the series are co-integrated, m is the number of lagged terms is selected in the same way as for the unit root tests. We use Mackinnon (1991) critical values to make a decision on the test statistic and not the individual unit root values of the ADF test.

3.2.4 The Error Correction Model (ECM)

To ensure that the regression model is not spurious, we difference the series and following the Engel and Granger Representation Theorem (1987), we expressed a general ECM of the form

$$\Delta \ln \text{y}_t = \alpha_0 + \sigma_1 \Delta \ln \text{X}_i + \sum_{i=1}^{p} \tau_i \Delta \ln \text{Y}_{t-i} + \sum_{i=1}^{p-1} \partial_i \Delta \ln \text{X}_{t-i} + \gamma \text{EC}_{t-i} + \varepsilon_t \quad (15)$$

Where ε_t is white noise, and γ is the coefficient of the error correction term (EC_{t-i}) which measures the speed of adjustment or the feedback effect which should be negative and statistically significant at any level of significance towards attaining the long run equilibrium resulting from the series. σ_1 is the short run elasticity. Therefore the ECM from equation (15) is appealing due to its ability by combining the short run and long run dynamics in a unified system. Hence the estimates of the parameters of the ECM are generally consistent and efficient. (Hendry and Richard, 1983)

3.2.5 Granger Causality Test

Causality is an important concept in empirical analysis and refers to the ability of one variable to predict or cause the other. The Granger (1969) causality procedure is developed to test for causal relation. According to Granger, Y causes X if the past values of Y can be used to predict X more precisely then simply using the past values of X and vice versa. Therefore, the relevance of this test is to determine the direction of causation between two variables(X and Y) in a time series data. The idea behind this test is to run the following bi-variate regression models, if we want to determine the direction of causality between X and Y

$$\text{X}_t = \gamma_0 + \sum_{i=1}^{n} \delta_i \text{X}_{t-i} + \sum_{j=1}^{m} \sigma_j Y_{t-j} + \mu_{1t} \quad (16)$$

$$Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_i X_{t-i} + \sum_{j=1}^{m} \beta_j Y_{t-j} + \mu_{2t} \quad (17)$$

Where m and n are the number of lagged, X and Y are the terms respectively. μ_{1t}, μ_{2t} are the random errors and follows $N(0,\sigma^2)$ equation (16) predicts that X_t is related to past values of itself as well as that of Y_t and equation (17) predicts similar trend for Y_t.If we want to test whether X Granger cause Y or/and Y Granger cause X we carry out an F-test on the joint significance of σ_j and α_i respectively. Therefore, we proceed thus;

$$H_0 : \sum_{j=1}^{m} \sigma_j = 0 \ and \ H_0 : \sum_{i=1}^{m} \alpha_i = 0$$

, respectively test thus:

We reject the H_0 ,if the calculated $F^* > F_{n-k}^{m}$ (k is the number of parameters estimated in equations (14) and (15), n is the number of observations. Otherwise we do not reject H_0 .We may also use the Probability value of the F-statistic to make a decision based on the significance level, usually 1%, 5% and 10% respectively.

3.3 Model Specification and Data Description

3.3.1 Model Specification

The study adopts a quantitative approach in the analysis. It makes use of secondary time series data in the regression. Capital (K), labour (L) and Government Management Policy of an economy (M) and (A) the technological change are significant to sustained economic growth and taking clue from previous studies like (Mankiw, et.al. (1992) and(Solow-Swan, 1957), we have a model thus;

$$Y_t = A_t K_t^{\alpha} L_t^{\beta} M_t^{\delta} e_t^{\mu} \quad (18)$$

Taking natural logarithm from equation (18) yields:

$$\ln y_t = \ln A_t + \alpha \ln K_t + \beta \ln L_t + \delta \ln M_t + \mu_t \quad (19)$$

This is the empirical basis for our model, furthermore, according to Barro (1989a), the growth of real GDP is considered to depend on several variables. For the purpose of our study, the relationship between natural resources endowment and growth can be augmented from the Barro-growth regression which takes the form thus;

Growth = α_0 + β_i[natural resources endowment] + γ_i[conditioning set] +μ_t (20)

Where $\beta_i$the coefficient of the measures of natural resources endowment indicators and γ_i is the coefficients of the set of control variables.$\mu_t$is the error term.Hence, we specified our model as Real Gross Domestic Product (RGDP) measured on an annual basis adjusted for inflation, and is a function of the indicators in parenthesis. (World Bank Data CD-ROM)

RGDP=F (NRE, SER, GEI, CI, OT and INF) and taking natural logarithms, the model can be decomposed in linear form thus:

$$\ln\mathrm{RGDP_t} = \delta_0 + \delta_1 \ln\mathrm{NRE}_t + \delta_2 \ln\mathrm{SER_t} + \delta_3 \ln\mathrm{GEI_t} + \delta_4 \ln\mathrm{CI}_t + \delta_5 \ln\mathrm{OT_t} + \delta_6 \ln \mathrm{INF}_t + \mu_t \quad (21)$$

From equation (21), the simultaneous interaction terms of natural resources endowment and corruption can be written as;

$$\ln\mathrm{RGDP_t} = \delta_0 + \delta_1 \ln\mathrm{NRE}_t + \delta_2 \ln\mathrm{SER_t} + \delta_3 \ln\mathrm{GEI_t} + \delta_4 \ln\mathrm{CI}_t + \delta_5 \ln\mathrm{OT_t} + \delta_6 \ln \mathrm{INF}_t + \delta_7 \ln(\mathrm{NRE}_t * \mathrm{CI}_t) + \mu_t \quad (22)$$

Where μ_t is the error term and ($NRE_{it} * CI_{it}$) denotes the interaction of natural resources export and corruption.

3.3.2 Data Description and Source

Table 1: Data Description and Sources.

Variable	Symbol	Description	Source	Expected sign
Natural Resources Export	NRE	The natural resources export as a share of GDP which is used as a measure of resource endowment for our study.	IFS CD-ROM/ World Bank CD-ROM	±
Secondary School Enrolment Rate	SER	The qualification that requires, as a minimum condition of admission of the completion of primary education and/or completion of basic education.	United Nations Educational Scientific and Cultural Organization (UNESCO) Institute of Statistics	+
Government Effectiveness Index	GEI	Government Effectiveness captures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The index ranges from 1 to 6. The World Bank defines 1 to indicate low and 6 means high effectiveness.	IFS CD-ROM/ World Bank CD-ROM	±
Corruption Index	CI	Corruption index is measured by the transparency and accountability index, which range from 1 to 6. The World Bank defines 1 as low corruption and 6means high corruption.	(WDI)/ World Bank CD-ROM	–
Openness to Trade	OT	Sum of export and import scaled by GDP	IFS CD-ROM	+
Inflation	INF	The consumer price index with 2000 as the base year	IFS CD-ROM	–
See equation (22) above	NRE*CI	Interactive terms of NRE and CN	(WDI)/ World Bank/IFS CD-ROM	–

WDI= World Development Indicators and IFS=International Financial Statistics

4. Result and Discussion

Table 2: Summary Statistics

Variables	RGDP	NRE	SER	GEI	CI	OT	INF
Mean	4.29	3.17	2.73	0.99	5.83	1.29	12.08
Maximum	2.47	1.94	3.79	1.22	3.79	0.66	24.5
Minimum	1.52	0.36	1.58	0.92	1.09	-1.72	-0.43
Std. Dev	1.15	1.09	0.04	0.06	2.46	0.07	2.89
Correlation							
RGDP	1.000						
NRE	0.21	1.000					
SER	0.13	0.55	1.000				
GEI	0.19	0.30	0.56	1.000			
CI	-0.23	-0.04	-0.05	-0.34	1.000		
OT	0.06	0.15	0.03	0.09	-0.01	1.000	
INF	-0.19	-0.11	-0.07	-0.16	0.10	-0.23	1.00

Note: All the variables are expressed in logarithm.

The result from the summary statistics in table 2,indicates that RGDP average around 4.29% which implies that the economy grows at a rate of 4.29% over the study period, NRE revenue is somewhat low (3.17% of GDP), SER average around 2.73%, for a developing country like Mali, the enrollment rate is fairly reasonable and thus signifies some level of progress in the educational sector of the economy.GEI on the economy average around 0.99which falls below the average value of 3, as per the World Bank ranking and hence, demonstrates low degree of efficiency by the government in the management and administration of the country.CI is (5.83) above the average level of (3.0) and almost close to 6, indicating the presence of high level corruption in Mali over the study period (The World Bank ranking for high corruption is 6, and 1 indicates low corruption).OT average around 1.29% of GDP and INF indicates double digit (12.08%), which demonstrate an indication of macroeconomic instability. The standard deviation indicates that INF and CI are highly volatile with a dispersion of 2.89 and 2.46 respectively. This implies that INF and CI are highly risky to growth. Although NRE revenue is also risky, with a dispersion of 1.09. But less risky compared to inflation and corruption. However, SER, GEI and OT are found to be less risky for growth, with a standard deviation of 0.04, 0.06 and 0.07 respectively.

The correlation matrix in the lower segment of table 7, above indicates that NRE, SER, GEI and OT are positively correlated with RGDP, which signifies that these variables are moving in the same direction with economic growth. Therefore, the hypothesis that positive correlation exist between natural resources endowment and economic growth is supported. CI and INF are found to be negatively correlated with RGDP. This implies CI and INF are moving in the opposite direction with RGDP. Therefore, the presence of high corruption and high inflation are bad for growth in Mali. The correlation values in the low segment of table 2 are moderate, indicating no serious problem of multicollnearity (There is no correlation value among the variables exceeding 0.7).

Table 3: Result of the Augmented Dickey Fuller (ADF) Unit Root Test

Variable		ADF Unit Root Test		Conclusion
		Constant	Constant and Trend	
lnRGDP	level	-2.423629	-2.422523	I(1)
	First difference	-8.341251**	-8.128522**	
lnNRE	level	-3.339694	-3.269866	I(1)
	First difference	-6.651691**	-6.537934**	
lnSER	level	-2.217390	-2.820558	I(1)
	First difference	-4.344215**	-4.339595**	
lnGEI	level	-1.536396	-0.546108	I(1)
	First difference	-6.132320**	-6.975158**	
lnCI	level	-9.870296**	-8.946260**	I (0), I(1)
	First difference	-13.18581**	-13.22873**	
lnOT	level	-2.083945	-2.198342	I(1)
	First difference	-6.457107**	-6.474042**	
lnINF	level	-4.752862**	-4.645799**	I (0), I(1)
	First difference	-6.814407**	-6.589695**	

Note: (**) denote 5% significance level respectively, I (1) means order of integration. The test is based on Schwarz Information Criteria (SIC)

The ADF unit root test in table 3, above shows that, apart from CI and INF that are stationary in level as well as first differencing, all the other variables are not stationary in level, but stationary at first difference. However, in the case of CI and INF, that are both I (0) and I (1), their linear combinations should be I (1). Therefore, all the variables are integrated of order one, denoted as I (1). This guarantees no spurious regression (no nonsense regression).

Table 4: Result of the Phillip - Perron Unit Root Test

Variable		Phillip- Perron Unit Root Test		
		Constant	Constant and Trend	Conclusion
lnRGDP	level	-2.687173	-2.981904	I(1)
	First difference	-9.367850**	-9.802817**	
lnNRE	level	-3.309093	-3.249876	I(1)
	First difference	-11.42194**	-10.94509**	
lnSER	level	-2.164915	-2.267565	I(1)
	First difference	-4.927312**	-5.037820**	
lnGEI	level	-2.074091	-2.187843	I(1)
	First difference	-7.716653**	-7.947453**	
lnCI	level	-8.941304**	-6.088078**	I (0), I(1)
	First difference	-13.39532**	-13.49442**	
lnOT	level	-1.978178	-2.198342	I(1)
	First difference	-6.492193**	-7.065771**	
lnINF	level	-10.93012**	-8.826940**	I (0), I(1)
	First difference	-11.25215**	-12.72338**	

Note: (**) denote 5% significance level respectively, I (1) means order of integration. The test is based on Schwarz Information Criteria (SIC)

The pre-condition of the series being integrated of the same order (ADF test) is verified with the Phillip-Perron (PP) tests. Each variable is tested using the Schwarz Information Criteria (SIC). For all series, the presence of a unit root cannot be rejected at 0.05 level of significance indicating that all the series are integrated of order one I(1).

The same analysis as above holds true for CI and INF.This guarantees no problem of heteroscedasticity, no autocorrelation in the residuals and no endogeneity of the regressors. The stationary condition is confirmed as shown by the graphs in the appendix.

Table 5: Result of the Co-integration Regression Augmented Dickey Fuller (CRADF) Test.

Null Hypothesis: E has a unit root				
			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.907335	0.0007
Test critical values:	1% level		-3.752946	
	5% level		-2.998064	
	10% level		-2.638752	
*MacKinnon (1996) one-sided p-values.				

The test-statistic on E (-1) which is **-4.907335**, with 23 observations after adjustment at 0.05 Mackinnon (1991) critical values is**-2.3001**. The calculated value of the test statistic is less-than the critical value rejecting the null hypothesis of no co-integration; the series is co-integrated. This implies long run equilibrium relationship between the dependent and the independent variables.

Table 6: Regression Output: Result of the Error Correction Model (ECM)

Variable	Model 1: Ln RGDP: (No interaction of NRE*CI)	Model 2: Ln RGDP (Interaction of NRE*CI)
Constant	1.047730 (0.561828)	0.407230 (1.663918)
lnNRE	0.280253 (2.529779)**	-0.500933 (1.904877)***
lnSER	0.703201 (3.066280)*	0.809101 (13.89737)*
lnGEI	0.731107 (3.063959)*	-0.256358 (-2.030217)**
lnCI	-0.008892 (-2.723624)**	-0.129150 (-8.245145)*
lnOT	0.354647 (2.218624)**	0.365162 (1.914607)***
lnINF	-0.078429 (0.745386)	-0.531954 (-2.438783)**
ln NRE* lnCI	…………….	-0.079534 (-3.833472)*
lnRGDP(-1)	0.671114 (-2.679681)**	0.238534 (2.218251)**
lnNRE(-1)	0.675066 (-2.455272)**	-0.575326 (1.909658)***
lnSER(-1)	1.325883 (-4.129359)*	0.812309 (3.398733)*
lnGEI(-1)	0.869308 (--3.502914)*	-0.191279 (-2.116999)**
lnCI(-1)	-0.035680 (-2.156745)**	-0.715825 (-10.11684)*
lnOT(-1)	0.094314 (1.767886)***	0.075767 (1.938847)***
lnINF(-1)	-0.027614 (-1.153239)	-1.060334 (-5.317834)*
ln NRE* ln CI (-1)	……………	-0.437605 (-2.939635)*
E(-1)	-0.703419 (-5.132278)*	-0.638512 (-9.102922)*
R^2	0.658421	0.845203
Adjusted R^2	0.537999	0.778057
Durbin Watson	2.011745	1.990511
Prob(F-statistic)	0.002604	0.044313

Note: The figures in parentheses are t-Statistics, * means significant at 1%, ** significant at 5%, *** significant at 10% and all variables are expressed in logarithm of the first difference (D ln).

In terms of the regression output from the error correction model (model 1) with no interactive term of natural resources export and corruption (no NRE*CI) in table 6 above. NRE impacts positively on growth and significant at 5% level and it lag term is statistically significant at 10% level. SER, GEI and OT positively impact on economic growth and significant at the 1%, 1% and 5% level respectively. However, CI impacts negatively on growth and significant at 5%, INF is found to be insignificant but impacts negatively on growth. The positive impact of natural resources export on economic growth indicates no case of natural resource curse in Mali for the study period (1990-2013) in model 1. This result lends credence to the study by (Spatafora and Warner, 2001) who find no evidence of natural resource curse in eighteen oil exporting countries.

Turning to the interactive term in model 2 (NRE*CI), NRE, CI and INF have been found to impact negatively on growth and statistically significant at 10%, 1% and 5% respectively. The interactive term (NRE*CI) and GEI have also found to impact negatively on economic growth and statistically significant at 1% and 5% level respectively.

This result indicates that, the interaction of corruption and natural resources export impact on growth negatively (reduces growth). This therefore, shows evidence of the resource curse phenomenon. This result is consistent with the study by (Robinson et al. 2006) who find that the discovery of natural resources is highly likely to generate some sort of economic rents that may result to higher tendencies of corruption in the public sector. This result also lends support to the study by (Auty, 2001) who find that natural resource abundance economies have the tendency to grow more slowly than economies without substantial resources due to corruption and ineffective government policies. The negative impact of inflation on growth indicates that high rates of inflation adversely affect growth. These results are not surprising because, growth is unlikely to occur unless policies produce stable macroeconomic environment in which inflation remains reasonably low. SER and OT are found to impact positively on growth and statistically significant at 1% and 10% level respectively. This means that the quality of human capital plays a significant role in promoting economic growth in Mali, and openness to trade increases growth via the enhancement of technological advancement, international exchange and foreign investment.

The coefficients of the error correction term E (-1)in model 1 and model 2 are(-0.703419, -0.638512) respectively, as measure of the speed of adjustment, both have the correct sign (negative) and statistically significance at the 1% level. It means that during periods of negative shocks and disequilibrium errors to the system, the variables increases less rapidly than consistent, and thus moving their lagged values below the long run steady-state path. This implies that for any drift away from the long run equilibrium in previous years, convergence to the equilibrium is corrected by 70.3% and 63.8% respectively. The R-squared values in model 1 and model 2 are reasonable (65.8% and 84.5%) respectively, indicating that the model best fits the data (coefficient of determination) and the Durbin Watson statistic (DW) values suggests no autocorrelation in the residuals as the values are around 2 (two).

Table 7: Result of the Granger Causality Tests

Hypothesis	No. of lags	F-Stat	Prob.	Conclusion
D ln NRE does not Granger Cause D ln RGDP	2	3.68***	0.049	Bidirectional Relationship
D ln RGDP does not Granger Cause D ln NRE	2	3.59***	0.051	
D ln GEI does not Granger Cause D ln NRE	2	6.58*	0.008	Unidirectional Relationship
D ln NRE does not Granger Cause D ln GEI	2	0.609	0.556	
D ln CI does not Granger Cause D ln NRE	2	1.07	0.366	Unidirectional Relationship
D ln NRE does not Granger Cause D ln CI	2	4.71**	0.026	
D ln SER does not Granger Cause D ln NRE	2	10.4*	0.001	Unidirectional Relationship
D ln NRE does not Granger Cause D ln SER	2	0.31	0.738	
D ln OT does not Granger Cause D ln NRE	2	7.96*	0.003	Bidirectional Relationship
D ln NRE does not Granger Cause D ln OT	2	3.81**	0.043	
D ln INF does not Granger Cause D ln NRE	2	0.16	0.847	No Casual Relationship
D ln NRE does not Granger Cause D ln INF	2	0.71	0.505	

Note: (*), (**) and (***) indicates that the null hypothesis is rejected at 1%, 5% and 10% level of significance respectively. The appropriate lag length is selected based on the Schwarz Information Criteria (SIC), the test is performed on the stationary data series.

The result of the Granger causality test in table 7 indicates a bi-directional relationship between NRE and RDGP at 5% and10%, level of significance respectively. There exist a unidirectional relationship between NRE and GEI; the causation runs from GEI to NRE at 1% level of significance, a unidirectional relationship also exist between NRE and CI, at 5% level running from NRE to CI. Causation runs from SER to NRE at 1% level of significance and does not run in the reverse sense. Bi-directional relationship exists between OT and NRE at 1% and5% level respectively. There is no causal relationship between INF and NRE. In general, the Granger causality test result demonstrates a fairly strong evidence of a bi-directional relationship between NRE and economic growth in Mali.

Hence, confirming the hypotheses that causality exists between NRE and economic growth. This could also be seen from the series that there is a strong speed of adjustment as it can correct about 70.3% and 63.8%convergence to equilibrium following a shock to the growth determinants in both the regressions of model 1 and model 2 above.

5. Conclusion

The study investigates the impact of natural resources endowment on economic growth in Mali using natural resources export revenue and growth controls data from 1990-2013. The Pair wise correlation result supports the hypothesis that natural resources export (endowment) has appositive impact on economic growth in Mali. However, when natural resources export interacts with corruption, the impact on economic growth is negative. That is the simultaneous interaction of natural resources export and corruption is bad for growth. The Granger Casualty result also confirmed the hypothesis that causality exists between economic growth and natural resources export (endowment). There is strong evidence of a bi-directional relationship between natural resources export and economic growth. This could also be seen from the growth variables that there is a strong speed of adjustment as it can correct about 70.3% and 63.8% in model 1 and model 2convergence to equilibrium following a shock to the system.

Our findings do not also support the resource curse phenomenon in Mali, however, when natural resources export interacting with corruption the resource curse phenomenon is confirmed in Mali. This may imply inefficient control of government on the economy and mismanagement of natural resources export revenue through high rate of corruption in the public sector in Mali. Therefore, for natural resources endowment to adequately benefit the citizen of Mali by way of improving their living standard, reducing poverty, deprivation of basic necessities of life and starvation, there is need for the country to improve on the management of natural resources revenues by putting in place effective and robust policy measures to mitigate and or possibly eradicate corruption in the public sector. Measures such as setting up of anti-corruption institution, making it more functional with prosecutorial powers and allow operating with some degree of independence.

Imprisonment and rejection of public officers from holding public offices if found guilty of corruption related cases. Such measures if effectively implemented could potentially help to reduce corruption, mitigate or eradicate conflict prevention and resolution so as combat the adverse effect of civil conflict, maximizing revenues from natural resources export and hence economic growth.

Weak economic growth as a result of government ineffectiveness in managing the economy, poor management of natural resources export revenues and corruption are the cases for most Sub-Sahara African countries including Mali, and these scenarios still remains a challenge. On this basis, we look forward to future study on growth issues with a view to further provoke policy discourse. Such study could be the nexus between poverty reduction and economic growth in Sub-Saharan Africa. Despite data limitation, our finding are still relevant and provides solid foundation of achieving broad based economic growth, preventing the re-occurrence of natural resource curse, civil conflict and corruption not only in Mali but in Africa and worldwide.

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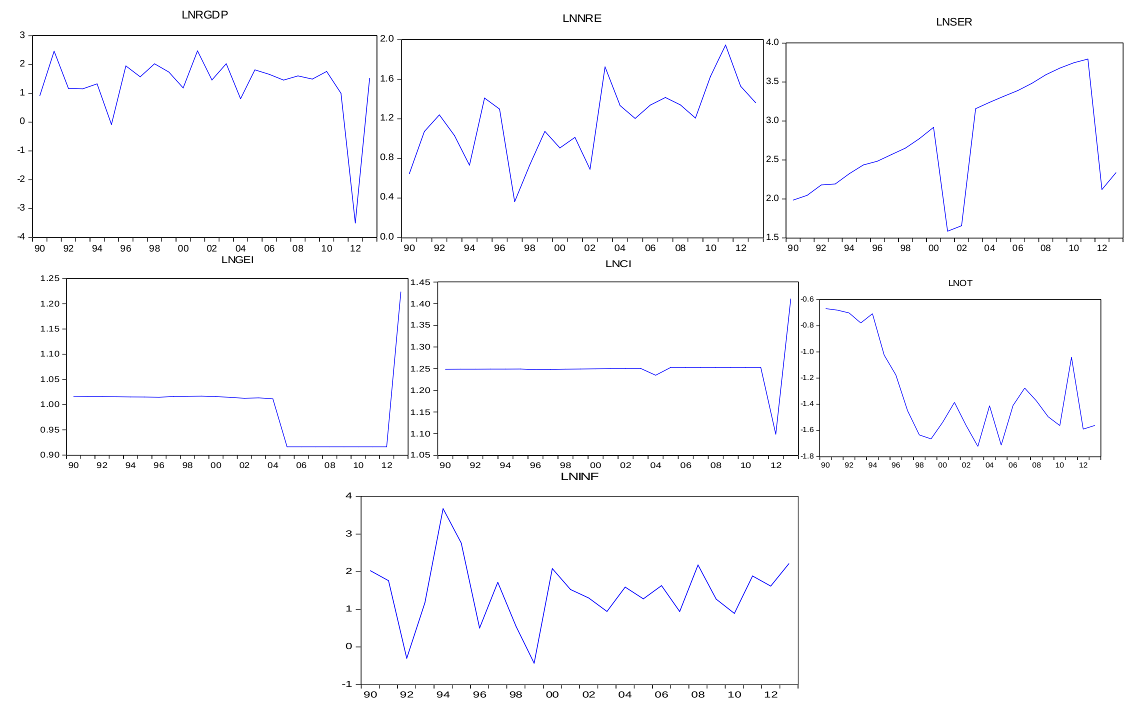
Appendices

Graphs of Level: Non-Stationary (Apart from CI and INF, graphs do not pass through the zero line very often)



Graphs of first difference: Stationary (graphs passes through the zero line very often)