OIL PRODUCTION REHABILITATION, FISCAL POLICY AND ECONOMIC DEVELOPMENT IN LIBYA: A FUTURE VIEW

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ABSTRACT

This paper develops and simulates a dynamic general equilibrium macroeconomic model to analyze the likely impact of oil production and revenue rehabilitation on the Libyan economy, under different government fiscal policy responses. The model is ideally appropriate to analyze macroeconomic issues in oil-producing developing countries. In particular, it is capable of incorporating alternative government policy responses toward the allocation of the oil revenue either upon consumption spending or development spending in the form of government investment spending upon infrastructure, human capital formation and technology acquisition in non-oil production. It is also capable of incorporating different degrees of international capital mobility and other features that characterize oil-producing developing countries. We distinguish between the short-run and long-run impact of the oil production recovery upon the real exchange rate, price level, the non-oil trade balance, foreign assets, physical capital stock, human capital stock, imported capital stock and non-oil production. Based on recent development of oil production in Libya the paper finds that fiscal policy responses exert a crucial impact on the macroeconomic adjustment process. In particular, the implementation of a development oriented policy in the form of increased government expenditure upon infrastructure, human capital formation, and technological acquisition can transform the economy into a well-equipped one able to diversify and build a viable non-oil economy, and, therefore, to maintain and improve its competitive advantages. This eventually will result in noticeably improved economic outcomes and overall development of the economy.

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1. INTRODUCTION

This paper studies the impact of an oil revenue windfall upon key macroeconomic variables in Libya. Based on recovery of oil production, following the armed conflict for eight months during 2011, and proven oil reserves, the oil sector is expected to generate substantive future revenue, essential for the reconstruction of the economy, its infrastructure and the attainment of sustainable growth. The eventual development of the Libyan economy calls for a better understanding of the impact of oil production rehabilitation on this economy, which currently operates with a fixed exchange rate regime.

There is extensive literature devoted to analyzing the effects of natural resource production upon the growth performance of small open economies over the short and long terms. A number of these emphasize that resource production affects the economy, specifically during the short-run, through a number of channels including: resource movement; spending; income; and exchange rate effects (see, for example, (Buiter and Miller, 1981; Buiter and Purvis, 1982; Eastwood and Venables, 1982; Neary and Van Wijnbergen, 1984)). The resource movement effect takes place when the higher income of the natural resource sector attracts production factors from other sectors, tradable and non-tradable, which in turn contributes to a slowdown in their output growth. The spending or wealth effect can be observed when lucrative natural resources cause increased demand, and hence inflation, in other sectors in the economy both tradable and non-tradable. As the price of goods in the tradable sector is determined by the global market, the economy becomes less competitive in those sectors. The exchange rate effect arises from a higher domestic price level during the short-run if the nominal exchange rate is fixed. This is mainly attributed to increased demand for non-oil output and the huge inflow of foreign exchange, which comes from natural resource exports during the boom period.

This literature was extended during the 1990s to capture long-run effects including capital stock accumulation (an additional wealth effect), foreign asset stock accumulation via the current account (a current account effect) and budgetary financing implications. Furthermore, the literature has also taken into account implications for adjustment arising from different exchange rate regimes (fixed or flexible) and the identification of optimal policy responses in a dynamic context with the objective of minimizing the adverse effects of a resource boom on the non-resource sector (see, for example, (Harvie and Gower, 1993; Harvie and Thaha, 1994; Cox and Harvie, 2010; Ali and Harvie, 2013)).

Given that oil production constitutes the major source of Libyan exports, the major share of national income and the main source of government revenue, the sector exerts a significant influence on the economy. From this point of view the Libyan economy presents an interesting case for analyzing the macroeconomic effects of an oil revenue windfall on economic development. Its experiences are also likely to be of interest to other developing economies with a similar abundance of natural resources. This issue has become of even more concern to the Libyan authorities due to the recent rehabilitation in oil production, which is expected to boost government revenue and exports and has intensified the need to identify how best to use this oil windfall for the sustained

growth and development of the economy. Therefore, there is a need to analyze the aforementioned impacts arising from oil related shocks upon a number of key macroeconomic variables, and to identify the impact from alternative policies in order to maximize the benefits and/or to minimize the adverse effects arising from additional oil revenue in Libya. To do so, we develop a dynamic general equilibrium macroeconomic model to evaluate the effects of additional oil revenue upon key macroeconomic variables, including the real exchange rate, the non-oil trade balance, foreign assets, physical capital stock, human capital stock, imported capital stock and non-oil production. This model emphasizes the aforementioned effects and extends the existing literature to capture long-run effects, including human capital stock accumulation (another additional wealth effect), imported capital stock accumulation via capital imports (a technology effect), and spending options, emphasizing the supply side, in a dynamic modelling context. We find that increasing government development spending upon human capital formation, technological acquisition and public capital stock, arising from oil production recovery, offsets or reverses the "Dutch Disease'' effects and enhances the overall productivity of non-oil production.

The remainder of the paper proceeds as follows: section two provides a brief overview of oil development in the Libyan economy. Section three discusses the theoretical framework utilized in this paper, with emphasis placed upon a fixed exchange rate combined with control over capital mobility. Section four presents data sources and estimation procedures. Section five discusses the results of simulation scenarios, and sections six provides concluding remarks.

2. THE IMPORTANCE OF THE LIBYAN OIL SECTOR FOR THE DOMESTIC ECONOMY AND THE WORLD OIL MARKET

Libya has been a substantive producer of oil since the early 1960s, and it makes a significant contribution to the economy from a number of perspectives: it is a major source of government revenue, contributing 91 percent of total government revenue in 2007, oil exports contributed more than 90 percent of total exports over the period 1970-2007, and it is a major contributor to national income (see Table 1). Despite the country's vast oil wealth the country's economic and social indicators have lagged those of other countries at a similar stage of economic development. The country's lack of transparency, inefficient government institutions, widespread corruption and misuse of its oil revenue and periods of international sanctions and embargoes that made access to modern technology almost impossible, combined to retard its economic growth and development. Moreover, this was further compounded when Libya experienced major political and economic upheaval arising from eight months of internal armed conflict in 2011.

Prior to the outbreak of the 2011 crisis the country produced around 1.7 million barrels of oil per day, generating enormous revenue as a result of high oil prices during the previous decade. The armed conflict occurred simultaneously with the imposition of international sanctions by the international community which paralyzed the domestic economy and almost halted Libya's oil production, and placed upward pressure on oil prices as Libyan crude is a key source of oil for several European refineries. Following the fall of the Gaddafi regime in October 2011 oil

production recommenced, and by December 2011 oil production recovered to 1 million barrels per day (bpd). As oil production in Libya continues to rehabilitate back to its pre-civil war level of 1.7 million bpd, the oil sector is also expected to generate substantive future revenue, essential for the reconstruction of the economy, its infrastructure and the attainment of sustainable growth. How effectively these will be obtained will critically depend on the new government implementing sound policies aimed at maximizing the benefits from current and future oil revenue. Such policies need to focus upon increasing productivity through increased investment in infrastructure (physical capital), human capital and technology acquisition in the non-oil output sector. The benefits for the non-oil sector arising from physical, human and imported capital stock (technology) accumulation induced by oil sector revenue could be substantial in terms of employment and growth generation. Critical to this, however, is the need to rapidly rehabilitate the oil sector and its production to pre-civil war levels.

Table-1. The Significance of Oil in the Libyan Economy*

	1970	1975	1980	1985	1990	1995	2000	2007
Oil revenues to total revenues (%)	84.6	74.2	88.7	65.9	58.0	73.9	57.3	91.1
Oil exports to total exports (%)	90.8	95.1	99.2	97.8	96.8	92.1	95.6	93.9
Oil GDP to total GDP (%)	74.4	57.3	46.9	39.3	35.1	34.2	33.8	39.8

Source: The Central Bank of Libya, Economic Bulletin, various issues.
*The Table is calculated at 1997 constant prices.

The recovery of oil production and its macroeconomic impact is of considerable contemporary importance not just for the domestic economy, but also for the global economy in general and for European countries in particular, as the majority of Libyan crude oil and natural gas in the past has been sold to Europe. The increase in Libyan oil production has the potential to prevent upward pressure on oil prices, which is expected to result from the embargo and sanctions placed on Iran by the European and other western economies. Libyan oil production averaged approximately 5-14 percent of total OPEC oil production over the period 1965-2010[1]. This contribution is expected to increase as Libya has the potential, with adequate rehabilitation measures, to raise oil and natural gas production significantly in coming years. This is due to a number of advantages that the Libyan oil and energy sector have. First, according to OPEC (OPEC, 2010/2011) Libya has huge proven crude oil and natural gas reserves of 47.1 billion barrels and 1.5 billion cubic meters, respectively, in 2010 (see Table 2). Second, Libyan oil is of a high quality with production costs among the lowest in the world[2]. Third, proximity of Libya to European markets provides a further advantage in terms of low transportation cost. Nowadays the majority of Libyan crude oil and natural gas are exported to European countries, including Italy, France, Germany, and Spain. Accordingly, given the aforementioned advantages, the recent political change in Libya, the willingness of European countries to diversify their crude oil and gas suppliers and, also, declining oil production from the North Sea (Bahgat, 2006) ensure that this unique relationship will remain strong and enable Libyan oil and gas to be shipped to the rest of the world through Europe. The return of Libyan oil to the

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[1] In 2011 its contribution to global production fell to 2 per cent due to the civil war.
[2] Only a handful of countries, such as Azerbaijan and Nigeria, produce such high quality oil which is in high global demand for usage in transportation, energy production and high value adding products.

international oil market is likely to put downward pressure on oil prices and ease global inflationary pressure.

Table-2. Proven Crude Oil (in billion barrels) and Natural Gas reserves (billion standard cu m) in Libya, 1990–2010

Year	Libyan Crude Oil Reserves	Libyan Natural Gas Reserves
1990	22.800	1.208
1995	29.500	1.313
2000	36.000	1.314
2005	41.464	1.491
2010	47.097	1.495

Source: OPEC, Annual Statistical Bulletin, Yearbooks 2008 & 2010/2011.

3. THEORETICAL FRAMEWORK: THE MODEL

3.1. Background

The oil related macroeconomic model utilized in the current study of the Libyan economy has its foundation in the models of Dornbusch (1976); Buiter and Miller (1981); Eastwood and Venables (1982); Buiter and Purvis (1982); Neary and Van Wijnbergen (1984); Harvie and Gower (1993); Harvie and Thaha (1994) and more recently and importantly, Cox and Harvie (2010) for the case of a flexible exchange rate in the context of advanced resource-abundant economies. The latter is a dynamic general equilibrium model focusing on the long run nature of the adjustment process. An important characteristic of each of these models is the role of financial markets (exchange rate, interest rate and Tobin's q ratio adjustments) in transmitting the effects of oil related shocks to the rest of the economy (goods, labour and external sectors). Ali and Harvie (2013) (henceforth A-H) (2011) argue, however, that such a transmission mechanism is not applicable for an oil producing developing economy such as that of Libya, where financial markets are unsophisticated, tightly controlled and largely passive. Consequently, a number of structural amendments to the C-H model must be addressed. These are as follows:

i)   The majority of oil production and its revenue is produced and generated by government owned entities; hence oil production and revenue generated from its production is under government control. Therefore, the way in which the government spends the oil revenue will have a significant impact upon the transmission of oil related shocks to the rest of the economy, and the future development of the economy.

ii) The Libyan government allocates oil revenue between two types of expenditure. First, current expenditure on wages and salaries, which stimulates the demand for non-oil output. Second, development (or investment) expenditure, which is divided into three parts; development spending on physical capital, development spending on human capital, and that devoted to imported capital or technology. The second type of government expenditure increases the demand for non-oil output but will also stimulate non-oil output supply.

iii) The Libyan economy has operated with a relatively fixed nominal exchange rate, and international capital mobility remains highly controlled by the government.

iv) In the C-H model there is assumed to be four financial assets available in the economy. These are domestic money, domestic bonds, foreign bonds and equities. In the case of Libya there is assumed to be only one financial asset available in the economy, which is a money asset. This assumption is due to the immaturity of financial assets in the economy, and lack of data available for other financial assets. Control of the money supply and nominal interest rate, therefore, remain blunt instruments of monetary policy.

v) The private sector remains largely underdeveloped and its contribution to the economy remains secondary to that of the government sector.

Like the C-H model the general means by which oil related shocks transmit their impact to the rest of the economy will be via a number of common effects. First, increased oil sector revenue will generate increased revenue for the government (*revenue effect*). Second, increased government consumption and development expenditure from oil revenue will generate a *spending effect*. Third, increased oil exports will lead to an accumulation of foreign asset stocks through improved trade and current account balances (*trade or current account effect*). Fourth, increased future oil income can also contribute to an increase in permanent income (*wealth effect*) for both the government and the private sector which can further influence spending. In the context of Libya the bulk of this wealth effect will primarily accrue to the government sector. Fifth, the extra spending generated by the spending and wealth effects increase the demand for non-oil output relative to its available supply. This can push up domestic prices and, with a fixed nominal exchange rate, result in an appreciation of the real exchange rate (*exchange rate effect*) and loss of competitiveness for the non-oil sector. Furthermore, unlike the C-H model, this paper extends the existing literature to capture other long-run effects, including human capital stock accumulation (*another additional wealth effect*), imported capital stock accumulation via capital imports (*a technology effect*), and *spending options*, emphasizing the supply side in a dynamic modelling context. These effects will expand the long run productive capacity and efficiency of the non-oil sector.

3.2. Model Equations

The equations of the model used in this study are now discussed in detail. All the variables are in log form except that of the domestic nominal and world interest rates and the parameter in front of each variable indicates its elasticity. Equilibrium in the model depends upon equilibrium in the product market, asset market and foreign sector. The product market is discussed first.

Product market equilibrium consists of Equations 1 – 18 below. Equation 1 describes the total demand, or spending, on non-oil output (No^d). It is a log linear approximation of total spending in the form of private consumption spending (c^p), private investment spending (i^p), government spending (g) (which is given by Equation 5 and is comprised of a weighted average of both government consumption and government investment spending) and the non-oil trade balance consisting of non-oil exports (x^n) and non-oil imports (m^n). The parameters (β_i) represent the

elasticities of spending in each category. In line with the C-H model the parameters are set to 1 indicating that a dollar spent by any of these components contributes equally.

$$No^d = \beta_1 c^p + \beta_2 i^p + \beta_3 g + \beta_4(x^n - m^n) \tag{1}$$

Private sector consumption expenditure is given by Equation 2. It depends positively upon non-oil output supply (income) (No^s) and private sector wealth (w^p). The production of non-oil output represents income generated by the public and private sectors, although most non-oil output is produced by the public sector[3]. The parameters in behavioural Equation 2 were empirically estimated using the ARDL approach (see Table 4).

$$c^p = \beta_6 No^s + \beta_7 w^p \tag{2}$$

Equation 3 describes private sector gross investment (i^p), which equals the change in the stock of private capital ($\dot{k}^p$), capturing the partial adjustment hypothesis. This partial adjustment arises from costs of adjusting the actual physical capital stock ($\dot{k}^p$) to the desired capital stock (k^{p*}):

$$i^p = \dot{k}^p = \gamma(k^{p*} - k^p) \tag{3}$$

This shows that the increase in capital from the end of the previous period to the end of the current period is some fraction γ of the divergence between the desired and actual stock of capital. The adjustment coefficient γ was selected to be 0.50, indicating moderate adjustment of the dependent variable. The desired capital stock is assumed to depend upon non-oil output (Equation 4), where the parameter δ is set to be 0.8.

$$k^{p*} = \delta No^s \tag{4}$$

Total government spending (g) is identified by Equation 5. It depends positively on two components of expenditure; government consumption spending (c^g) which is assumed to be dependent upon oil revenue ($o^a + po + e - p$) as shown in Equation 6, where o^a is actual oil production, po is the price of oil, e is the nominal exchange rate and p is the domestic price level, and government development expenditure which will directly influence the production of non-oil output as given by Equation 26. Government development spending is divided into three parts; spending on physical capital (infrastructure) (i^g), spending on human capital (i^h), and that devoted to imported capital and technology (i^{cap}). Government development expenditure on human capital consists of government spending on the education and health sectors[4], where the public sector in Libya plays an important role in providing free education and healthcare necessary

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[3] Non-oil output can be considered as a good which can be either consumed domestically or exported, and is an imperfect substitute for the foreign non-oil imported goods.
[4] The inclusion of health services can be justified by the fact that a healthy person can not only work more effectively and efficiently, but also devote more time to productive activities, (see Baldacci, Clements, Gupta and Cui (2004).).

to build human capital[5] (World Bank, 2006). Government spending on imported capital represents technological acquisition from overseas. Equations 7, 8, and 9 describe government investment spending on the physical, human and imported capital stocks, respectively, which arises from a gradual adjustment of the actual capital stock of each of these variables (k^g, k^h, k^{cap}) to their policy determined levels (k^{g^*}. k^{h^*}, k^{cap^*}). The policy determined levels are determined by oil revenue as given by Equations 10, 11, and 12, and this is another major difference between this model and that of the C-H model. For adjustment equations 7, 8 and 9 the adjustment coefficients were selected to be 0.50, indicating moderate adjustment of the dependent variables. The parameters for Equations 6, 10, 11, and 12 were chosen as weighted averages, indicating how the government distributes oil revenue between desired physical capital stock, desired human capital stock, desired imported capital stock and consumption expenditure according to its policy priorities[6]. The summation of these parameters is one, as all oil revenue goes to the government and is totally disbursed in the previous four ways.

$$g \;\; = \beta_8 c^g + \beta_9 i^g + \beta_{10} i^h + \beta_{11} i^{cap} \qquad (5)$$

$$c^g = (1 - \theta_1 - \theta_2 - \theta_3)(o^a + po + e - p) \qquad (6)$$

$$i^g = \dot{k}^g = \varphi(k^{g^*} - k^g) \qquad (7)$$

$$i^h = \dot{k}^h = \sigma(k^{h^*} - k^h) \qquad (8)$$

$$i^{cap} = \dot{k}^{cap} = \lambda(k^{cap^*} - k^{cap}) \qquad (9)$$

$$k^{g^*} = \theta_1(o^a + po + e - p) \qquad (10)$$

$$k^{h^*} = \theta_2(o^a + po + e - p) \qquad (11)$$

$$k^{cap^*} = \theta_3(o^a + po + e - p) \qquad (12)$$

Equation 13 identifies the budgetary stance, which is government expenditure (g) less tax revenues (t^x). The budget deficit (*bd*) can be financed in three ways; through money accommodation (sales of government bills and securities to the Central Bank of Libya (CBL)), by borrowing domestically from the private sector, or by borrowing from abroad. In Libya the government issues bonds to the central bank only, and does not issue bonds to the public. The

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[5] In this context, Libya has achieved essential improvements in terms of primary, secondary, and tertiary school enrolments. For example, secondary school enrolment substantially increased from 21 percent in 1970 to 95 percent in 2002. Also, tertiary enrolment recorded a significant increase from 3 percent to 53 percent in the same period. However, there are concerns about the quality of the content and access to up-to-date knowledge and expertise. These concerns are attributed mainly to Libya's isolation for more than a decade due to the embargo and the sanctions imposed upon the country by the US and UN, and the ban on foreign languages from the curricula. Regarding the health sector, life expectancy has increased from 52 years in 1970 to 72 years in 2002 as a result of improvement in health care services (for more detail, see World Bank (2006).

[6] These can be regarded as policy determined parameters.

public are not able to buy treasury bills and bonds due to the lack of financial institutions in the economy. Also, the Libyan government has not, as yet, borrowed from abroad. Therefore, Equation 13 shows that any excess of real total expenditure over real total tax revenue must be financed by borrowing domestically from the CBL resulting in an expansion of the real monetary growth rate ($\dot{m} - \dot{p}$)[7]. Tax revenues are generated from two sources, oil production and non-oil production (No^s) (Equation 14). The parameter (β_{13}) in Equation 14 is set to 0.70 as the bulk of government revenue comes mainly from oil, with oil revenue contributing 70 percent on average of total government revenue during the period 1970-2007.

$$bd = g - t^x = \beta_{12}(\dot{m} - \dot{p}) \qquad (13)$$

$$t^x = \beta_{13}(o^a + po + e - p) + (1 - \beta_{13})No^s \qquad (14)$$

The non-oil trade balance (*T*) is disaggregated into non-oil exports less non-oil imports as shown in Equation 15. Equation 16 specifies non-oil exports, which depends positively upon the real exchange rate $(e + p* - p)$ [8] and world real income ($y*$) which is assumed to be exogenous. Equation 17 shows that non-oil imports is also disaggregated into non-oil consumption imports (m^{con}) and non-oil capital imports (i^{cap}). Equation 18 identifies the consumption of non-oil imports, which depends negatively upon the real exchange rate and positively on domestic real income (y). Equation (9) identifies capital imports which are assumed to be endogenously determined, arising from a gradual adjustment of actual imported capital spending to its policy determined level. The parameters in behavioral Equations 16 and 18 were empirically estimated using the ARDL approach (see Table 4). Libyan capital imports, comprised predominantly of capital goods and raw material goods, increased rapidly during the oil boom periods. This is attributed to the highly ambitious development programme conducted by government during the oil boom periods. Thus, a large share of oil revenue is being used directly for the purchase of imports, in particular capital imports containing advanced technology. This is another departure from the C-H model, and in addition is considered as one of the main contributions of the A-H model.

$$T = x^n - m^n \qquad (15)$$

$$x^n = \beta_{14}(e + p* - p) + \beta_{15}y* \qquad (16)$$

$$m^n = m^{con} + i^{cap} \qquad (17)$$

$$m^{con} = \beta_{16}y - \beta_{17}(e + p* - p) \qquad (18)$$

Real and permanent income definitions, first used by Buiter and Purvis (1982) are given by Equations 19 and 20 as in the C-H model. Real income, as identified in Equation 19, depends upon non-oil output production (No^s), oil production (o^a) that is assumed to be exogenous, the world

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[7] $\dot{m}$ indicates the rate of change of the money stock (m) while $\dot{p}$ indicates the rate of change of domestic prices (p).

[8] Where $p*$ is the world price level.

price of oil (po) that is also exogenous, the real exchange rate[9] and the exogenously determined price of non-oil imported goods ($p *$). In this model only real non-oil income, generated from real non-oil output, accrues directly to the private sector, and real oil income generated from real oil production goes directly to government. Real oil output (government oil revenue) will directly affect government income and in turn spending, as in Equations 5, 6, 7, 8 and 9. It will also affect non-oil output supply as in Equation 26 through imported, human and physical capital accumulation, and the current account as indicated in Equations 27 and 28. Non-oil output will directly influence private sector consumption and the money market, as in Equations 2 and 21.

$$y = vNo^s + (1-v)o^a + (1-v-\mu_2)po + (\mu_1-v)(e-w) - (1-\mu_1-\mu_2)p * \qquad (19)$$

Equation 20 represents permanent income (y^p), which is a function of exogenous permanent non-oil output (No^{Sp}), exogenous permanent oil output (o^p), the world price of oil, the real exchange rate and price of non-oil imported goods (see also Harvie (1994)). The parameters in identity Equations 19 and 20 are based upon the calculated share of current and permanent oil output in total current and permanent output, respectively. It is assumed that v , the share of current and permanent non-oil production in total current and permanent output is the same in real and permanent income and constant through time (see Buiter and Purvis (1982)). The share of oil output in domestic real income $(1-v)$ is deliberately set to be larger than its share in domestic consumption (μ_2) resulting in the Libyan economy being a net oil exporter in the model.

$$y^p = vNo^{sp} + (1-v)o^p + (1-v-\mu_2)po + (\mu_1-v)(e-w) - (1-\mu_1-\mu_2)p * \qquad (20)$$

Asset market equilibrium is given by Equations 21 – 23. According to conventional money market equilibrium the demand for real money balances depends upon real income, and the nominal interest rate as the opportunity cost of holding real balances. However, the special characteristics of Libya, like most other developing countries, should be considered when specifying the functional form of money demand. Libyan financial markets are immature and still in the process of being liberalized and capital flows are restricted due to the constant nominal interest rate. Thus, there is a limited range of alternative financial assets. Furthermore, the interest rate does not reflect the increase in price levels. As a consequence the interest rate does not reflect the true opportunity cost of holding money in Libya. In addition, since the interest rate is subject to regulation by policymakers, it is no longer a good proxy for the cost of holding money but, rather, tends to show the restrictiveness of monetary policy. Therefore, the rate of inflation is utilized, besides the interest rate, as a proxy variable for the opportunity cost of holding money in the A-H model[10]. For this reason the specification of money market equilibrium, as given by Equation 21,

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[9] The real exchange rate in these equations is defined to be the nominal exchange rate deflated by domestic nominal wages (W).

[10] In this respect, many researchers have used alternative variables to that of the interest rate in the demand for money equation in developing countries. For instance, Usui (1996). used the rate of inflation as a proxy for the opportunity cost of holding money beside the interest rate in the demand for money for the Indonesian economy. He found that the inflation rate is significant and negatively related to money demand, reflecting the opportunity cost of holding money, while the interest rate is not significantly related to money demand.

incorporates real non-oil income, the interest rate and the rate of inflation[11]. The nominal money supply is assumed to be endogenous as the nominal exchange rate is fixed. The demand for real money balances (the nominal money stock m deflated by the consumer price level p) depends positively upon real non-oil income (No^s), representing a transactions demand, and negatively upon the domestic interest rate (r) and the inflation rate (π). It is assumed that the money market always clears, so this equation always holds. The estimated parameters of Equation 21 are shown in Table 4.

$$m - p = \varepsilon_1 No^s - \varepsilon_2 \pi - \varepsilon_3 r \tag{21}$$

Domestic private sector real wealth (w^p) is given by Equation 22 as in the C-H model, except that real bond holdings by the private sector are excluded. This is because of the fact that the Libyan government does not issue bonds to the public. Domestic private sector real wealth consists of three components. The first major component is real money balances ($m - p$), which consists of cash, deposits, and savings of the private sector. The second major component is the private capital stock (k^p) assumed to be owned entirely by the private sector. The private capital stock is produced from private investment. The final component is permanent non-oil income equivalent to that of permanent non-oil output[12]. The parameters in Equation 22 are set to 1 indicating the equal importance of each of the components to total private sector wealth.

$$w^p = \varepsilon_5 k^p + \varepsilon_6 (m - p) + \varepsilon_7 No^{sp} \tag{22}$$

Equation 23 shows the money growth equation. It indicates the assumption of a fixed exchange rate combined with imperfect capital mobility[13]. Since a fixed exchange rate is assumed for the case of Libya, the money supply, and hence growth of it, is endogenously determined, and depends upon exogenously determined changes in domestic credit expansion ($d\dot{c}e$) and the accumulation of foreign exchange reserves through balance of payments surpluses/deficits ($f\dot{e}s$) (see (Harvie, 1993; Harvie and Thaha, 1994)) as shown in Equation $23*$.

$$\dot{m} = d\dot{c}e + f\dot{e}s \qquad\qquad \text{Equation } 23*$$

$d\dot{c}e$ is exogenously determined by government, and hence in this study it is assumed for simplicity that the change in it is zero. Whilst $f\dot{e}s$ indicates changes in foreign exchange reserves arising from balance of payments surpluses or deficits, which arise from developments in the current account ($\dot{f}$) and capital flows arising from the differential between the domestic and

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[11] As indicated in Table 3, the inflation rate coefficient (0.36) is negative and also significant at the 1 percent level, supporting the theoretical specification identified in this paper. This means that a 1 percent increase in the inflation rate will bring about a decrease in real money demand by 0.36 percent. However, the long-run coefficient of the domestic interest rate is not significant; indicating that the interest rate does not reflect the true opportunity cost of holding money in Libya.

[12] This is a proxy for the present value of the future income stream for the private sector.

[13] This assumption means that there is a discrepancy between the return on domestic financial assets and foreign financial assets, which can continue for a prolonged period of time. A fixed nominal exchange rate, which is unable to adjust in order to achieve the equalization between expected returns on domestic financial assets and foreign financial assets, and differences in the returns on domestic and foreign financial assets results in continuous capital flows. However, in the case of Libya capital flows are heavily controlled.

foreign nominal interest rate $(r - r*)$, as shown in Equation ($23**$), where τ indicates the degree of capital mobility[14].

$$f\dot{e}s = \tau(r - r*) + \dot{f} \qquad\qquad \text{Equation} \quad 23**$$

By substituting Equation $23**$ into Equation $23*$, Equation 23 is obtained.

$$\dot{m} = d\dot{c}e + \tau(r - r* + \dot{f}) \qquad\qquad (23)$$

Equations 24 – 26 define the price level, wage inflation ($\dot{w}$) and aggregate non-oil output supply. Equation 24 defines the domestic price level, which is a weighted average of nominal wages (w), the domestic cost of oil $(e + po)$ and the domestic cost of the world non-oil imported good, which is represented by the imported goods price index in foreign currency multiplied by the exchange rate $(e + p*)$. The weights used in the consumer price index in Equation 22 are approximated, based on Libyan data.

Adjustment of nominal wages (w) is generated by an expectations augmented Phillips curve, as given by Equation 25. Two possible adjustment sources are considered, these being excess demand for non-oil goods relative to its available supply $(No^d - No^s)$ and core inflation (π). Core inflation depends upon developments in the monetary growth rate ($\dot{m}$) (Equation 23). The estimated parameters of Equation 25 are contained in Table 4.

$$p = \mu_1 w + \mu_2(e + po) + (1 - \mu_1 - \mu_2)(e + p*) \qquad\qquad (24)$$

$$\dot{w} = \psi_1(No^d - No^s) + \psi_2\dot{m} \qquad\qquad (25)$$

Aggregate non-oil output supply is endogenously determined, as given by Equation 26. It depends positively on the public capital stock (k^g)[15], human capital stock (k^h), private capital stock (k^p), imported capital stock (k^{cap}) and employment (em). Government investment is divided into three parts; capital that affects non-oil output through physical capital stock accumulation, capital that affects non-oil output through human capital formation and capital imports (technology acquisition). The estimated parameters of Equation 26 are shown in Table 4.

$$No^s = \phi_1 k^p + \phi_2 k^g + \phi_3 k^h + \phi_4 k^{cap} + \phi_5 em \qquad\qquad (26)$$

Inclusion of the public capital stock is attributed to the assumption that it is complementary to that of the private capital stock in nature. For example, Aschauer (1989a; 1989b) argues that public capital spending, especially on infrastructure, such as highways, streets, water and sewerage systems and airports operates as a complement to private sector inputs, and "crowds in" private

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[14] The value of parameter τ can range from zero to infinity. If τ is equal to zero then there is imperfect international capital mobility, whereas if τ tends to infinity there is perfect international capital mobility.
[15] The reason for including government development expenditure is to capture the effects of government-led development strategies. In particular, during the oil boom periods.

capital accumulation and enhances its efficiency. In addition, Morrison and Schwartz (1996) examine the relationship between public capital and costs of private production. Their results indicate the importance of public infrastructure investment to the private sector's productivity. They find that public infrastructure investment reduces the cost of private production, and hence leads to an increase in productivity performance. Hence it has a potentially positive and significant effect on aggregate supply. Furthermore, like other typical oil-exporting countries in the Middle East and North African regions, Libya is dependent on imports of industrial inputs, in the form of physical capital and technology, from developed countries. Importation of capital goods and raw materials, which contribute more than 65% of total imports (Annual report, The Central Bank of Libya (2005)) are crucial for the production of non-oil output, hence they play an important role in the economic development process. Thus, unlike the C-H model and other long run models, the stock of capital imports (k^{cap}) is vital for the supply of goods and services and are also included in Equation 26.

The overseas sector consists of the current account and the oil trade balance. Developments in the current account are given by Equation 27a (see for example Harvie and Gower (1993) and Harvie (1994)).

$$\dot{f} + e - p = \alpha_1 T + \alpha_2 (r * f + e - p) + \alpha_3 (o^x + po + e - p) \qquad \text{27a}$$

where o^x represents net exports of oil and f the country's foreign asset stocks, or reserves, held predominantly by the government. Re-arranging Equation 27a and expressing this in terms of changes in foreign exchange reserves, Equation 27 is obtained. This shows that changes in foreign exchange reserves, as reflected in the current account balance ($\dot{f}$), depends positively upon the non-oil trade balance (as given by Equation 15), foreign interest income ($r * f$), net oil exports and on the real exchange rate ($e - p$). In long run steady state the current account balance must be zero, otherwise further wealth effects will arise requiring further macroeconomic adjustment. The estimated parameters of this equation are contained in Table 4.

$$\dot{f} = \alpha_1 (x^n - m^n) + \alpha_2 r * f + \alpha_3 (o^x + po) - (1 - \alpha_2 - \alpha_3)(e - p) \qquad (27)$$

Equation 28 indicates that net oil exports are exogenously determined, dependent upon government policy towards the domestic usage of oil production or that for export. The parameter in Equation 28 has been selected as 0.70, indicating a more export oriented policy.

$$o^x = \zeta o^a \qquad (28)$$

Finally, Equations 29 and 30 define two variables which are used extensively throughout this study. Equation 29 defines the real exchange rate, while Equation 28 defines real money balances.

$$c = e - w \qquad (29)$$
$$l = m - w \qquad (30)$$

4. DATA SOURCES AND ESTIMATION PROCEDURES

Due to data limitations the historical data used to estimate the behavioral equations cover the period from 1970 to 2007, which includes the oil boom and post oil boom periods, and other important events which took place during the 1980s and 1990s such as the embargo and sanctions imposed by the United States and the United Nations. The relevant data were obtained from two different sources, i.e. international and local publications such as the Central Bank of Libya, Libyan National Authority for Information and Documentation, International Financial Statistics (IFS) Yearbook published by the International Monetary Fund (IMF), Annual Statistical Bulletin published by OPEC and World Development Indicators (WDI) issued by the World Bank.

The parameter values utilized to conduct the numerical simulation scenarios are summarized in Table 3. It contains the 19 estimated parameters obtained from using the ARDL cointegration technique[16], for behavioral equations 2, 16, 18, 21, 25, 26 and 27, where they are significantly different from zero (see Table 4) However, before the behavioral equations are estimated the major structural break(s) in the intercept and trend using the LM unit root test of Lee and Strazicich (2003; 2004) is identified and incorporated in the estimated equations. Furthermore, testing for the existence of a long-run relationship among the variables is conducted, where the results presented in Table 5 indicate conclusive outcomes for the dependent variables $c^p, x^n, m^{cap}, m-p, \dot{w}, No^s$

and $\dot{f}$, as computed F-statistics are greater than the upper bound critical values. The exception to this result is the computed F-statistic for m^{con} , where the result is inconclusive at the 95 percent level as the computed $F-$ statistic is greater than the lower bound and less than the upper bound; however, it is conclusive at the 90 percent level. These results imply that the variables of interest are bound together in a long-run relationship. The remaining parameters in Table 3 were chosen from prior studies and/or calculated from available data, and are also utilized in the simulation analysis.

Table-3. Parameters values - summary

β_1 ***	1.0	θ_1 **	0.3	ε_7 ***	1.0
β_2 ***	1.0	θ_2 **	0.2	τ ***	0.8
β_3 ***	1.0	θ_3 **	0.2	μ_1 ***	0.6
β_4 ***	0.75	β_{12} **	1.0	μ_2 ***	0.1
β_6 *	0.6	β_{13} *	0.7	Ψ_1 *	0.65
β_7 *	0.3	β_{14} *	0.45	Ψ_2 *	0.4
Υ ***	0.5	β_{15} *	5.0	Φ_1 *	0.1
$\eth$ *	0.8	β_{16} *	0.75	Φ_2 *	0.5
β_8 **	0.4	β_{17} *	0.25	Φ_3 *	0.4
β_9 **	0.3	v **	0.7	Φ_4 *	0.3
β_{10} **	0.15	ε_1 *	0.4	Φ_5 *	0.2
β_{11} **	0.15	ε_2 *	0.36	α_1 *	0.15
					Continue

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[16]Following Pesaran, Shin and Smith (2001; 2009). and without having any prior knowledge about the direction of the relationship among the variables, the behavioral equations are expressed in the form of an unrestricted error correction model (UECM).

Φ ***	0.5	ε_3 *	0.09	α_2 *	0.5
σ ***	0.5	ε_5 ***	1.0	α_3 *	0.35
λ ***	0.5	ε_6 ***	1.0	$\mathfrak{r}$ ***	0.05
				r s ***	0.05

* Estimated coefficients obtained using the ARDL model, as contained in Table 4.
** Calculated by the authors based on available data.
*** Cox and Harvie (2010), and Harvie and Thaha (1994).

Table-4. Estimated Long-Run Coefficients using the ARDL technique for Equations 2, 16, 18, 21, 25, 26 and 27

Equation 2: The long-run coefficient estimates based on ARDL (3,0,0) and selected lag based on AIC

$$\Delta c^p = \alpha_0 + \sum_{j=1}^{n} b_j \Delta c_{t-j}^p + \sum_{j=0}^{n} c_j \Delta No_{t-j}^s + \sum_{j=0}^{n} d_j \Delta w_{t-j}^p + \delta_1 c_{t-1}^p + \delta_2 No_{t-1}^s + \delta_3 w_{t-1}^p + \delta_4 D_{83} + \delta_5 D_{2000} + \varepsilon_t$$

Variables	No^s	w^p	Constant	Trend	D1983	D2000
coefficients	0.6636	0.4438	-0.6310	-0.0533	-0.1423	0.0872
t-statistics	2.9561	2.1632	-0.8602	-4.2839	-1.6100	0.9116
R²=0.74	D-W=2.10					

Equation 16: The long-run coefficient estimates based on ARDL (1,0,0), and selected lag based on AIC

$$\Delta x^n = \alpha_0 + \sum_{j=1}^{n} b_j \Delta x_{t-j}^n + \sum_{j=0}^{n} c_j \Delta(e+p^*-p)_{t-j} + \sum_{j=0}^{n} d_j \Delta y_{t-j}^* + \delta_1 x_{t-1}^n + \delta_2 (e+p^*-p)_{t-1}$$
$$+ \delta_3 y_{t-1}^* + \delta_4 D_{78} + \delta_5 D_{2000} + \varepsilon_t$$

Variables	$(e+p^*-p)$	y^*	Constant	Trend	D1978	D2000
coefficients	0.4735	5.0362	-113.30	-0.2154	-0.1012	2.0708
t-statistics	1.4607	2.3759	-2.3044	-2.0094	-0.1869	2.0416
R²=0.60	D-W=2.03					

Equation 18: The long-run coefficient estimates based on ARDL (1,0,0) and selected lag based on AIC

$$\Delta m^{com} = \alpha_0 + \sum_{j=1}^{n} b_j \Delta m_{t-j}^{com} + \sum_{j=0}^{n} c_j \Delta y_{t-j} + \sum_{j=0}^{n} d_j \Delta(e+p^*-p)_{t-j} + \delta_1 m_{t-1}^{com} + \delta_2 y_{t-1} + \delta_3 (e+p^*-p)_{t-1}$$
$$+ \delta_4 D_{87} + \delta_5 D_{2003} + \varepsilon_t$$

Variables	$(e+p^*-p)$	y	Constant	Trend	D1987	D2003
coefficients	-0.2565	0.7438	2.4202	-0.0355	0.6507	-0.6605
t-statistics	-2.2490	3.5753	1.4721	-2.0950	2.1544	-1.9677
R²=0.67	D-W=2.31					

Equation 21: The long-run coefficient estimates based on ARDL (1,0,1,0) and selected lag based on AIC

$$\Delta(m-p) = \alpha_0 + \sum_{j=1}^{n} b_j \Delta(m-p)_{t-j} + \sum_{j=0}^{n} c_j \Delta No_{t-j}^s + \sum_{j=0}^{n} d_j \Delta r_{t-j} + \sum_{j=0}^{n} e_j \Delta \pi_{t-j} + \delta_1 (m-p)_{t-1}$$
$$+ \delta_2 No_{t-1}^s + \delta_3 r_{t-1} + \delta_4 \pi_{t-1} + \delta_5 D_{81} + \varepsilon_t$$

Variables	No^s	π	r	Constant	D1987	D2003
coefficients	0.4102	-0.3624	-0.0987	1.3204	-0.0738	-0.1166
t-statistics	10.1153	-3.1979	-1.5171	1.8935	-1.6850	-1.6537
R²=0.76	D-W=2.14					

Equation 25: The long-run coefficient estimates based on ARDL (1,0,1) and selected lag based on AIC

$$\Delta \dot{w} = \alpha_0 + \sum_{j=1}^{n} b_j \Delta \dot{w}_{t-j} + \sum_{j=0}^{n} c_j \Delta(No^d - No^s)_{t-j} + \sum_{j=0}^{n} d_j \Delta \pi_{t-j} + \delta_1 \dot{w}_{t-1} + \delta_2 (No^d - No^s)_{t-1} + \delta_3 \pi_{t-1} + \varepsilon_t$$

Variables	$(No^d - No^s)$	$\dot{\pi}$				
coefficients	0.6778	0.4109				
t-statistics	1.6985	2.2924				
R²=0.73	D-W=2.13					

Table-4. Continued

Equation 26: The long-run coefficient estimates based on ARDL (2,0,1,2,0,0) and selected lag based on AIC

$$\Delta No^s = \alpha_0 + \sum_{j=1}^{n} b_j \Delta No_{t-j}^s + \sum_{j=0}^{n} c_j \Delta k_{t-j}^p + \sum_{j=0}^{n} d_j \Delta k_{t-j}^g + \sum_{j=0}^{n} e_j \Delta k_{t-j}^h + \sum_{j=0}^{n} f_j \Delta l_{t-j} + \sum_{j=0}^{n} g_j \Delta k_{t-j}^{cap}$$
$$+ \delta_1 No_{t-1}^s + \delta_2 k_{t-1}^p + \delta_3 k_{t-1}^g + \delta_4 k_{t-1}^h + \delta_5 l_{t-1} + \delta_6 k_{t-1}^{cap} + \delta_7 D_{89} + \varepsilon_t$$

Variables	k^p	k^g	k^h	k^{cap}	em	Constant	D1996
coefficients	0.0866	0.5061	0.5225	0.3105	0.2014	-2.4822	0.0416
t-statistics	0.9019	4.2342	2.4162	2.0154	2.1358	-2.1223	0.3905
R²=0.87	D-W=1.93						

Equation 27: The long-run coefficient estimates based on ARDL (2,0,2,0,0) and selected lag based on AIC

$$\Delta \dot{f} = \alpha_0 + \sum_{j=0}^{n} c_j \Delta T_{t-j} + \sum_{j=1}^{n} b_j \Delta \dot{f}_{t-j} + \sum_{j=0}^{n} c_j \Delta r^* f_{t-j} + \sum_{j=0}^{n} d_j \Delta(o^x + po)_{t-j} + \sum_{j=0}^{n} e_j \Delta(e-w)_{t-j}$$
$$+ \delta_1 \dot{f}_{t-1} + \delta_2 T_{t-1} + \delta_3 r^* f_{t-1} + \delta_4 (o^x + po)_{t-1} + \delta_5 (e-w)_{t-1} + \varepsilon_t$$

Variables	T	$r^* f$	$(o^x + po)$	$(e-p)$	Constant	Trend
coefficients	0.1506	0.5175	0.3250	-0.3787	-0.9352	0.0058
t-statistics	1.1327	4.1594	2.0135	-1.2976	-1.3189	1.8155
R²=0.86	D-W=2.16					

Table-5. Testing for the Existence of a Long-Run Relationship among the Variables*

Equation	95% Lower bound	95% Upper bound	90% Lower bound	90% Upper bound	The computed F-statistic
$F(c^p / No^s, w^p, D_{83}, D_{2000})$	7.1331	8.1223	5.9643	6.8483	8.5036
$F(x^n / (e+p^*-p), y^*, D_{78}, D_{2000})$	7.2027	8.0224	5.9599	6.8090	9.5687
$F(m^{con} / y, (e-p^*-p), D_{87}, D_{2003})$	6.8999	7.9831	5.7676	6.7289	6.9717
$F(m-p / No^s, r, \dot{\pi}, D_{81})$	4.9827	5.9803	4.1361	5.0154	6.1426
$F(\dot{w}/(No^d - No^s), \dot{\pi})$	2.8906	4.1355	2.2636	3.3349	6.7978
$F(No^s / k^p, k^g, k^h, em, k^{cap}, D_{89})$	3.6605	5.0006	3.0991	4.2756	6.2444
$F(\dot{f} / T, r^* f, (o^x + po), (e-p))$	4.0285	5.3829	3.3851	4.627	5.9057

*Critical values are obtained directly from the empirical results generated by Microfit 5.

5. MODEL SIMULATION AND FISCAL POLICY OPTIONS

The impact of oil revenue and its expenditure in the form of consumption or capital investment on the Libyan macroeconomy for the case of oil production rehabilitation is now analyzed. Four scenarios B, C, D and E are compared with scenario A, which represents the base scenario[17]. The policy simulation analysis emphasizes dynamic adjustment to long-run steady state with focus on a number of key macroeconomic variables arising from oil related shocks. These variables are real income, real oil income, non-oil output, private capital stock, public capital stock, human capital stock, imported capital stock, foreign asset stock, non-oil trade balance, real exchange rate, domestic prices and private sector real wealth[18].

Five simulation scenarios are conducted, as shown below, representing government policy responses toward oil production rehabilitation. It is assumed for each of these scenarios that there is an overall 60 per cent recovery in oil production to its pre-civil war level of 1.6 million bpd. It is also assumed that it takes 5 time periods for oil production to recover to its pre-civil war level. Regarding the oil price it is assumed to remain constant as the rehabilitation of Libyan oil production will place downward pressure on it, whereas the expected embargo and sanctions on Iran and Middle East instability will exert upward pressure[19]. The relevant policy determined parameters for the government responses are θ_1, the proportion of government spending allocated towards the desired public (physical) capital stock (infrastructure), θ_2, the proportion of government expenditure allocated towards human capital stock, θ_3, the proportion of government spending directed towards imported capital (technology) stock, and then the remainder $(1 - \theta_1 - \theta_2 - \theta_3)$ which is directed to government consumption expenditure. The five simulation scenarios arising from a recovery of oil production, and its impact upon eleven macroeconomic variables, are as follows:

Scenario A: 60% increase in oil production, representing the base scenario.

A: $\theta_1 = 0.30$, $\theta_2 = 0.20$, $\theta_3 = 0.20$, and $(1 - \theta_1 - \theta_2 - \theta_3) = 0.30$

Scenario B: 60% increase in oil production with an expansion in government spending on the public capital stock (infrastructure).

B: $\theta_1 = 0.40$, $\theta_2 = 0.20$, $\theta_3 = 0.20$, and $(1 - \theta_1 - \theta_2 - \theta_3) = 0.20$

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[17] These simulation scenarios are conducted by using a program called "Dynare", which is designed for solving and simulating deterministic and stochastic dynamic general equilibrium models (see, Adjemian, Bastani, Juillard, Mihoubi, George, Ratto and Villemot (2011)).

[18] The adjustment of a number of macroeconomic variables can be obtained from the simulation analysis. However in order to keep the discussion of the results tractable, focus is placed only on a few key variables as emphasised here.

[19] The slight upward or downward changes in the oil price associated with rehabilitation of oil production, in the context of this study, will not influence the profile of the adjustment path of the variables of interest, but will affect only the magnitude of their deviation from the baselines.

Scenario C: 60% increase in oil production with expansion in government spending on human capital.

C: $\theta_1 = 0.30$, $\theta_2 = 0.30$, $\theta_3 = 0.20$, and $(1 - \theta_1 - \theta_2 - \theta_3) = 0.20$

Scenario D: 60% increase in oil production with expansion in government spending on imported capital (technology).

D: $\theta_1 = 0.30$, $\theta_2 = 0.20$, $\theta_3 = 0.30$, and $(1 - \theta_1 - \theta_2 - \theta_3) = 0.20$

Scenario E: an instantaneous and unanticipated 60% increase in oil production in conjunction with an expansion in government consumption spending.

E: $\theta_1 = 0.20$, $\theta_2 = 0.20$, $\theta_3 = 0.20$, and $(1 - \theta_1 - \theta_2 - \theta_3) = 0.40$

5.1 Oil Production Increase (altering θ_1, θ_2 and θ_3)

The steady state properties of all the above scenarios are summarized in Table 6 and can be compared with the base scenario A[20]. Also, the adjustment path of each variable of interest toward long run steady state is shown in Figure 1. The simulation results of the base scenario, scenario A, show that the increase in oil production can produce: an increase in government revenue, and increased government spending in the domestic economy including that on economic development programs. This potentially results in an increase in private capital stock, private sector wealth, real income, public capital stock, human capital stock, imported capital stock and non-oil output supply and demand. However, these developments have also produced adverse consequences upon the non-oil sector by a loss of competitiveness of non-oil tradable goods arising from an appreciation of the real exchange rate during the adjustment process, increased imports arising from increased real income, and, accordingly, a deterioration of the non-oil trade balance. The simulation results also indicate that the government can play an essential role in the way that the additional oil revenues generated from an increase in oil production are spent, and hence in promoting alternative economic development outcomes.

Table-6. Steady state properties of the model for government response scenarios (B, C, D and E) and the base model (A) (Percentage deviation from baseline)

Variable	g	f	T	ℓ	w^p	y	No^s	k^g	k^h	k^{cap}	k^p
A	40	23	-11.5	0.0	25.0	23.0	16.0	15.0	10.0	10	17
B	40	25	-14.0	0.0	30.0	29.0	21.0	20.0	10.0	10	22
C	40	25	-14.0	0.0	30.0	28.0	20.0	15.0	15.0	10	21
D	40	25	-13.8	0.0	29.0	27.0	19.0	15.0	10.0	15	21
E	40	25	-13.0	0.0	22.5	21.0	13.0	10.0	10.0	10	16

*Oil production increase

The simulation results in Table 6 and Figure 1 show that foreign asset stocks initially accumulate throughout the adjustment path in all scenarios, indicating substantive current account

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[20] The numbers in Table 6 display the long run deviations in the steady state values of the variables of interest, in percentage terms, from their initial base values.

surpluses. Foreign asset stocks accumulate by 25% in all scenarios in long run steady state. In general, the superior developments in the current account in the long run steady state is due to an increase in oil production, and also to an increase in foreign interest income arising from higher foreign asset stocks *per se*.

The real exchange rate initially appreciates in all scenarios, but more so for base scenario A and scenario E. In scenario E the real exchange rate appreciates by approximately 7% from its initial base value on impact and consistently overshoots its long run rate throughout the adjustment process. This is due to the fact that in this scenario the price level rises by more which contributes to a greater loss of competitiveness for non-oil tradable goods, as the real exchange rate appreciates by more and deteriorates the non-oil trade balance in comparison with the other four scenarios (A, B, C, and D). Thereafter, the real exchange rate depreciates gradually toward its long run steady state, indicating a more competitive situation for the non-oil tradable sector and slightly alleviates the Dutch disease consequences[21] during adjustment to long run steady state. The above results suggest that Dutch disease effects can be mitigated through a more investment oriented policy by government. That is, more development spending upon infrastructure, human capital and technology acquisition will enhance non-oil output supply, and improve the competitiveness and performance of the non-oil tradable sector and the non-oil trade balance overall. Even though more spending on technology acquisition from overseas will have adverse effects upon the non-oil trade balance in the form of an increase in non-oil imports, it also improves domestic non-oil output supply. The simulation results also show that during the dynamic adjustment process an increase in

θ_1, θ_2 and θ_3 produce a higher and continuous increase in non-oil output and mainly in scenario

B. On the other hand, an emphasis on expanding government consumption expenditure, as in scenario E, also increases non-oil output, but this is much less than that for the base and other

scenarios. In long run steady state non-oil output increases by more the larger is θ_1[22] (by 21% in

scenario B). However, without an increase in the share of government capital spending in total expenditure, as in scenario E, non-oil output increases to a level below that of the base scenario, where it increases by only 13% compared to that of 16% for the base case. The major contributory factors for these differences in outcomes during the adjustment process relate to changes in private capital, public capital, human capital and imported capital (see Figure 1). As these increase during the adjustment process for scenarios B, C and D a higher level of non-oil output supply is produced. The increase in non-oil output stimulates demand via private consumption and private investment. The increase in non-oil output increases the nation's real income and induces imports to rise, thereby possibly leading to a trade balance deficit. Thus, the positive effects of an increase in non-oil output are offset partially by deterioration in the non-oil trade balance. However, it is

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[21] The Dutch Disease refers to the situation in which a booming sector, the oil sector in this case, results in an increase in the relative price of non-tradable goods to that of non-oil tradable goods, resulting in a reallocation of production factors towards the oil sector and non-tradable goods and harming growth in the non-oil tradable goods sector.
[22] An increase in investment in the economy increases the productivity of the non-oil sector, and hence real income. This would induce imports to rise, thus possibly resulting in a deficit in the non-oil trade balance.

apparent that it is changes in the real exchange rate that are more important in terms of influencing changes in the non-oil trade balance.

The Dutch disease effect, in terms of loss of non-oil output, is not likely to occur during the early stage of the adjustment process toward long run steady state from the above results. It is assumed that the windfall revenues arising from the rehabilitation of the oil sector bring about a real exchange rate appreciation, which in turn reduces the competitiveness of the non-oil tradable sector, thus undermining the output of the non-oil tradable sector. However, in this case the Dutch disease effect during the early periods of adjustment could be offset by increased spending on public, human and imported capital, which stimulates an accumulation in physical, human and imported capital stocks and, thereby, increasing non-oil output supply[23] (see Figure 1).

Private sector real wealth increases throughout the adjustment process towards the long run steady state, and mainly in scenarios B, C and D. Specifically, altering θ_1, θ_2 and θ_3 in scenarios B, C and D, has noticeable positive effects upon private sector real wealth. This can be attributed to the larger accumulation of public capital stock, human capital and imported capital stock improving private investment and the accumulation of private capital stock. Nevertheless, private sector real wealth also increases in scenario E but by less than that of the base and other scenarios.

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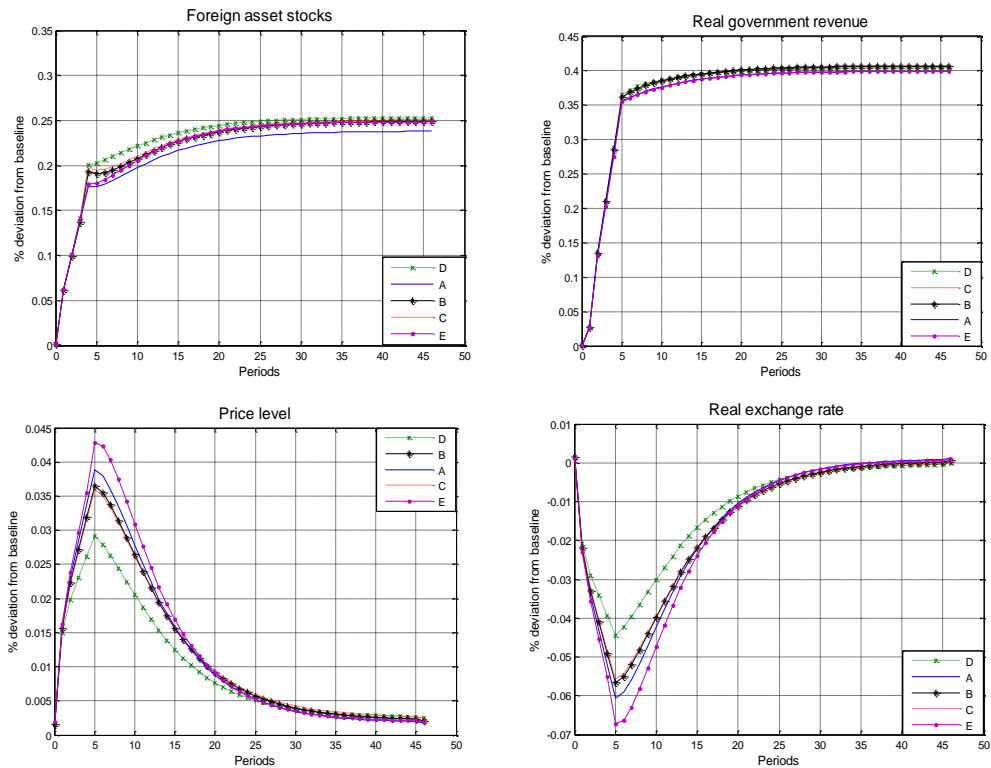
23 Another possible explanation for this result is that the real wage is not included in Equation (24) due to technical problems. Therefore the absence of this variable could mitigate the Dutch disease effect upon non-oil output.
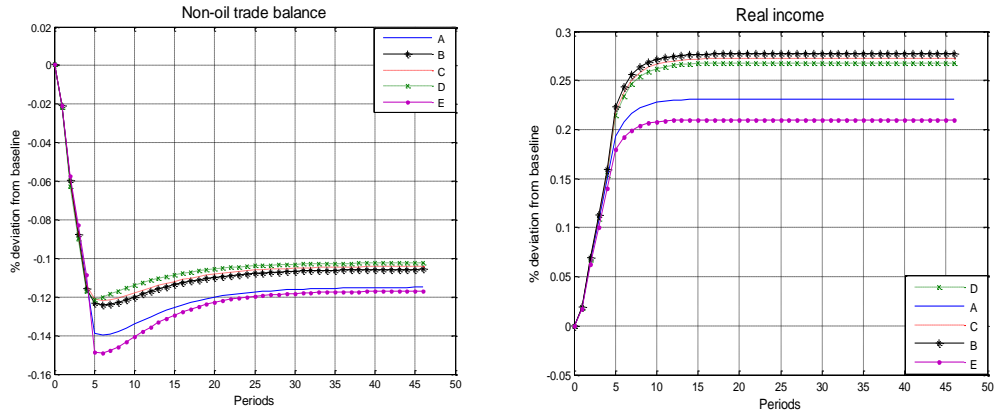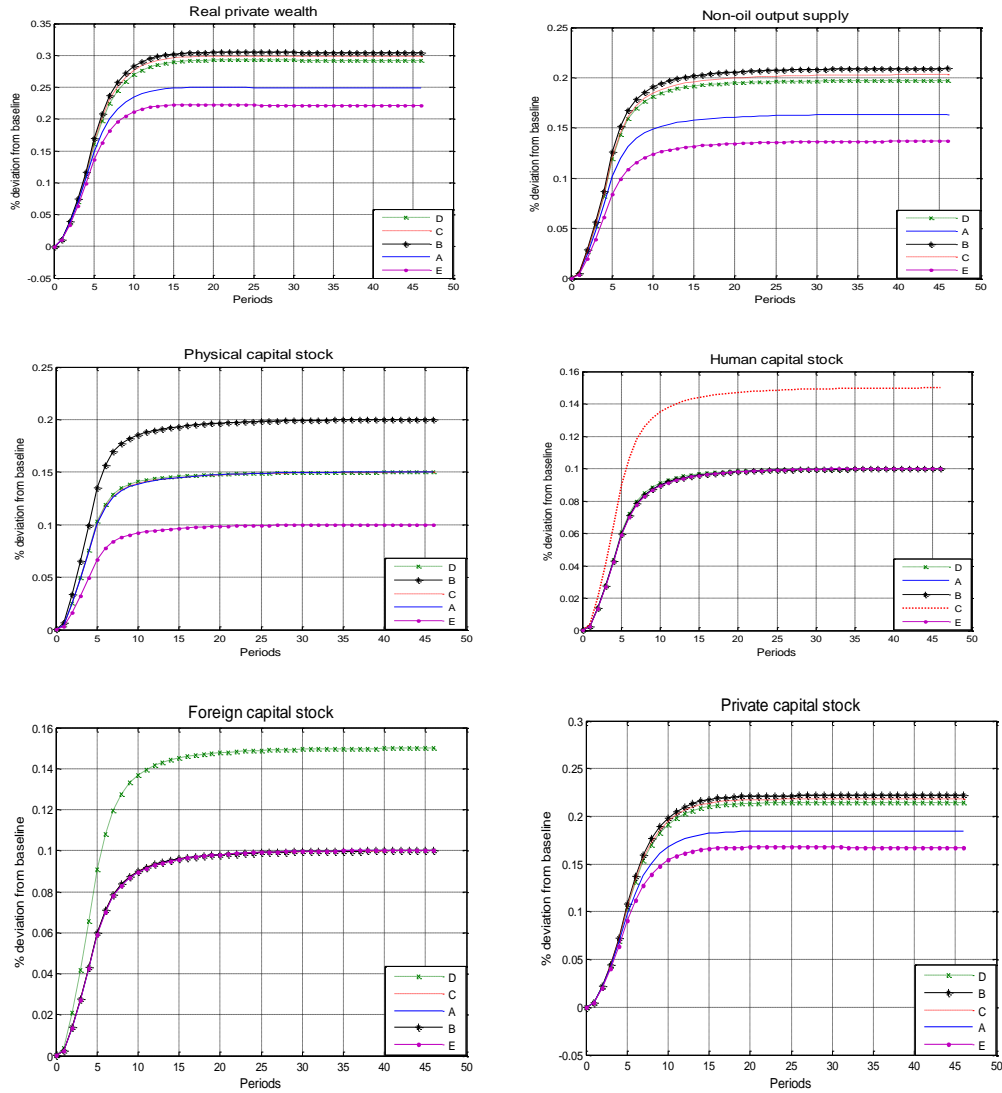
Figure-1. Oil production rehabilitation (Altering θ_1, θ_2 and θ_3)

6. CONCLUDING REMARKS

This paper has developed and utilized a dynamic general equilibrium macroeconomic model for Libya, an important oil producing and exporting economy, aimed at evaluating the effects of additional oil revenue upon key macroeconomic variables. Additional oil revenue is assumed to have occurred as a result of oil production rehabilitation. The model developed and results presented in this paper are likely to be of interest to other developing economies with a similar abundance of natural resources.

The simulation results for the base scenario for the Libyan economy suggests that an increase in oil production by 60 percent would potentially result in an increase in private capital stock, private sector wealth, real income, public capital stock, human capital stock, imported capital stock and non-oil output supply and demand. However, the oil sector boom also has the potential to deteriorate the non-oil trade balance through a loss of competitiveness from a real exchange rate appreciation. The fiscal policy responses by government have a crucial role to play in maximizing the benefits from a booming oil sector, and to alleviate and/or eliminate the adverse effects of the oil boom upon some macroeconomic variables. This is due to the fact that in the case of the Libyan economy a key transmission mechanism of an oil shock is through government fiscal expenditure, as the oil sector is effectively publically owned. This crucial role takes the form of implementing policy measures aimed at increasing productivity in the non-oil output sector, such as the manufacturing and agricultural sectors, through increasing government investment in infrastructure (physical capital), human capital and technology acquisition in this sector. By conducting alternative simulation scenarios this paper concluded that a targeted investment oriented policy focusing upon government expenditure on public capital (infrastructure), human capital (education and training) and imported capital (western technology) will produce noticeable and sustainable beneficial outcomes for the private sector, non-oil output supply, employment and the overall economy. This will also further increase government tax revenue and in turn government development spending, and further stimulate private sector wealth and the development of the economy as whole. On the other hand, a development oriented policy enhances the demand side via a smaller appreciation of the exchange rate, which improves non-oil exports and thereby the non-oil trade balance. This will also facilitate an improved performance in terms of foreign asset stocks which can be subsequently utilized to obtain important capital and technology and further enhance the private sector and the development of the economy as a whole.

It is believed that the short and long-run feasible strategy of sustainable development for Libya is to utilize the oil revenue not only to develop its infrastructure, but also to accumulate foreign technology acquisition and to achieve a highly skilled and well-educated labour force. This strategy will offer Libya the capacity to use and absorb the foreign capital and ultimately develop its own economy. An accumulation of physical, human and foreign capital stock would transfer the economy into a well-equipped one able to diversify and build a viable non-oil economy, and, therefore, to maintain and improve its competitive advantages. That is, it will enhance the ability of the Libyan economy to withstand shocks in the future by promoting diversification of the economy

towards other tradable and more labor-intensive sectors such as that of agriculture and manufacturing. Therefore, if additional oil revenue is utilized in an appropriate and targeted manner to stimulate public capital, human capital and technological acquisition, then oil wealth will be seen as a blessing and not a curse as its Dutch disease consequences can be mitigated. The optimal allocation of government development expenditure between these three forms of expenditure will depend upon existing capital and technology constraints and relative effectiveness, requiring a more detailed analysis that is beyond the scope of the present study.

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