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HARNESSING NATURAL RESOURCE FOR SUSTAINABLE DEVELOPMENT: A RESOURCE EXCHANGE MODEL APPROACH

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Abstract

This study evaluates a possible alternative view on the literature on managing resource revenue for economic growth. Based on recent postulates that resource revenues should be primarily used to increase current consumption and capital stock through investments in both public and private sectors of the economy, we evaluate the implications of this policy on an economy plagued by low capital absorption, dysfunctional public and private institutions and corruption, while contrast our findings with the applicability of an alternative proposition. We established, using a replica of the Ramsey model and solving for optimal decisions with a Hamiltonian function, that the problems of corruption and dysfunctional institutions can potentially stymie any form of economic growth in the short term. This in turn crowds out needed investment and can deepen the problem of the popular natural resource curse. However, we introduce a form of international trade whereby resources are exchanged for needed capital investments as a possible alternative to managing resource booms. We established that this alternative will boost economic growth even in the presence of corruption and guarantee increased consumption and capital stock but only in the short run.

Keywords: Paradox of plenty, Natural resource curse, Corruption, Institutions, International Trade and Exchange

INTRODUCTION

Normatively, one would expect that the occurrence of a resource boom for an economy low in capital stock and consumption levels presents a viable opportunity to capture and sustain potential economic growth during the time of the resource boom. Historical data and empirical studies have shown otherwise (Sachs and Waner 1997; Auty 2001). For developing economies, it is common knowledge that they are rich with hydrocarbons and mineral resources but still experience a form of depression in economic growth. This phenomenon has been called the "natural resource curse" or "paradox of plenty". Sole dependence on one primary commodity which makes the economy less diversified, the transient and volatile nature of these resource revenues, hurtful increases in exchange rates and dysfunctional economic and social institutions have been put forward as possible explanations to the predominance of this paradox in resource rich countries.

Over the period 2000-2005, these resources accounted for over 50% of exports and contributed over half of total fiscal revenue for African Countries that had experienced a resource boom (IMF, 2007). It was estimated that these earnings were further increased due to booms during the period of 2006-8 and continued at even higher levels. Yet there has not been any significant form of economic growth and development (Collier et al., 2010; Olters, 2007).

The problem lies in the nature of the resource revenue as well as socio-economic and political conditions of the economy. The revenues from the resource are temporal (mainly due to the fact that they are gotten from a depleting stock) and volatile (consistent with commodity prices) which make them unreliable for increasing consumption patterns and capital stock. This justifies the need to save and invest the resource revenue in the domestic economy to guard against changing consumption patterns that are not desirable (van der Ploeg, 2011). The use of resource revenues can serve as a means of financing these growth stimulating investments, but there is a need for efficient management of the resources in order to achieve this goal. According to van der Ploeg (2008) such investments should be in the form of tangible and intangible goods such as; education, infrastructure and capacities that increase government effectiveness and economic management.

Also, the roles of public and private institutions are important factors in determining the means of harnessing the resource revenues. The occurrence of a resource boom causes a rapid change in revenues and expenditure pattern of the government. Therefore, there will be a need for in public and private institutions that guide and monitor these changes to enable them perform their duties within the evolving economy. Failure in considering this need may render these institutions ineffective and redundant in perform its functions. This ultimately leads to corrupt practices, unproductive use of resource revenues and rent seeking.

Although the literature differs on the supposed effect of a resource boom, they however agree that economies with low capital, low incomes and with a dysfunctional institutional framework will experience this curse once a resource boom emerges if certain policies are not put in place. How then does such a country manage its resource revenue in order to capture all economic growth potential and at the same time escape from the natural resource curse?

Though different policy measures have been used in answering the question above, for the purpose of this study, we are interested in one possible policy that is becoming increasingly popular amongst concerned citizens and policy makers in developing countries. We call this idea Resource Exchange. It involves the reduction in actual sales of the resource while exchanging the resource for needed capital and infrastructure from abroad. The foundation of this idea is based on the general consensus that the existence of corruption, as an off shoot of abundant resource revenues, will stymie any form of economic growth that can be achieved. Hence the need to reduce the amount of resource revenue generated in order to reduce corruption effects on growth. At the same time allow for an increased influx of direct investments from abroad in the form of capital and economic overhead which will be financed by exchanging the resource for these necessities.

The main objective of this work is to evaluate the proposed policy of a resource exchange as an effective means of managing resource booms and resultant revenues to induce economic growth in the short run. We present a rigorous contrasting analysis of a possible and optimal alternative to the existing literature on managing resource revenues. By introducing social problems of corruption and dysfunctional institutions (private and Public) into the proposed model and an alternative model, we determine their implications on the level of consumption and capital stock.

LITERATURE REVIEW

The emergence of a resource boom in many African countries during the 1960s has not always been a blessing to their domestic economies. Various reasons have been put forward by researchers as possible explanations that have led to this phenomenon popularly known as the "Dutch Disease" or "Paradox of Plenty". These postulates of the paradox of plenty range from economic theoretical reasoning to social and political reasoning.

In the work of van der Ploeg (2007), various factors were elaborated as the reasons why resource rich African countries were plagued by the paradox of plenty. Citing specific characteristics of a natural resource windfall such as volatility of natural resource windfalls and the temporal nature of the windfall because they are derived from a finite stock of resource, the research placed emphasis on an optimal solution for the management of natural resource for capital scarce countries.

The central point about the paradox of plenty is that windfall revenues from the exploration of a natural resource increases the real exchange rate for an economy that has low capital absorption, and at the same time induce a reduction in traded non-resource sectors of the economy, thus making the economy less diversified (Hausmann and Ribogon 2002; Sachs and Waner, 1995). Here emphasis is placed on the exportation of primary commodities and a capital intensive manufacturing base. The repercussion of this decision process is to slow down the growth process of these economies, van der Ploeg (2007), van der Ploeg and Venables (2011), Liete and Weidmann (1999). A blessing has become a curse and growth seems to be distant and not achievable if there is a continued use of natural resource to foster economic growth.

Sachs and Warner (1995) was the pioneer study that elaborated the relationship between a natural resource boom and economic growth. They were able to show that countries that experienced a form of natural resource boom grew slower when controlling for macroeconomic policies and income levels. Liete and Weidmann (1999) also supported this postulate of a negative relationship between a resource boom and economic growth. Papyarkis and Gerlagh (2004) were able to show specifically how resource boom directly and indirectly affects the economy, even though a negative effect usually outweighs a positive effect when macroeconomic policies like trade openness and investment in human resource were considered.

Humpherys et al., (2007) elaborated the natural resource curse via its volatility. They argued that this volatility arises from different extraction costs with the repercussion of sporadic public spending, problematic planning and making investment in the country risky. Other important possible transmission channels by which the natural resource curse can be explained have been highlighted by the literature.

Hausmann, Rodriguez, and Wagner (2007), emphasised the country's vulnerability to external shocks and possible different productive linkages. They were able to show that countries with lower export flexibility find it difficult to recover from any sort of export induced economic problems. This explanation is most relevant to economies with natural resource contributing more to its total exports. Institutional weakness has been put forward as a possible transmission mechanism (Lederman and Maloney, 2008; Wright and Czelusta 2007; Lane and Tornell, 1999).

However, one would expect that a resource boom should induce the desired higher level of economic growth. This can be achieved by harnessing the revenues from this boom to serve as a boost to the economy via increased investment in economic overhead, public infrastructure and human capital (Burnside and Dollar, 2004). Ultimately, a country that experiences a resource boom should have higher growth rates (Sachs and Warner, 1999). This line of thinking by Sachs and Waner (1999) has been supported by part of the literature, making the theory of the paradox of plenty inconclusive. Lederman and Maloney (2007) were able to argue against a natural resource curse on GDP and human development using samples from Latin American countries. They emphasised the need to differentiate the effects of a natural resource boom from other factors that affect growth. They distinguished between the role played by a resource boom in economic growth and its interactions with other determinants of economic growth. Introducing intra industry trade and export concentration to their analysis, they found no form of a negative relationship between natural resource and Growth in the presence of export concentration.

According to van der Ploeg and Venebles (2011), optimal time paths were gotten from welfare maximisation functions in explaining the decision process of managing a natural resource windfall. The study contrasted between two possible solutions which were all optimal based on specific characteristics of the country involved. For countries that were developed and had a high level of income, the Permanent income Hypothesis (PIH) and Bird-in-Hand (BIH) encouraged the use of a sovereign wealth Fund (SWF) as optimal solutions. Whereas, for a country that had inadequate infrastructure, a low capital-labour ratio, low income, and increasing domestic interest rates, should not hold a sovereign wealth Fund (SWF) because this policy has an incentive to transfer increases in consumption to future generations. Instead, they advocated the use of a policy that had a preference for increasing consumption patterns in current generations.

Numerous investment channels of resource revenues present themselves, but the literature is specific about four. According to Collier, et al., (2010) resource revenues can be distributed as private consumption through private transfers to citizens or through manipulation of the tax system. Also, the resource revenues can be used directly by the government to increase public spending either for public consumption or public assets. Thirdly, they can be held as a form of government financial asset but lent to the private sector or foreigners. Finally, they can be held as foreign reserves by establishing a Sovereign Wealth Fund (SWF) and lent to foreigners. We introduce our main idea (Resource Exchange: which entails exchanging a fraction of resources for the much needed capital transfer and investment from abroad) of how the resource revenue should be managed by contrasting its application with those already elaborated in the literature.

We base our contrast, following the literature (Gupta, et al., 2006; Collier et al., 2010), on who gets ownership of the resource, which controls the macro level time path? Who controls micro level spending and finally the implications on consumption and investment?

TABLE 1: Alternative Measures of Managing Resource Revenues

	Resource Availability	Private Consumption	Government Consumption	Private Capital Stock	Public Capital Stock	Foreign Assets
1.Tax cut /Transfer	1	c	0	$1-c$	0	0
2.Public Spending	1	0	G	0	1 - g	0
3.Debt Reduction	1	z	0	$\lambda(1-z)$	0	$(1-\lambda)(1-z)$
4.Resource Exchange	1	γN_2	0	$(1-\gamma)N_2$	$(1-\varphi) N_1$	φN_1
Account Identity	$R - C_p - C_g = I_p + I_g + I_f$					

Note: c– share of consumption from a tax cut; g – share of consumption in government spending; z – share of consumption in private response to government debt reduction/lending; N_2- shares of resource revenue actually gotten from sales, N_1 – share of guaranteed capital stock and investment from resource exchange. C=consumption, I=investment, subscripts p-private, g-government-foreign.

Source: van der Ploeg (2008) and Author

A detailed analysis of the applications of alternatives 1, 2 and 3 can be found in the work of van der Ploeg (2008). The table above shows the direct implications of the proposed policy of exchanging some of the resource for capital and direct investments in order to escape the effects of corruption and induce economic growth. In the resource exchange model, a fraction of the resource is sold for revenue N_2 and the other fraction N_1 is exchanged for capital and investment. A fraction of N_2,γN_2 will be used to increase private consumption through a reduction in tax or increased subsidies as well as noting the possibility that these transfers will not all be consumed but also used to increase private capital stock by saving $(1-\gamma)N_2$. The other fraction of the available resource that is being used for the exchange, $(1-\varphi) N_1$, should guarantee the increase in public investments through the exchange of $(1-\varphi) N_1$ of available resource for these investments. At the same time avoiding increases in corruption level following the assumption that resource revenues breed corruption, while this form increment in capital accumulation and investment is devoid of corruption. The idea here is that corruption is inherent in an economy that has experienced a resource boom. Capital accumulation and domestic investment in the economy are represented by the sum of $(1-\gamma) N_2$and $(1-\varphi) N_1$. Part of the resource available for exchange φN_1 is also held as foreign assets help guard against resource volatility and exchange rates. The paper therefore follow the conclusions of Liete and Weidmann (1999), Sala-i-Martin and Subramanian (2003) and Isham et al. (2005) that a natural resource revenues breeds corruption which will in turn hurt the economy. In the work of Bhattacharyya and Hodler (2009), they concluded that resource abundance will ultimately lead to increases in corruption in countries with poor democratic institutions (democratic institutions were captured by the ability of people to determine who governs them) but this relationship does not hold in countries with better democratic institutions.

THEORETICAL MODEL

We follow the pioneering work of van der Ploeg and Venables (2011) and take the conclusions of that paper as given as it answers the question of whom to invest the resource revenue on. In summary, Van der Ploeg and Venables(2011) was able to show that the current literature postulate of harnessing a windfall either by the theories of Permanent Income Hypothesis (PIH) or Bird-in-Hand (BIH) are not feasible and practicable in a developing economy that is characterised by low capital, low investments and growth rates. Instead, using optimisation rules, he was able to show that it will be better for such a country to discard the use of PIH or BIH (which place more emphasis is consumption smoothing) and rather invest these resource revenues for current consumption. They noted that both theories maintain a permanent consumption levels by borrowing before the windfall and offsetting their debts with the revenue from the windfall. Hence, both PIH and BIH transfer much of consumption increments due to a resource boom to future generations. While this may be optimal for an already developed economy, the same cannot be said for a developing economy.

The paper considers a Hypothetical open economy that can borrow and lend at world interest rates. This economy has just experienced a natural resource boom at time T_0, and intends to use the revenues gotten from this boom for current purposes. As already stated, we are assuming that the government implements the idea of van der Ploeg and Venebles (2011) and is committed to enhancing current growth prospects by investing for current consumption and capital stock. We also assume that the government is the only decision making agent and citizens do not own any form of asset but receive some form of transfer from the government. The social planner (or Government) is faced with the problem of maximizing its citizen's utility;

$$U \equiv \int_0^\infty \frac{C^{1-\left(\frac{1}{\sigma}\right)}+\mu G^{1-\left(\frac{1}{\sigma}\right)}}{1-\left(\frac{1}{\sigma}\right)} \exp(-\rho t)\, dt \ldots\ldots. (1)$$

Where C represents private consumption and G represents public consumption. σ is for the elasticity of inter-temporal substitution and ρ indicates time preference. μ indicates the weight that is given to the portion of government expenditure that goes to public consumption. Maximisation of this inter-temporal utility function is subject to the constraints,

$$\acute{K} = F(K, L, G, N)-C-G+N \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (2)$$

With the initial capital stock being K_0. $\acute{K}$ is the rate of increase in capital stock at any date and is determined by the variables C, G, N and by a unique production function F (K, L, G, N). N stands for the windfall revenue from the natural resource boom and it accrues in totality to government. We will assume that the following relationship holds in our production function; $\partial F_k/\partial N > 0$ and $\partial F^2{}_k/\partial N^2 < 0$, $F_k>0$ and $F_{kk}< 0$ where F_k is the marginal product. We model N in such a way that we are assuming that every year there is a particular ceiling quantity of natural resource that can be extracted and it is determined by the government. This makes N to be endogenous and no need to make an optimal choice about its exploration. The study uses this to abstract from resource depletion cost and placing a constraint on N in such a way that it restricts the policy maker from extracting limitless amounts of resources following the efficiency conditions of a Ramsey model.

The optimal conditions rules open to the government are all too familiar. Following a basic Ramsey Model and solving using a Hamiltonian function, the efficiency conditions state that both consumption types (private and Public) will have to be in fixed proportions i.e. we first write a Hamiltonian function given by

$$H(C,G,K,N) \equiv \int_0^\infty \frac{C^{1-(\frac{1}{\sigma})}+\mu G^{1-(\frac{1}{\sigma})}}{1-(\frac{1}{\sigma})} \exp(-\rho t) + q_t[\,F(K,L,G,N) - C - G + N \quad .....(3)$$

H represents the Hamiltonian and q stand as the co-state variable .Taking the first derivative with respect to C, G and q; we get the following optimal solutions

$$H_C : C^{-(1/\sigma)} - q_t = 0 \quad .... (4)$$

$$H_G : \mu G^{-(1/\sigma)} - q_t = 0 \quad .... (5)$$

$$H_k: q_t F_k (K, L, G, N) = -(dq/dt) \quad .... (6)$$

Where H_C, H_G and H_K represent the first derivatives with respect to C, G and K respectively. The transversality condition which holds is

$$\text{Lim}_{t\to\infty} (\exp\rho t)\, q_t K_t = 0 \quad ...... (7)$$

It thus follow that $G = \mu^\sigma C$. The constraints can then be re written as

$$\acute{K} = F(K, L, G, N)-C-G+N = F(K, L, G, N) - C- \mu^\sigma C + N$$

Which can be further written as $\acute{K} = F(K, L, G, N) - C(1 + \mu^\sigma) + N$ .... (8)

Hence the permanent changes in both variables will depend on the present value of the natural resource which we assume to be V_0 and Y which is the total output from Non resource products. The permanent level of consumption becomes

$$C + G = Y + V_0 \quad .... (9)$$

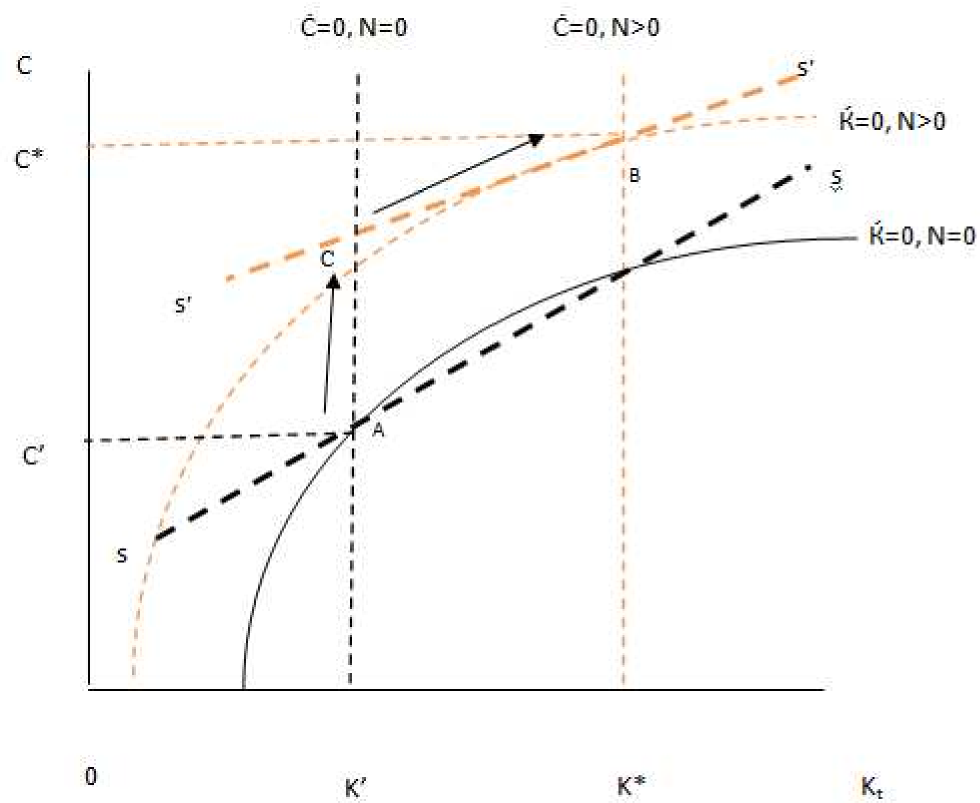
The dynamics of consumption can be explained when take the time derivative of our co state variable and substituting the value in our efficiency solutions.

We end up with an equation as follows,

$$\dot{C} = U_C/U_{CC}\,[(F_k\,(K, L, G, N) - \rho] \;\ldots\ldots\ldots\ldots\; (10)$$

$Uc = C^{-(1/\sigma)}$; is the first derivative of our utility function with respect to consumption and $U_{CC} = (-1/\sigma)\ C^{-(1-\sigma/\sigma)}$; represents the second derivative of the utility function with respect to consumption. For $\dot{C}=0$, F_k (K,L,G,N) = ρ. How then does the variable N vary with the steady state capital stock? What is dK/dN? As noted earlier, given F_k is increasing in N, it follows that an increase in N will make Fk (K, L, G, N) >ρ. Hence to bring them back to equality we have to increase K because F_k is falling in K. Therefore dK/dN>0.We further employ the use of a phase diagram to show the development path that may arise following our benchmark scenario.

Figure 1: Consumption and Capital Dynamics without the Influence of Corruption



With a natural resource boom, the economy moves from its initial steady state at point A and jumps to the new trajectory at point C and move towards its new steady state at point B.

From figure 1, the $\acute{K}=0$, N=0 represents the locus of points that are stationary for capital stock when there is no windfall revenue. The line is concave in nature due to the assumptions we had earlier made about the production function. For a specific level of capital, $\dot{C}=0$ if F_k (K, L, G, N) =ρ. If this level of capital stock is called K1, then $\dot{C}>0$ when F_k(K,L,G,N) >ρ at which the level of capital $K_2 < K_1$, where K_2 is the level of capital that persists when $F_k(K,L,G,N) > \rho$. Alternatively, for a specific level of consumption, =0 when C = F (K,L,G,N) + N. Here, the value of C is increasing until the point where F_k (K, L, G, N) = N after then it decreases. Whenever C exceeds the value that makes $\acute{K}$ =0, K will fall; whenever C is lower than this value, K will rise.

Without the leisure of a natural resource windfall, the economy is at a steady state level at point A, determined by the intersection of the $\acute{K}$= 0 and $\dot{C}$ = 0 lines. At this point the corresponding levels of consumption and Capital are C' and K' respectively. It becomes noteworthy that we are currently assuming that these levels of consumption and Capital are very low and domestic interest rates being higher than world interest rates signifying a developing economy. At its current point on the saddle path, it can easily gain from higher returns on possible investments and capital increments. Hence the Growth path of this economy is defined by the line ss and this will remain the economic growth trajectory. We are basing our analysis of economic growth based on the increment of consumption/savings, Investment as well as increasing capital stock. Following the Neoclassical theory, emphasis for growth had been placed on capital accumulation and savings (Caselli and Ventura, 2000). Even though promoting the accumulation of capital my not serve as an optimal solution for long run purposes due to diminishing returns setting in and choking off growth, in the short run, it will serve as the much needed boost that a capital scarce economy may need in order to harness potential high return investments and economic growth.

In order to keep $\acute{K}$ = 0 line constant, when there is a natural resource boom, there will have to be a corresponding proportional change in the level of consumption. That is, for $\acute{K}$ = 0, then C= Fk (K, L, G, N) + N. Thus for an increase in N, C must also increase to keep $\acute{K}$ =0. Also from the model, we are assuming that the revenue from the natural resource boom will have some positive effects on the production process. Our idea is that, these resource revenues can serve as a boost to the domestic productive process especially in both traded and non-traded sectors of the economy given a high rate of return on investment (due to capital scarcity, high interest rate characterised by developing economies). Therefore, it follows that, with the occurrence of a surprising natural resource boom in the short run, the revenue from the resource can be used to increase current consumption and capital stock and investment given their already low level. It is the presence of profitable investments (we refer to investments in public goods e.g. education, health, infrastructure and institutions that induce good government and economic management) that ultimately puts the economy on a higher level of consumption, income and higher economic growth. Point B represents the new steady state point of the economy after it has experienced a resource boom. The economy will jump from its old steady state (point A) to the new trajectory (at point C) and continue until it gets to the new steady state at point B, i.e. a jump from line ss to line s′s′. The economy will move from point A to point B with evidence of an increased level of consumption and Capital stock due to increased domestic investment via resource revenues which are optimal following the literature by van der Ploeg and Venables (2009).

Our bench mark has been able to show the implication of a natural resource boom on consumption and capital stock. According to van der Ploeg and Venables (2011), the revenue from the resource boom should induce the accumulation of these necessary factors of economic growth for countries that have experienced this windfall if they invest in the public sector. Having concurred with the postulate through our bench mark, we want to evaluate the impact of this policy when we introduce corruption into the model. Does dedicating resource revenue to public infrastructure in order to increase current consumption and capital still remain optimal? If it does not, then what is the possible alternative for an economy that has experienced a resource boom but plagued by corruption.

EFFECT OF CORRUPTION ON BENCH MARK

We introduce corruption into our bench mark analysis through the transmission channel of a natural resource boom. Considering that natural resource boom breeds corruption (Isham, et al., 2005), we postulate that the effect of this form of corruption is reflected as misappropriation of resource revenue. Instead of using these windfall revenues for capital accumulation and investment, rent seeking individual covert it for private and unproductive endeavors. This implies that corruption inherently reduces the amount of resource revenue that can be used to encourage growth. Given N as the resource revenue without the influence of corruption and Ň is resource revenue with corruption, N>Ň and N – Ň = Φ which represents the amount of resource revenue misappropriated due to corruption. As corruption increases the value of Φ also increases in value and this reduces the resource revenue available for economic decision and growth.

If we further assume that a fraction of the available resource revenue in the presence of corruption, Ň is used for productive purposes i.e. ωŇ where 0 < ω < 1 and the other fraction (1 – ω) Ň is used to facilitate other government decision processes. Our initial Ḱ dynamics becomes;

$$\acute{K} = F(K, L, G, \omega\check{N} - C - G + (1-\omega)\check{N} \quad \ldots\ldots\ldots\ldots\ldots (11)$$

The social planner will thus be faced with the problem of maximizing;

$$U \equiv \int_0^\infty \frac{C^{1-\left(\frac{1}{\sigma}\right)} + \mu G^{1-\left(\frac{1}{\sigma}\right)}}{1-\left(\frac{1}{\sigma}\right)} \exp(-\rho t)\, dt$$

The Hamiltonian for this social planner's problem with the introduction of corruption becomes;

$$H(C,G,K,(1\text{-}\omega)\ \check{N}) \equiv \int_0^\infty \frac{C^{1-\left(\frac{1}{\sigma}\right)}+\mu G^{1-\left(\frac{1}{\sigma}\right)}}{1-\left(\frac{1}{\sigma}\right)} \exp(-\rho t)dt + q_t[\ F(K,L,G,\omega\check{N})\text{–}C\text{-}G\ \text{–}(1-\omega)\ \check{N}] \ ...(12)$$

Solving this Hamiltonian function following the same efficiency conditions as our bench mark, we arrive at the following results;

$$H_C: C^{-(1/\sigma)} - q = 0$$

$$H_G: \mu G^{-(1/\sigma)} - q = 0$$

$$H_K: q_t F_K\ (K, L, G, \omega\check{N}) = -\ (dq/dt)$$

The transversality condition that prevails is $\text{Lim}_{t\to\infty}\ (e^{\rho t})\ q_t K_t = 0$ and the rate of change in capital stock can be written as

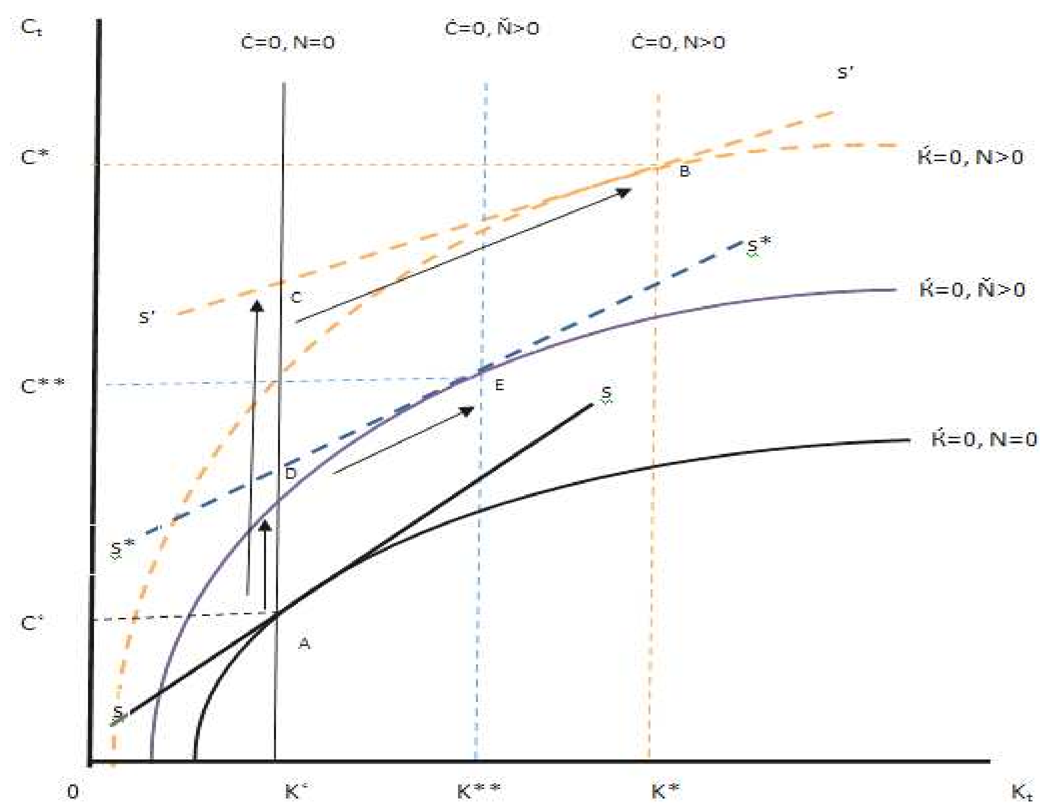
$$\acute{K} = A\ (F(K,L,G,\ \omega\check{N}) - C(1 + \mu^{\sigma}) + (1\text{-}\omega)\ \check{N} \ \text{.........}(13)$$

The dynamics of consumption can be derived by following the normal Ramsey model where

$$\dot{C} = U_C/U_{CC}\ [(F_k\ (K,\ L,\ G,\ \omega N) - \rho] \quad \text{..................}\ (14)$$

As explained earlier the dynamics of both Consumption and capital stock still remains the same. We use the phase diagram below to explain their co movements. We compare the movement of the economy in the graph below for both our bench mark model and the economy with the persistence of corruption.

Figure 2: Consumption and Capital Dynamics with the Effect of Corruption



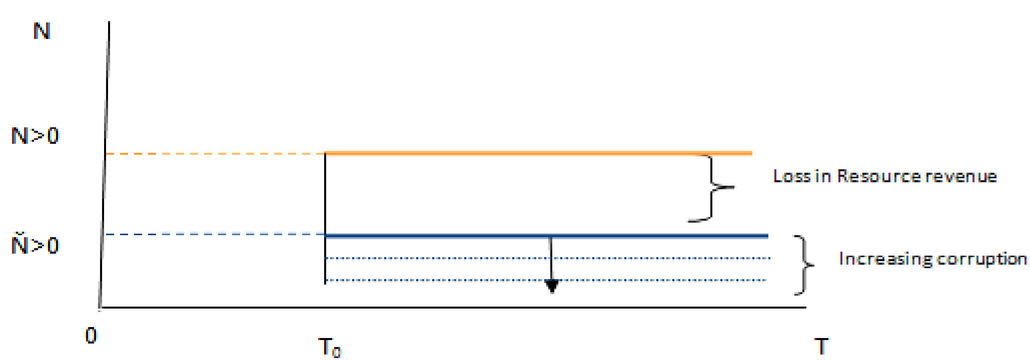
At its initial steady state (point A), the economy moves to a higher trajectory (point C) with the occurrence of resource boom and will end up at a higher steady state. With corruption, the initial jump in consumption, will not be as high as without corruption (Point C > point D) and ultimately a lower steady state, which may be temporal if corruption increases.

Starting from an initial steady state without the natural resource boom at point A, the prevailing level of consumption and capital stock in the economy is C'and K' respectively. The economy will continue to remain at line ss saddle path. With the emergence of a resource boom and the government's decision to use its increasing source of revenue to further invest on current consumption and capital (following the postulate of van der Ploeg and Venables (2009), there will be an expansion of both capital stock (from K' to K* where K*> K') and the level of consumption (from C' to C*, where C*> C'). This represents our bench mark via the saddle path line S̓S̓. As the Natural resource revenue continues to flow in, the level of corrupt practices begin to rise. The assumption here is that in our hypothetical economy, there are dysfunctional government institutions, prevalence of low capital, low incomes and macroeconomic instability, which encourages corrupt practices especially with a resource boom. The effect of which reduces revenue amount that can be potentially spent on accumulation of capital and Production.

The negative effect of corruption thus makes the Ḱ = 0 line to increase, but not as much as it would have if there were no corrupt practices. The locus of points Ḱ =0, Ň>0 is the new production function where only a fraction of the available resource revenue ωŇ will have a positive effect of increasing the production process. As long as Ň>0 and remains that way, there will always be an increase in the consumption level (from C'to C**, where C*>C**> C') and capital stock (from K' to K** where K*> K** > K'). However, this still remains sub optimal given the potential loss in both current consumption (C* - C**) and current capital stock (K* - K**). It becomes obvious that corruption erodes part of the growth potential of the economy. We present graphically the change in Natural resource revenue (A), consumption levels (B) and capital stock (C) below.

Figure 3: Changes in Consumption, Capital and Natural Resource with Corruption

(A)



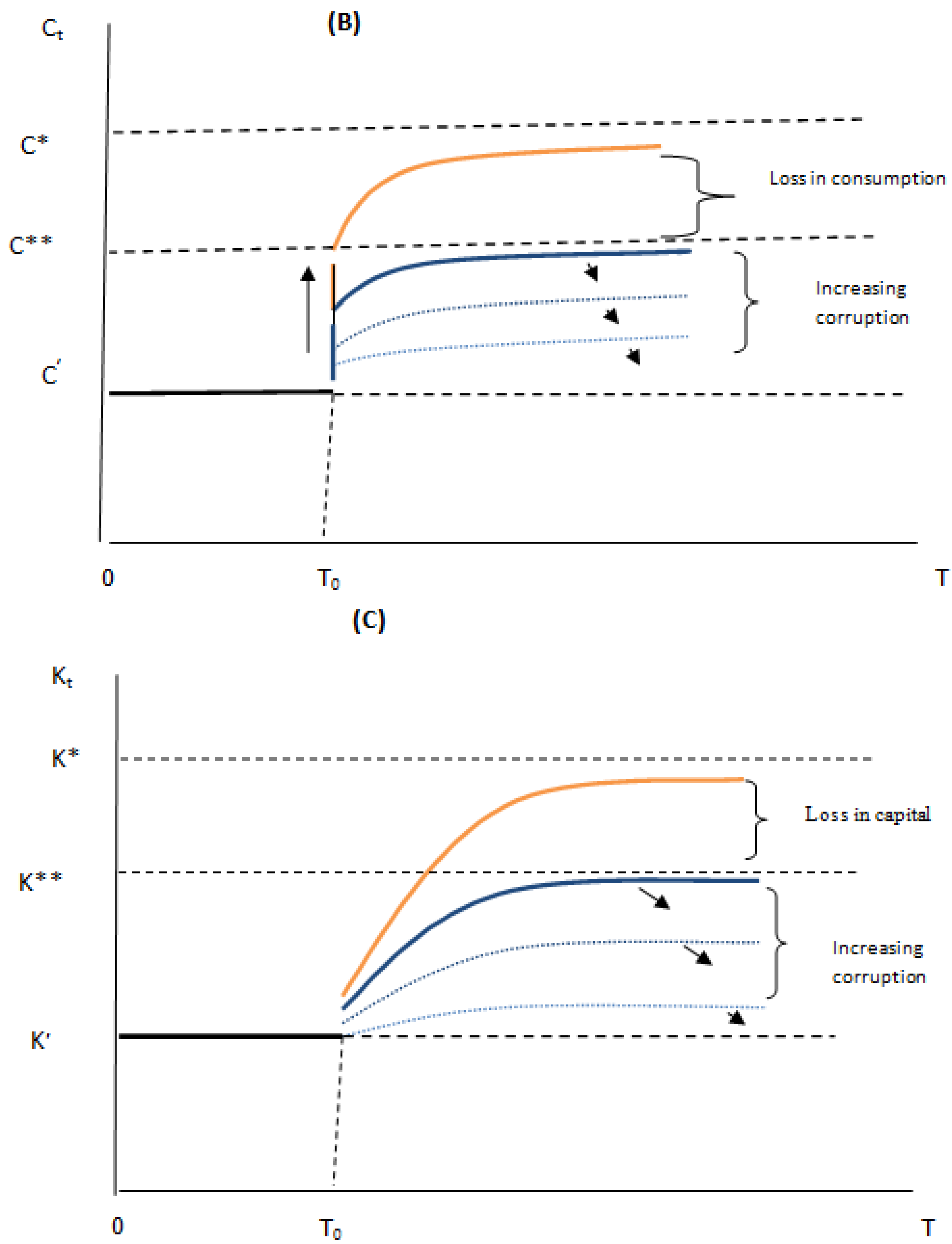


Figure (A) shows the occurrence of a resource boom and potential loss in resource revenue from corruption.
Figure (B) shows the changes in consumption and the potential loss with increasing corruption.
Figure(C) shows changes in capital stock and also the potential loss with increasing corruption.
Source: Author

From the diagram above, a natural resource windfall is experienced at time T_0. From our capital stock and consumption dynamics, this has the implication of increasing consumption (consumption jumps from C' to C*) and capital (capital gradually increases with time from K' to K*) to capture current economic growth potentials as postulated by Vander ploeg (2011).

However, with the increasing source of revenue to the government and the existence of economic problems like low capital, low income and dysfunctional institutions , the increase in consumption level (a jump in consumption from C to C**) and Capital (a gradual Increase in capital from K to K**)will not be as much as it will have been without corruption. The loss in both consumption and Capital stock is further worsened if the resource boom is not temporal.

This has the potential of eroding any meaning full form of increased consumption and capital stock. This can be seen in graphs A, B and C. As the resource revenues increase over time, the level of corruption also increases which in turn reduces resource revenues available for productive endeavors (downward shift in the Blue line in Graph A), reduction in consumption levels (a downward shifts in blue line in graph B) and loss of capital stock (a downward shift in blue line in graph C) due to depreciation, lack of maintenance culture, non-accountability, non-existing innovation and research etc. The level of corruption can be so high that it stymies increases in consumption and capital stock, thereby returning the economy back to its former steady state without the existence of a resource boom. Therefore applying the idea of Van der Ploeg (2011), however optimal, can still encourage the emergence of a resource curse in countries that have poor institutions which breed corruption.

RESOURCE EXCHANGE IN THE MODEL

The Problem of using revenue from a resource boom to increase the current level of consumption and capital stock for an economy that needs to develop is founded on a relationship between resource revenue booms and corruption. Even though we still maintain that our benchmark remains optimal, the presence of corruption falters the process. Hence the need for a responsible government to apply the idea of van der Ploeg and Venables (2011) in such a way that the desired result of increasing consumption and capital can still be achieved with the aid of a resource boom and the presence of increasing corrupt practices.

The idea of a resource exchange may be a possible solution. As earlier stated, the proposed theory is to shelve the sales of the resource (not in totality) and rather enter into some form of international transfer between the country experiencing the boom and countries willing to buy the resource. In this form of international trade, the country experiencing the resource boom will only exchange its resource for needed capital stock and investments. This model presents the following advantages;

- It reduces the amount of resource revenues available for misappropriation and corrupt practices
- It guarantees consumption, capital and investment increases in the short run
- Reduces dependency on one product

Assumptions

- This is an open economy that has experienced a resource boom over a period of time but has not yet experienced significant economic growth
- Low consumption and capital stock levels
- There is a possibility of citizens having assets
- We are also place restrictions on the kind of capital goods that are exchanged. We emphasise that these goods cannot be resold and will only be used for what they were originally intended for.
- We assume that it is possible to exchange the resource for capital in a 1 for 1 manner where the terms of trade between each country is negotiated and agreed upon
- We assume a low transaction cost associated with the trade.
- We still hold our restriction on natural resource depletion.

The social planner's problem will thus be to maximize;

$$U \equiv \int_0^\infty \frac{C^{1-\left(\frac{1}{\sigma}\right)}+\mu G^{1-\left(\frac{1}{\sigma}\right)}}{1-\left(\frac{1}{\sigma}\right)} e^{(-\rho t)})\, dt$$

Subject to: $\acute{K} = F(K_1, K2, L, G, \omega N2)-C-G+N_1+(1-\omega) N_2$ ………… (15).

K_1 represents the pre-existing level of capital stock before the resource boom (which we are assuming to be very low in our hypothetical economy) and K_2 represents the capital stock and foreign investment due to the exchange of a resource boom. The total available capital will thus be K_1+K_2. We assume that the country derives N as its returns from the resource boom which is made up of; N_2 being the revenue gotten from sales of the resource and N_1 gotten from the exchange of the resource for different types of economic overhead e.g. capital, manpower, education, technology etc. which cannot be resold or coveted by individuals. We also assume that corruption through misappropriation of resource revenues can only increase if N_2 increases, i.e. if the government remains dedicated to selling the resource for revenue. Thus optimally, in the short run the Government should commit itself to acquiring more of N_1 than N_2, limiting corruption but still increasing consumption and capital stock. Where $d F_{K2} (K_1,K_2,L,G,N) / d N_1 > 0$ if $N_1 > N_2$, if $N_2 \geq N_1$ and given that increases in corruption follow increases in N2, the net effect is the possibility of the production function not shifting of possibly shifting downwards in order to keep $\acute{K} = 0$

Using the Hamiltonian function;

$$H(K_2,C,G,N_1) \equiv \int_0^\infty \frac{C^{1-\left(\frac{1}{\sigma}\right)}+\mu G^{1-\left(\frac{1}{\sigma}\right)}}{1-\left(\frac{1}{\sigma}\right)} e^{(-\rho t)} + q_t[F(K_1,K_2,L,G,\omega N_1)- C-G+N_1+(1-\omega)N_2 ......(16)$$

We derive the consumption dynamics. We are skipping the efficiency conditions here because they are similar to our bench mark in derivations. The only difference is that for the optimal rule for capital, we will be optimizing for both forms of capital K_1 and K_2 in such a way that we will use the total sum of both forms of capital as a measure of capital in the economy.

$$\dot{C} = U_C/U_{CC}\,[F_{K2+K1}\,(K_1, K_2, L, G, \omega N_2) - \rho] \;\ldots\ldots\ldots\ldots\ldots\ldots\; (17)$$

With F_{K2+K1} = Total Marginal product of all the capital available for production. And the transversality condition that $\text{Lim}_{t\to\infty}\,(e^{\rho t})\, q\,(K_{2t} + K_{1t}) = 0$. Optimal decisions will be similar to our bench mark but the economies movement to its steady state will be determined by different optimal decisions. As the government enters into bargaining and exchange, it accumulates more of N_1 type of foreign investments and capital stock. This inevitable increases the amount of K_2 available for production. The amount of K_2 depends on the amount of N_2 that the government is willing to accept form exchange of the resource thereby limiting rapid changes in its actual revenues and discouraging corruption. In other to keep $\acute{K} = 0$, it follows that $C= F\,(K_1, K_2, L, G, \omega N_2)+ N_1+ (1-\omega)\, N_2$. If the governments stick to using its resource revenues to increase capital and consumption, as $N_2> 0$ over time, $(1-\omega)\, N_2$ increases and ωN_2 will have a positive impact on the production function. This is not a stable steady state because of the inevitable increases in corruption level which will erode current consumption over time. For $\dot{C}= 0$, $F_{K2+K1}\,(K_1, K_2, L, G, \omega N) = \rho$. With a policy of using resource revenues, changes in the marginal product of capital due to changes in ωN_2 cannot be sustainable also. This is because of the negative impact of corruption on resource revenues and the fact that capital is already low. Hence the total marginal product becomes smaller and smaller over time making $F_{K2+K1}\,(K_1, K_2, L, G, \omega N) < \rho$. To make $\dot{C}= 0$, there will be a reduction in capital stock bringing the economy back to a lower level of capital stock.

However, because there is no assumed relationship between N_1 and corruption and with restrictions placed on the type and use of K_2, increasing use of exchanging the resource for K_2 type capital stock will push the economy to the bench mark trajectory ss. There will be a jump in consumption from Point C' to point C* and also for capital stock from K' to K*. The government thus has the choice of policy whereby it can follow our alternative optimal solution (exchanging resource for capital goods) in the very short term, until it has increased current consumption and capital stock the necessary institutions have also evolved and the economy is on a higher growth path. Then in the mid-long term it can switch to our benchmark policy (using resource revenues), where it will be able to tackle the issue of corruption, economic growth and development due to better public and private institutions already evolved.

CONCLUSION

Managing resource booms and the resultant rapid changes in revenue has always been a challenge to policy makers and governments. The need to diversify the economy, maintain stability of prices and exchange rates as well as nurture the needed changes in public and private institutions are part of the problems of a resource boom, which if treated without caution, may lead to the popular natural resource curse. Even with contrasting evidence on the effect of a resource boom on economic growth, recent literature leans towards the idea of investing resource revenues for current generations in order to increase consumption and capital stock van der Ploeg and Venebles (2011).

We have been able to show that the resource exchange model can serve as a possible investment channel for developing countries, in particular, African countries that are resource rich. This model is far from conclusive in its postulate as well as its practicability. We did not include political problems and resource ownership conflicts that are associated with a resource boom. Also, we did not consider the effects of resource depletion and its associated cost in the model. We only looked at corruption from the point of resource revenue generation and expenditure, without taking into consideration other aspects from which corrupt practices occur. Despite our limitations, the resource exchange model still presents a viable opportunity for a responsible government to induce economic growth for its respectable economies. We conclude with a need to further study this idea and its general implications for a developing economy. Further research into this idea should focus on the practicability – the effects on terms of trade; implications on exchange rates, capital absorption, and political economic issues; and public sector practices – of the resource exchange model. For now, it remains a plausible opportunity for managing resource booms.

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