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Exhaustible Resources and Sustainable Growth: Evidence from Libya

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Abstract: Natural endowments and economic growth are often connected. However, this relationship is still controversial. Although natural resources are crucial for economic growth, there is a kind of puzzling aspect in their relationship. For the oil-based economies, the negative impact becomes clear. This paper explores how far extracting oil and using its revenues are affecting the economic growth in Libya as an example of a highly dependent economy on natural resources. Applying Charles Jones model for this purpose and utilising data for the period of (1962-2017). The paper explores the potential impacts of natural resources on changes in output controlled with population growth. This model explains the influences of both natural resources and population growth on economic growth. Findings confirmed the natural resource curse in the Libyan economy and showed that it experiences an unbalanced growth.

Furthermore, even if the growth rate is adjusted to the Balanced Growth Path BGP, it seems to decline over time as population growth is higher than natural resources can cope. Authority needs to use more proportions of oil (Higher depleting rate) if the previous standards of living to be maintained. This means that along with recent population growth, the resources available eventually depletes, would not be sufficient to prevent a foreseen problem.

1. INTRODUCTION

It is widely accepted that an abundance of natural resources strongly influences economic growth (Sachs and Warner 2001: Williams 2011: Arezki *et al.* 2012: Gylfason *et al.* 1999: Gerelmaa and Kotani 2016). This idea is still dominating the economic literature although it has been investigated and criticised in recent years. However, empirically, there is no consensus on this topic yet. (Havranek, *et al.* 2016) arrived at that 40% of empirical studies concluded a negative impact of natural resources on economic growth while 40% find no effect and only 20% supported the negative link. In this regard, Jones (1998) suggested a theoretical model in which he connected the economic growth of a country with its natural resources. He argued that presence of natural resources in production function such land and non-renewable resources like oil, iron ore, coal, and copper, reduces the long-run growth once these resources start depleting beyond a critical threshold. He explains that capital and labour run into diminishing returns due to depleting natural resources. Higher population growth adds more pressure to the finite resources; diminishing of returns cannot be avoided without high technological progress.

This paper examines whether this resources driven growth model is applicable to explain the process of growth in the Libyan economy. This model has been not applied to an oil-based economy like Libya, which is highly depending on extracted resources for investment in economic infrastructure and social development for a long time. The scarcity of alternative sources of saving makes Libya an appropriate case to the applicability of the resource-driven growth model.

2. LITERATURE ON NATURAL RESOURCE DRIVEN ECONOMIC GROWTH

Since Thomas Malthus penned his ideas about the scarcity of resources in the late of the eighteenth century (Malthus 1798), natural resources have been considered the centre of many theories and studies (Barbier 2007). The argument on non-renewable resources and its relation to the economic growth continues to appear and disappear in public debates, often supported by evidence in each case. Although natural resources were historically at the core in some economic prosperities of several countries, it also seems to work negatively in economically less diversified economies. Only industrial economies are immune to the natural resource curse so far (Larsen, 2005)[1]. Sachs and Warner (1995), (2001) claimed that the negative relationship between resources abundance and slow economic growth holds even controlled for other valid variables. They concluded that almost resource-abundant countries-particularly mineral-intensive ones- have experienced stagnation in economic growth. Furthermore, it is suggested that oil-rich economies cannot escape the negative influence of high oil prices (Abeysinghe, 2001). Empirically, Cox & Harvie (2010) illustrated how boomed resource prices of commodities, particularly oil, have had positive and negative macroeconomic implications. They notably demonstrated adverse effects on the non-resource sector and slowed down the growth in the labour-intensive ones. Ali & Harvie (2013) stated that Dutch Disease consequences are likely to be confined to the non-oil sector, especially when the recovery in the oil sector happened rapidly in Libya. Satti and others (2014), Usui (1996) confirmed the natural resource curse for Venezuela and Indonesia, respectively.

On the other hand, some researchers have different ideas. Al Mamun *et al.*, (2017) demonstrated that oil rents have a positive and significant influence on growth only in the short-run. This puts more pressure on oil-rich countries to aim at building sustainable capacity that would extend the benefits of oil rents from short runs to more extended periods. Plenty of studies revealed that the relationship would not be entirely negative, but mixed ones (Meadows *et al.* 1972), (Ehrlich 1970) and (Jackson & Webster, 2017). Stijns (2005), Cox & Harvie (2010) also argued that evidence suggests that natural resources may affect the economic growth in either a positive or negative way, especially for mineral and fuel reserves.

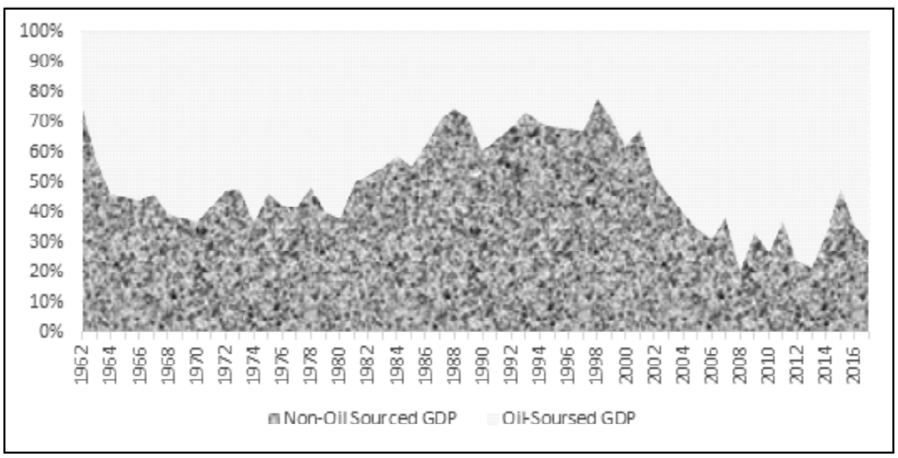
Taking into account early efforts dealt with optimal depletion of exhaustible resources. Dasgupta and Heal (1974) admitted that economists have rarely laid enough emphasis on this topic. Arguments on this issue can be categorised into two ideas: while pessimist economists follow Malthusian prospect that stocks of resources are finite or at least grow at an insufficient rate, therefore, it is unwise to be exploited sooner. Others believe that a human being has the ability to invent a new solution (Mihaela 2011). In regards to oil as a particular type of natural resource, there is evidence of the positive relationship with economic growth conditioned on threshold effect (Mehrara *et al.* 2011). However, the natural resource curse is still widely accepted for the oil-based economies after crossing that threshold.

3. THE ROLE OF NATURAL RESOURCES IN THE LIBYAN ECONOMY

Traditionally, the Libyan economy is highly dependent on oil (Akli & Kim, 2014). It is often described as "rentier states" along with most of the MENA countries (Ross 2001). The share of resource rent in GDP is the highest in the world while the share of value-added of manufacturing (Bjorvatn and Farzanegan 2015). It taps more than 90% of total government revenues from oil, and 95% of earned income in Libya is based on oil (Ahmouda, 2014, Bhattacharyya and Blake 2010). Despite that remarkable progress has been made in developing social infrastructure. Government, not the private sectors, dominates these activities in the Libyan economy. The government has started excess burden in developing essential services continuously as the private sector still out of its eyes in any of these sectors (Otman and Karlberg 2007). As shown in figure (1) since oil started to flow, it guided the trend of both non-oil and aggregate GDP. The ratio of oil-based GDP has risen quickly suddenly after oil discovering from zero in the early 1960s to 70% in a few years. This ratio kept at almost higher than 50% except for the period of the mid-eighties when prices fall. Meanwhile, the non-resource sector contribution declined from 47% in 1962 to around 27% after just three years.

Over two decades of declining in the resource sector (1981-2000), there was an expansion in the public and government-owned sector, which in turn depended on oil revenues (Masoud 2014). The public sector widened and played a pivotal role benefited mainly from oil revenues (Ruhaet 2013; Solarin and Ozturk 2016). More recently, World Bank has stated that the growth in MENA has been lowered to 0.6% in 2019, this downward from 1.5% is mainly attributed to a voluntary cut to oil production downward (World Bank 2019).

Figure 1: GDP by sectors in percentages in Libya from 1962-2017



Source: Author work. - Resource sector includes primary sectors such as oil extracting and mining. The non-resource sector includes agriculture, industries, transportation, electricity, trade, retails and constructions. - Public services sector includes government-funded services such as education, health, security, and defence

Fluctuations in the oil sector were entirely reflected in GDP, demonstrating how insignificant is the non-oil GDP. Correlation between aggregate GDP and Oil-sourced GDP is about [0.98]. In more details; non-oil GDP is also highly depended on oil and was correlated to oil GDP at [0.89], which presents the dilemma of the Libyan economy.

Meanwhile, the Libyan proven reserves[2] were estimated at 48.36 Bill/Bars in 2014. This is equivalent to 4% of the whole OPEC reserves, which likely promotes the effects and continuity of dependency on natural resources for the coming years as seen in the table below.

Table 1: Libyan Proven Reserves of Gas and Oil

Details	*Oil Bill/Bars*	*Gas Trillion /Mtr sq*
Reserves	48.36	1504.9
Expected life span	76	50

Source: OPEC bulletin, *http://www.opec.org/opec_web/en/data_graphs/330.htm*

4. METHODOLOGY

4.1. Micro Foundation

Following growth with natural resources model suggested by Jones (1998), we aim to explain the Balanced Growth Path [BGP] for the Libyan economy. For this purpose, Cobb-Douglas a simple production function with natural resources will be applied to capture the basic process of economic growth, then obtained parameters will be employed to calculate the growth path.

$$Y = AK^{\alpha}R^{\gamma}L^{1-\alpha-\gamma} \qquad (1)$$

where K, R and L are capital accumulation, natural resources and labour as inputs factors respectively, and $0 < \alpha + \gamma < 1$

As in the standard Solow model, the capital accumulated as:

$$K = sY - \delta K \qquad (2)$$

Where sY is the saving rate and δ is the depreciation rate in the economy. Labour supply grows at the same rate as the population:

$$\frac{\dot{L}}{L} = n \qquad (3)$$

Variable with a dot is the differential concerning time as in economic parlance, while technological progress is given at:

$$\frac{\dot{A}}{A} = g_A \qquad (4)$$

Suppose the non-renewable resource is N. Therefore, there is an initial quantity of it equal to N_0. Every period the economic activity uses the amount R subtracted from the total stock of natural resources N; therefore, the latter is depleted by R.

Then natural resources depleting can be written as follows:

$$\dot{N} = -R \tag{5}$$

By dividing both sides of this equation by *N*, we arrived at the rate of declining in the stock of certain resources over time:

$$\frac{\dot{N}}{N} = -d_R \tag{6}$$

Where the term d_R denotes the depleting rate of resources *R*.

By integration of this equation, we can obtain the behaviour of depleting over time. Since its growth rate is negative, it is the reverse of the behaviour of capital accumulation.

$$N_t = N_0 e^{-d_R t} \tag{7}$$

The growth rate of exhaustible resources must be negative, and the path of depleting will be on a downward slope. The quantity used of resources is given by:

$$R = d_R N_0 e^{-d_R t} \tag{8}$$

Although the stock of remaining resources is decreasing over time, the amount used would be constant over the period when the stock is higher than the required usable fraction of it as follow:

$$N_t > R(d_R N_0 e^{-d_R t}) \tag{9}$$

Otherwise, the quantity used definitely will decline, resulting in declining in aggregate output through equation (1).

Now, what would be the growth path with depleting resources? One can imagine that equation (9) is more compatible with the real situation of most oil-based economies because of two reasons: firstly, most of the resource-rich countries are in need for revenues to fund both consumption and investment. Secondly, there is a common belief that reduction in the extraction of ore material such as iron ore, copper, oil, and gold may lengthen the lifetime of these resources, This might lead to a decrease in prices particularly if any alternatives would have been discovered.

From Eq. (1), (2), (3), (4) and (8) together we can form the balanced growth path for Libyan economy by using the capital-output ratio instead of capital stock by dividing both sides of Eq. (1) by Y^{α} then solve for *Y* as follows:

$$Y = A^{\frac{1}{1-\alpha}} \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} R^{\frac{\gamma}{1-\alpha}} L^{1-\frac{\gamma}{1-\alpha}} \tag{10}$$

Substituting the used fraction of non-renewable resources in Eq. (10) gives:

$$Y = A^{\frac{1}{1-\alpha}} \left(\frac{K}{Y}\right)^{\frac{\alpha}{1-\alpha}} (d_R N_0 e^{-d_R t})^{\frac{\gamma}{1-\alpha}} L^{1-\frac{\gamma}{1-\alpha}} \quad (11)$$

Now, taking logs of Eq. (11) and differentiating it to capture the growth in output due to changes in the depleting rate of resources, and with the assumption of constant capital-output ratio we obtain:

$$\Delta_{YBalanced} = \frac{g_A}{1-\alpha} - \frac{\gamma}{1-\alpha} d_R + \left(1 - \frac{\gamma}{1-\alpha}\right) n \quad (12)$$

Where $\Delta_{YBalanced}$ denotes the balanced growth rate BGR in output. This is what Jones terms the Balanced Growth Path [BGP], and is the growth rate at which the economy grows while keeping its natural resources at least at the same quantity[3]. It can be noticed here that balanced growth depends positively on technological progress, the growth in labour supply (population) and negatively on the proportion extracted from non-renewable resources. In the same time, the output elasticity with respect to capital α affects the growth might be positive or negative depends on the magnitude of the three terms where it is placed. From the last term of the equation, one can note that the effect of n on growth depends on the magnitude of both γ and α. Once α and/or γ become higher, the population effect will be higher and vice-versa. This means that the higher the output elasticity with respect to capital and the higher output elasticity with respect to natural resources, both could offset the negative impact of population growth.

Since population growth cannot be controlled completely, it is the depletion rate, which will be the target for adjusting economic growth. At first glance, one can suggest keeping the depletion rate at zero to reduce the negative effect of the RHS term in Equation 12. This is mathematically true, but this action would reduce the essential factor of the economy's growth (revenues needed for both investment and consumption). Thus, since there is kind of a trade-off between depletion rate and growth rate, the authorities should find the optimal levels of both: This implies choosing the position between two extreme levels: highest growth rate with short life-span of non-renewable resources and the longest time of natural resources with lower rates of economic growth.

If we divide the equation (1) by L it will represent the output per worker, and following a similar process, the growth rate in output per worker will be:

$$g_Y = g_A - \gamma(d_R + n) \quad (13)$$

From Eq. (13), high population growth also leads to lower growth in output per worker by reducing labour productivity and lowering the per worker capital.

From equation (12), we can expect the partial effect of exhaustible resources on long-run growth as follows:

$$\frac{\partial y}{\partial d_R} = -\frac{\gamma}{1-\alpha} \tag{14}$$

Growth in output is affected negatively by two parameters, depleting rate of natural resources and capital share in output (elasticity of output to capital). The RHS of equation (14) is negative. Therefore, the negative influence of depleting rate of natural resources appears.

First order condition of equation (12) gives the optimal depleting rate:

$$-\frac{\gamma}{1-\alpha} = 0 \tag{15}$$

As stated by Jones; zero rates of depleting might be the optimal policy for sustained growth; this is mathematically true. However, this implicates an error, because using any amount of resources is crucial for economic growth, and if depleting rate is set equal to zero or near to, it would harm the short-run growth. There is a kind of trade-off between recent and future usage of resources. Therefore, the authority should look for an optimal level of the depleting rate. Optimal rate must raise the growth rate as high as possible and maintains the stock of resources as long as possible in the meantime.

Finally, it is worthy of mentioning that this model is based on the extracted amount of natural resources (depleting rate) as energy for economic activities. While for oil-based economies, the extracted quantity of oil and gas is not only for energy; instead, it is the main source to fund both consumption and investment. Therefore its impacts will be broader.

4.2. Data Description and pre-estimation Tests:

2.1. Variables Definitions and Data Sources

To estimate the output parameters; two proxies will represent the dependent variable output: real GDP, and GDP per worker measured in real values of Libyan currency. These proxies are usually employed along with per capita output in such studies, especially in developing countries (Asongu and Ssozi 2016; Mankiw, Romer *et al.* 1992). In addition, the real non-oil output per-worker will be also employed to avoid endogeneity on one hand and to investigate the impact of oil on the non-oil output. Aggregate real GDP is usually employed in such issues; however; the non-oil GDP will be used as well to avoid endogeneity.

Capital will be represented by two proxies; annual capital stock and per-worker capital stock in both aggregate and non-oil sector.

For labour, the annual number of labour forces is considered as a proxy due to three reasons. First: no data available on working hours as a proxy for this variable. Second: wages have been fixed during the oil prices fall (1986-2000); therefore, remuneration is not expected to mirror the changes in employment and its relationship to output. Third: because the government-owned sector employs 80%17 of the labour force, and salaries in the public sector are not related to productivity, instead they reflect the regulations and socio-political policies of the authority.

Finally, for the natural resource, two proxies are widely used (Mehrara, Sadr *et al*. 2011), oil revenues and quantities of oil extracted periodically. The second proxy is to represent the main idea of the model (extracted quantity of resources every period). In this context, the ratio of primary exports to GDP is the conventional standard proxy of natural resource used by Sachs & Warner (1995, 2001) and Collier & Hoeffler (2005) has been criticised because it captures the resource dependence of the economy rather than abundance (Brunnschweiler and E.H. Bulte 2008). They distinguished between resource dependence and resource abundance, and they challenged the notion of the resource curse and variables that could demonstrate this topic (Mavrotas *et al.* 2011). In this paper, the annual extracted quantities of oil will be used.

Data are extracted from the annual publishing of the Central Bank of Libya and the Ministry of planning. All variables are in 2010 prices.

Tables (2) below shows the employed variables and their definitions, respectively. For regression purposes, the equation (1) will be estimated twice: with and without imposing condition of the sum of parameters equal to one, in this case, all variables will be divided by [L] as follows:

$$\ln\frac{Y_t}{L_t} = \ln A + \alpha \ln\left(\frac{K_t}{L_t}\right) + \gamma \ln\left(\frac{R_t}{L_t}\right) + e_t \qquad (16)$$

Then it will be re-estimated without condition. All variables are in logs.

Table 2: Variables Definition

Variable Name	*Variable Symbol*	*Definition*
Out put	*Ln(GDP)Ln(NGDP)*	Aggregate outputNon-oil output
		Per-worker aggregate output
		Per-worker non-oil output
	Ln(CapStk)	Capital stock
Capital	*Ln(NCapStk)*	Capital Stock in the non-oil sector
	ln (CapStk/LbFr)	Per-worker capital stock
	ln (NCapStk/NLbFr)	Per-worker capital stock in the non-oil-sector
		Number of workers in each year
Labour	*Ln(NLabFr)*	Number of workers in the non-oil sector
	Ln(OilPrd)	Annual extracted quantities of oil
Natural Resources	*Ln (YOilPrd/LbFr)*	Per-worker quantities of oil produced annually
	Ln(YOilPrd/NLabFr)	Annual quantities of oil produced/non-oil workers

2.2. Pre-estimation Tests

Pre-estimation tests for stationarity have been conducted. Results are shown below.

Table 3: Unit root test for used variables

Test / *Variable*	*ADF**		*PP**	
	I (0)	*I (1)*	*I (0)*	*I (1)*
Ln(GDP)	-2.52	-7.04***	-2.53	-7.08***
Ln(NGDP)	-2.09	-1.17	-2.14	-7.22***
Ln (GDP/LbFr)	-1.98	-7.14***	-2.28	-7.15***
Ln (NGDP/NLbFr)	-1.56	-1.49	-0.93	-7.44***
Ln(LabFr)	-2.20	-3.91***	-1.86	-2.74*
Ln(NLabFr)	-1.95	-3.62***	-1.96	-3.63***
Ln(CapStk)	-2.57	-3.01**	-2.18	-3.01**
Ln(NCapStk)	-2.62*	-2.85*	-1.72	-4.14***
ln(CapStk/LbFr)	-2.54	-4.46***	-2.68	-4.44***
ln (NCapStk/NLbFr)	-2.92**	-4.95***	-1.61	-5.06***
Ln(YOilPrd)	-4.03***	-7.92***	-4.13***	-8.01***
ln (YOilPrd/LbFr)	-0.63	-7.65***	-1.20	-7.71***
ln (YOilPrd/NLbFr)	-0.62	-7.67***	-1.18	-7.74***

All variables under consideration are stationary at the first difference; in this case, the Fully Modified Ordinary Least Squares (FMOLS) method is applicable if the co-integration relationship between variables exists. FM-OLS technique, in particular, has two advantages: (i) it corrects for endogeneity by adding the leads and lags as this issue results from the existence of a co-integrating relationship and common for output in oil-based economies, (ii) it modifies the least squares to account for serial correlation problem, (iii) it eliminates samples bias asymptotically and take care of small sample bias (Acikgoz & Mert, 2014). The estimators, in this case, will be reliable (Atia, 2004). For this purpose, the co-integration test is conducted for the relationships of interest; results are demonstrated below.

Since the Null hypothesis of this test is: Series are not co-integrated, the null hypothesis can be rejected, and the test confirms the existence of co-integration between all series under consideration.

Table 4: Engel-Granger co-integration test

Dependent Variable	*Independent Variables*			*Tau-statistic*		*z-statistic*	
				Stat	*Prob.*	*Stat*	*Prob.*
Ln(GDP)	*Ln(LabFr)*	*Ln(CapStk)*	*Ln(YOilPrd)*	-2.389	0.732	-10.775	0.007
Ln(NGDP)	*Ln(NLabFr)*	*Ln(NCapStk)*	*Ln(YOilPrd)*	-2.30.	0.769	-11.425	0.006
Ln (GDP/LbFr)	*Ln (CapStk/LbFr)*	*Ln (YOilPrd/LbFr)*		-5.42	0.001	-41.36	0.000
Ln (NGDP/NLbFr)	*Ln (NCapStk/NLbFr)*	*Ln (YOilPrd/NLbFr)*		-4.72	0.008	-29.25	0.001

* *Mackinnon (1996) p-values, null hypothesis: series are not co-integrated, automatic lags*
Specification based on Schwarz criterion (max lag=10).

Results of the ADF test also show that residuals of all estimated series are stationary at level, confirming the co-integrating between variables included in each relation.

Table 5: Residual unit root test for estimated relationships

Dependent Variable	*Independent Variables*			*t-Stat*	*Critical*	*Prob**
Ln(GDP)	*Ln(LabFr)*	*Ln(CapStk)*	*Ln(YOilPrd)*	**2.61**	**2.61**	**0.020**
Ln(NGDP)	*Ln(NLabFr)*	*Ln(NCapStk)*	*Ln(YOilPrd)*	**2.61**	**2.60**	**0.009**
Ln (GDP/LbFr)	*Ln (CapStk/LbFr)*	*Ln (YOilPrd/LbFr)*		**-2.19**	**-2.61**	**0.029**
Ln (NGDP/NLbFr)	*Ln (NCapStk/NLbFr)*	*Ln (YOilPrd/NLbFr)*		**-4.94**	**-3.49**	**0.0001**

**MacKinnon (1996) one-sided p-values.*

5. RESULTS

The analysis is carried out in two steps: aggregate output against input variables and then, Non-oil output against input variables. Both with and without imposing $\propto + \beta + \gamma = 1$ condition.

5.1. Aggregate output function:

The output function is estimated applying FMOLS and DOLS techniques to avoid potential serial correlation.

As seen in the table, the conditioned relationship gives almost the same parameters under both FMOLS and DOLS. The two methods gave slightly the same parameters in terms of magnitude and significance. However, the elasticity of output with respect to capital estimated using DOLS is quite higher, and overall fit of estimations are statistically good according to *R*-squared. Both estimations indicate the increasing returns to scale and the importance of capital in the output over natural resources.

This is expected because the stock of capital is crucial for the oil-sourced output while the quantities of oil produced are often pre-determined by the OPEC quotas,

Table 6: Estimated aggregate output function 1962-2017

Dependent Variable	*Conditioned*		*Unconditioned*
	$\ln\left(\frac{GDP}{LbFr}\right)$	$\ln\left(\frac{GDP}{LbFr}\right)$	*Ln(GDP)*
Constant	-0.32 (-0.12)	-1.00 (-0.33)	-20.89*** (-3.63)
Ln(LabFr)			1.02*** (6.45)
ln(CapStk/LbFr) *Ln(CapStk)*	0.78*** (3.49)	0.86*** (3.41)	0.71*** (3.07)
Ln(YOilPrd/LbFr) *Ln(YOilPrd)*	0.30*** (2.88)	0.27*** (2.62)	0.43** (1.93)
Adj R-sq	0.38	0.69	0.74
J-B	1.82	0.359	2.35
Normality Prob.	0.40	0.84	031
N	55	53	55
Regression Method	FMOLS	DOLS	FMOLS

which gave the resource input less role in the output. When the unconditioned formula is estimated, the overall fit did not change. Parameters of capital and resources both have lowered, which is expected when adding a new explanatory variable. The elasticity of output with respect to resources is not significant; however, it becomes higher. Labour shows high parameter relatively. This is also predicted for the economy with a lack of labour input. Finally, constant-returns-to-scale CRS is assumed following (Hicks 1989).

However, the sum of elasticities in all estimations is quite higher than unity even with the conditioned formula. This may be explained by the effect of oil-rich economies where the increased returns are not caused by productivity rather due to the effect of natural resources. When the CRS condition is ignored, the sum of elasticities rose to more than 2. This is mainly because of labour which measured (1.02). In the oil-rich economies, the role of labour crucial; however, the link between wages and marginal productivity is not working properly. Therefore, this result can be explained in the context of distribution rather than productivity.

B. Non-oil output

The aggregate output is replaced by the non-oil output to investigate the impact of natural resources on the growth in the non-oil output, and a similar process is followed. Results are demonstrated in the table (7). As seen, with the conditioned formula, the magnitude of capital decreased in favour of resources. Significance of parameters enhanced slightly and the overall fit of the estimation as well. Independent variables explain 76% of variations in the non-oil output. The sum of parameters equals to one, which makes obtaining the elasticity of labour with respect to labour impossible. With unconditioned formula, the overall fit enhanced remarkably; however, the labour input becomes insignificant.

Moreover, the CRS assumption is satisfied as the sum of parameters is close to one. Even without the CRS condition. Parameter of labour is insignificant. The role of labour is lower in the non-oil sector than that in the aggregate.

As the aim of this study is to look for the impact of resources on the non-oil sector, model No. 2 in table 7 is the best estimation for the output function statistically. Accordingly, the parameter of resources (γ) will be 0.31, which will be employed in the next step.

Table 7: Estimated output function in the non-oil output 1962-2017

Dependent Variable	*Conditioned 1*	*Conditioned 2*	*Unconditioned*
	$\ln\left(\frac{NGDP}{NLbFr}\right)$	$\ln\left(\frac{NGDP}{NLbFr}\right)$	*Ln(NGDP)*
Constant	1.35	1.74	-10.8***
	(0.41)	(0.96)	(-3.08)
Ln(NLabFr)			0.28
			(1.32)
ln(NCapStk/NLbFr)	0.53***	0.68***	
	(4.29)	(3.96)	
Ln(NCapStk)			0.46***
			(3.74)
Ln(YOilPrd/NLbFr)	0.39***	0.31***	0.57***
Ln(YOilPrd)	(5.17)	(4.05)	(4.47)
R^2	0.60	0.76	0.85
Adj R-sq	0.59	0.72	0.84
J-B	1.85	0.59	4.13
Normality Prob.	0.35	0.74	0.06
N	55	53	55
Regression Method	FMOLS	DOLS	FMOLS

*Note: T-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1. J-B is Jarque-Bera test*

6. DISCUSSION

6.1. Balanced Growth Path

Obtaining the parameters of input factors, allows us to calculate the balanced growth path BGP for the Libyan economy using estimated parameters and equation (12).

Figure (2) illustrates the calculated BGP. One can notice the strong influence of natural resources on the BGP in many years (i.e. first oil shock in 1974, second shock in1979, US embargo in 1981.

When BGP is plotted against actual growth, it shows that the actual growth pattern is not consistent with the balanced path, as seen in figure (3).

This result asserts the unbalanced growth for the Libyan economy over the studied period. In addition, it reveals no relationship between actual and balanced paths throughout the period.

Figure 2: BGP for Libyan economy 1962-2017

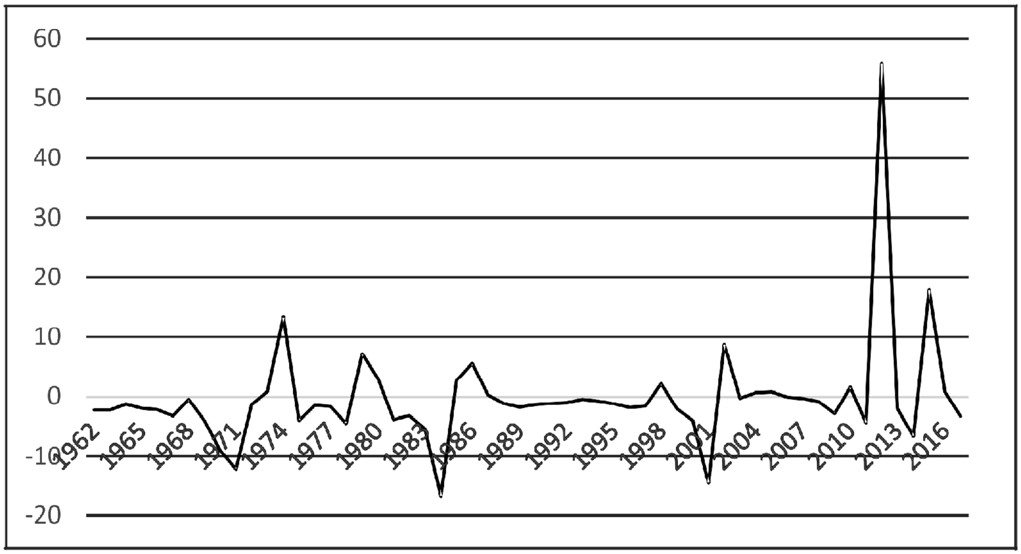
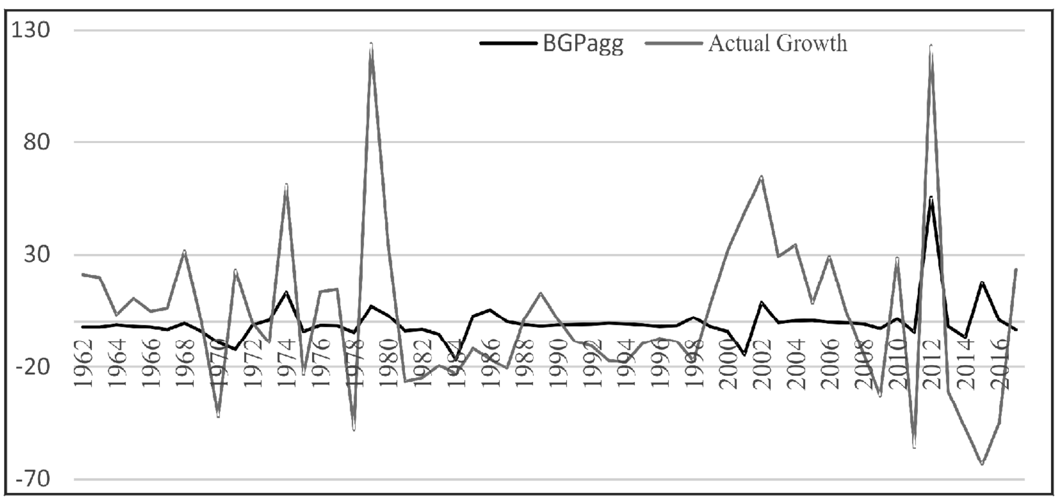


Figure 3: BGP and growth rate in GDP (1962-2017)



In other words, the Libyan economy grew at rates higher or lower than it supposed to be. In this regard, Zarmouh, (2010) pointed that Libyan economy was investing higher than the optimal rate during the oil boom in the seventies and less than optimal during the oil prices collapse period in the mid-eighties. It can be claimed that above-balanced growth during (1962-1980) was attributed to these investments and vis-versa in (1981-1998). Moreover, these rates have resulted in global shocks rather than endogenous process. Because growth is mainly attributed to the growth in the oil sector.

Balanced growth path can also be calculated differently according to the growth accounting equation as follow: $g_Y = g_A + \propto g_K + (1 - \propto) g_L$

Where g_Y is the output growth, g_A is TFP growth, $\propto g_K$ is the growth in capital stock and g_L is the labour (population) growth.

In the steady-state balanced growth, output and capital both grow at the same rate, say g, therefore:

$$g_Y = g_K = g$$

$$g = g_A + \propto_g + (1 - \propto)\, g_L \tag{17}$$

Solving for [g] we obtain BGP:

$$g = \frac{g_A}{(1 - \propto)} + g_L \tag{18}$$

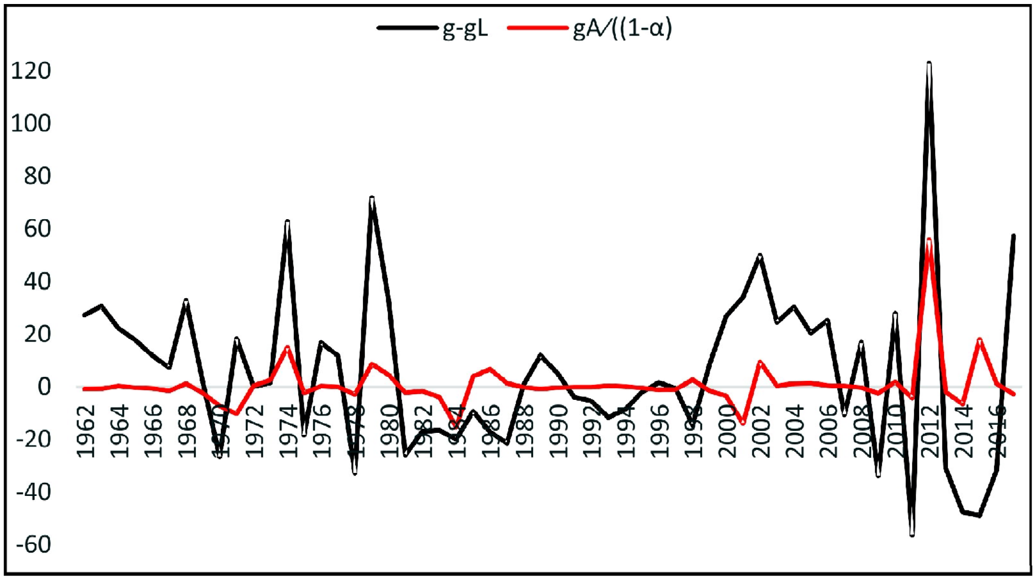
Or

$$g - g_L = \frac{g_A}{(1 - \propto)} \tag{19}$$

If $g_A = g_L = 0$ then g will equal to zero; therefore technological progress must grow at any positive level, and labour should grow at the same rate of technology otherwise, output per worker will go up or down resulting increasing or declining in output. Accordingly, we calculate both sides of equation (19) for the studied period.

Figure (4) shows that the left-hand side ($g - g_L$ i.e. growth in output minus population growth) is always higher than the right-hand side ($\frac{g_A}{(1 - \propto)}$ i.e. technological progress). This also, confirms the unbalanced growth depending on a higher rate of depleting than it should be. In the meantime, as Total Factor Productivity [TFP] is very low, while the population growth is quite higher. It shows that except for the period 1981-1999) the actual growth rates were far from the BGP. This result is similar to what has been obtained previously along with natural resource effect in figure (3).

Figure 4: BGP in the Libyan economy 1962-2017 (Growth accounting)



The plausible explanation of this pattern of growth is due to two reasons: Firstly: Oil share in GDP consists more than 50% and influences growth rate of GDP, In fact, oil revenues reflect nor the economic growth neither economic activities. Instead, they mirrored the global shocks of oil prices. Secondly: The low technological change TFP, which measures negative or almost zero for many years as well (Pipitone 2009; Fargani 2013: Bhattarai & Taloba 2017: API 2018).

6.2. Determinants of BGP

In general, steady-state or BGP depends on five factors (Bradford Delong 2005):

1. Saving rate in the respective economy S/Y.
2. Labour force growth rate, which is, in fact, the population growth (*n*).
3. Capital depreciation rate (δ).
4. Technological change or efficiency of labour (g).
5. The economy's growth multiplier (comes from the capital share of output).

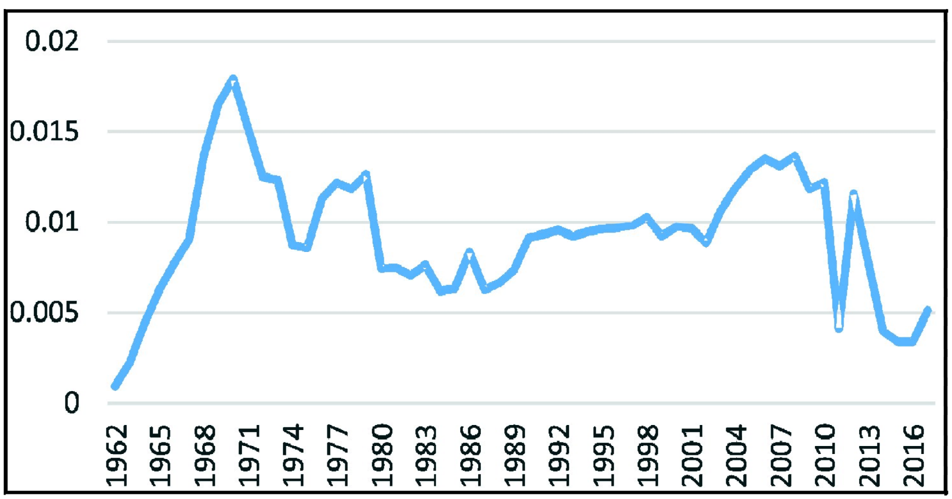
However, in underdeveloped countries, balanced growth doctrine is not often applicable, especially for natural resource-based economies (Blume and Durlauf 2005), the output does not entirely depend on labour efforts due to oil-surplus availability. It is needless to say that oil revenues are the main source to fund both consumption and investment. Consequently, the rate of depleting becomes an important factor along with these five determinants; therefore, it is useful to investigate the role of depleting rate and population growth in such case.

A. Depletion Rate

The depleting rate fluctuated widely throughout the studied period; three stages can be observed: increasing rate from 1962 to 1970, then decreasing with fluctuation mode up to the mid of the eighties, then it started to rise again. However, it fluctuated heavily recently due to global and local effects. The overall trend of depleting rate is declining on average, as seen in figure (5).

According to Jones (1998) the depleting rate should be at a level that keeps at least the same amount of natural resources; otherwise, natural resources would decline and affect future economic growth.

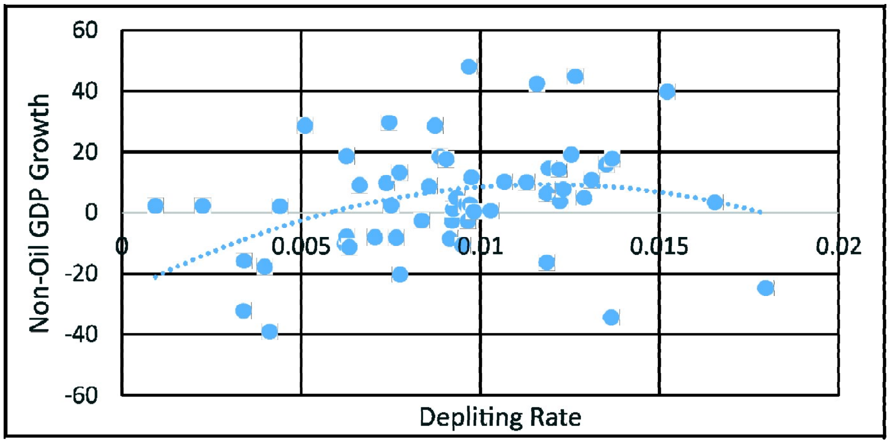
Figure 5: Depletion rate of oil over 1962-2017 in Libya



Because of the dual impact of depleting rate (e.g. The negative impact on resource reserve and the positive impact on growth), it is difficult to determine the optimal level for economic growth, because it depends on the time preference of the society and their choice of present-future.

Figure (6) shows depleting rates and growth rates in the non-oil GDP assosiation. The relationship is not strong; however, one can notice the positive trendline when depleting rates are low then, when depleting rates become higher; the trend turns into negative.

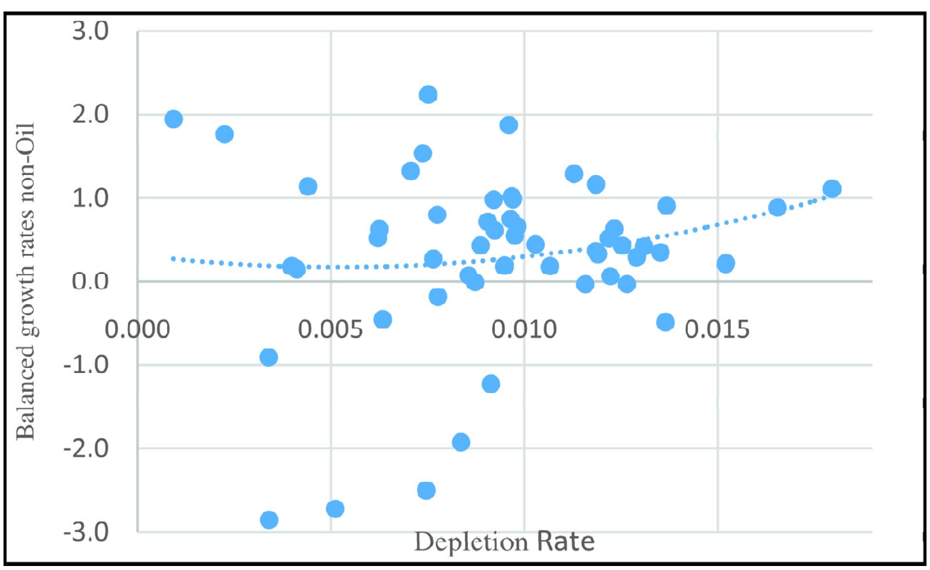
Figure 6: Depleting rate and growth in the Non-oil GDP 1962-2017



One possible explanation is that oil revenues are necessary to initiate the growth in the first stage. Nevertheless, these funds play a negative role in the next stages as natural resource curse starts to work. This converted U-shaped indicates the threshold level of resources exploitation and confirms both assumptions of the necessity of natural resource and its curse.

Meanwhile, figure (7) shows the association between BGP and depleting rates. As depleting rates become higher, the BGP tend to be positive and vice versa, this

Figure 7: Depletion rate and BGP association



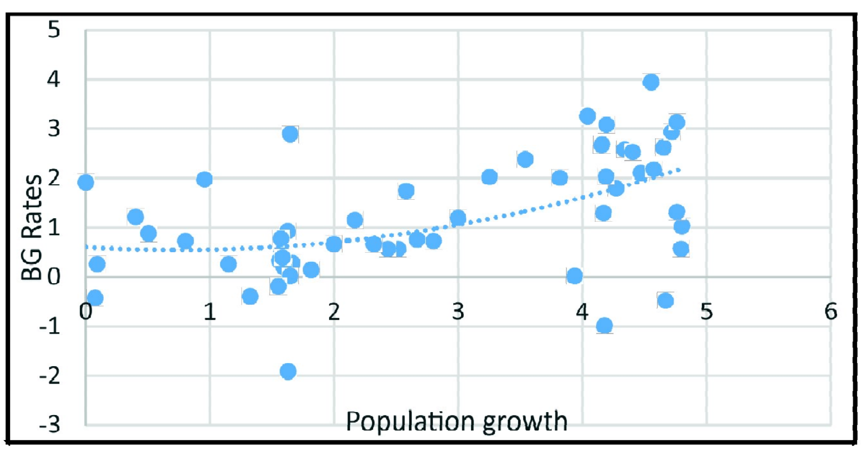
also evident two more suggestions: on the one hand, it supports the initial assumption of the positive relationship between growth and natural resources usage as Jones suggested. On the other hand, it confirms the high dependency on the natural resource (oil) in our case. Therefore, the Libyan economy would not be able to maintain sustainable growth with lower depleting rates.

B. Population Growth (Labour)

According to Jones (1998), the higher rate of the population growth would reduce economic growth unless higher growth in technology offsets it. Figure (8) below shows that higher BGP are associated with higher rates of population growth; this contradiction would not be surprised in such a rentier economy. In fact: one explanation is that there is a kind of separation between, economic growth and the role of labour (i.e. population) in economic activities. This result supports the assumption of the oil role on the macroeconomic level as the primary source of consumption rather than investment.

The possible explanation is that the causality between population growth and economic growth in rent-seeking economies is different from that in the non-resource economies Stijns (2005). Causality is often from population growth to output growth. In rent-seeking economies, this relationship is opposite; population increases as a result of wealth abundance. Therefore the causality runs from depleting rate to population growth. High dependence on oil leads to a positive relationship between population growth and BGP as in figure (8), oil revenues abundance ultimately result in population growth.

Figure 8: Population growth against balanced growth rates



7. CONCLUSION

Despite the importance of natural resources in economic growth, these resources might turn into a natural resource curse rather than a blessing. Estimating the BGP for the Libyan economy showed that, Jones' model provides an appropriate tool for analysing the pattern of growth for such an economy. Findings show that the Libyan economy experiences high dependence on depleting reserves. These reserves play a crucial role in the long-run growth, only because the negative effect of a depleted resource has not appeared yet. This role is attributed mainly to the growth in the resource sector.

Meanwhile, the higher population growth rate is negatively related to economic growth due to the weak role of human capital and labour force in economic activity. Because the increasing needs of a larger population cannot be fulfilled through a fixed amount of oil revenues. The contribution of this paper is to highlight the inventible foreseen problem addressing the Libyan economy regarding high dependency on oil. The sustainable standards of living would not be guaranteed without more relying on depleting resources.

Notes

1. Larsen had published an excellent article (2006), titled "*Escaping the Resource Curse and the Dutch Disease? When and Why Norway Caught Up with and Forged Ahead of Its Neighbours,* explaining how Norway escaped the Resource Curse" for more than two decades and he wondered whether Norway could maintain its growth out of resource curse.
2. In general, reserves are defined as quantities of natural resources that could be distracted and transformed into a different kind of wealth or income by selling directly or through a production process using the available technology. This concept often used especially in oil and natural resources. (*http://www.opec.org/opec_web /en/data_graphs/330.htm*).
3. By this sentence, Jones considered renewable resources which can be kept at the same level, while for non-renewable resources this assumption can not be held.

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