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Exogenous oil shocks and the fiscal policy response in oil-exporting countries: evidence from Libya

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Abstract

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EXOGENOUS OIL SHOCKS AND THE FISCAL POLICY RESPONSE IN OIL-EXPORTING COUNTRIES: EVIDENCE FROM LIBYA

*Issa Ali and Charles Harvie**

Introduction

The downtrend in oil prices beginning in 2014 represents a challenge for small-open developing and exporting economies like Libya. This stems from the importance of government revenue generated from the natural resource sector in financing government consumption and investment expenditures as well as capital imports. The dependency on the natural resource sector and a relatively weak non-natural-resource tax base renders fiscal positions highly challenging in oil-exporting countries. As more than 90 percent of Libya's government revenue is generated from the oil sector, the budget components are the most influenced by oil-related shocks. Transitory oil price increases, especially after 2000, brought about fiscal surpluses in the government budget and the trade balance, and this, in turn, induced the government to increase consumption and development spending. In particular, several development projects were implemented that originally aimed to build a viable economy through diversification and by increasing the

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share of the nonoil sector in gross domestic product (GDP), particularly the nonoil tradable sector such as those of manufacturing and agriculture.

However, Libya experienced major political and economic upheaval arising from eight months of internal armed conflict in 2011. As a result of this, nonoil economic activities were disrupted, oil production almost halted, government revenues declined, and foreign assets were frozen due to sanctions imposed on the country by the United Nations Security Council.[1] Following the 2011 uprising, Libya undertook serious steps in order to improve the nation's security and economic situation, whereby efforts to rehabilitate oil production allowed the country to come close to reaching its per-war level of 1.6 million barrels per day by the end of 2012.[2] Additionally, the financial situation improved as most of the imposed sanctions were lifted, enabling the central bank to provide liquidity in foreign currency. Furthermore, significant financial surpluses were achieved and government current expenditures were increased, especially salaries and wages, administrative expenses, and fuel subsidies.

However, the recent decline in world oil prices, which started in June 2014 and resulted in a price fall of more than 50 percent by the end of January 2015, placed greater pressure on the nation. This was further compounded when the amount of oil production decreased significantly as a result of armed conflict in the "Oil Crescent" in eastern Libya resulting in a steep production decline—less than 400 thousand barrels per day—which is adversely affecting key macroeconomic variables, particularly oil government revenues and expenditures. In the case of the continued decline in oil prices and production, oil revenue is expected to have sharply dropped in 2015 and the government's budget is expected to experience a large deficit. This requires designed fiscal policy to curb the growth in government spending and to increase nonoil revenues generated from nonoil economic activities so as to reduce the expected budget deficit and find alternative sources for its financing.

Therefore, there is an urgent need to investigate the impact of lower oil prices and production upon the Libyan government's budget and other key macroeconomic variables in order to develop appropriate economic policies to address the negative effects on the government's budget.

The remainder of this paper proceeds as follows: an outline of the theoretical framework of the model is provided in the second section. Next, we offer a description of our data sources and estimation procedures. In the fourth section, we present the simulation outcomes from the model for the case of oil-related shocks and, in the final portion, we give our concluding remarks.

Theoretical Framework: The Model

This study has utilized a general dynamic macroeconomic model for the Libyan economy developed by I. Ali and C. Harvie.[3] The model is more applicable for the case of a fixed exchange rate in the context of a developing resource-abundant country. It also can be adapted for the case of a flexible exchange rate in the context of a developing resource-abundant country (see, I. Ali and C Harvie's 2015 article).[4] The model has its foundation in the contributions of R. Dornbusch, W. Buiter and M. Miller, R. Eastwood and A. Venables, W. Buiter and D. Purvis, J. Neary and S. Van Wijnbergen, C. Harvie and L. Gower, C. Harvie and A. Thaha, and, more recently and importantly, G. Cox and C. Harvie for the case of a flexible exchange rate in the context of advanced resource-abundant economies.[5] 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, labor, and external sectors).

However, I. Ali and C. Harvie[6] argue 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.[7] They suggest that since oil production and revenue generated from its production is under government control, the way in which the government spends oil revenues 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.

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

The model is capable of analyzing the impact of oil-related shocks on macroeconomic variables of interest, particularly, government revenues, government spending, budget deficit, foreign assets, real income, and nonoil output supply.

The model utilized in this paper is extensively discussed by I. Ali and C. Harvie.[8] The equations of the model and explanation of symbols used in the model are contained in tables 1 and 2, respectively. A brief discussion of the model is presented in the Appendix.

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. The relevant data were obtained from two different sources, i.e., international and local publications such as the Central Bank of

Table 1
ALI AND HARVIE MACROECONOMIC MODEL FOR LIBYA[a]

Equations	Equation Number
Product Market	
$No^d = \beta_1 c^p + \beta_2 i^p + \beta_3 g + \beta_4 (x^n - m^n)$	1
$c^p = \beta_6 No^s + \beta_7 w^p$	2
$i^p = \dot{k}^p = \gamma\left(k^{p*} - k^p\right)$	3
$k^{p*} = \delta No^s$	4
$g = \beta_8 c^g + \beta_9 i^g + \beta_{10} i^h + \beta_{11} i^{cap}$	5
$c^g = (1 - \theta_1 - \theta_2 - \theta_3)(o^a + po + e - p)$	6
$i^g = \dot{k}^g = \varphi\left(k^{g*} - k^g\right)$	7
$i^h = \dot{k}^h = \sigma\left(k^{h*} - k^h\right)$	8
$i^{cap} = \dot{k}^{cap} = \lambda\left(k^{cap*} - k^{cap}\right)$	9
$k^{g*} = \theta_1 (o^a + po + e - p)$	10
$k^{h*} = \theta_2 (o^a + po + e - p)$	11
$k^{cap*} = \theta_3 (o^a + po + e - p)$	12
$bd = g - t^x = \beta_{12} (\dot{m} - \dot{p})$	13
$t^x = \beta_{13} (o^a + po + e - p) + (1 - \beta_{13}) No^s$	14
$x^n = \beta_{14}\left(e + p^* - p\right) + \beta_{15} y^*$	15
$m^{com} = \beta_{16} y - \beta_{17}\left(e + p^* - p\right)$	16
$y = vNo^s + (1 - v)o^a + (1 - v - \mu_2)po + (\mu_1 - v)(e - w) - (1 - \mu_1 - \mu_2)p^*$	17
$y^p = vNo^{sp} + (1 - v)o^p + (1 - v - \mu_2)po + (\mu_1 - v)(e - w) - (1 - \mu_1 - \mu_2)p^*$	18
Asset Market	
$m - p = \varepsilon_1 No^s - \varepsilon_2 \pi - \varepsilon_3 r$	19
$w^p = \varepsilon_5 k^p + \varepsilon_6 (m - p) + \varepsilon_7 y^p$	20
$\dot{m} = d\dot{c}e + \tau\left(r - r^* + \dot{f}\right)$	21
Aggregate Supply and Demand	
$p = \mu_1 w + \mu_2 (e + po) + (1 - \mu_1 - \mu_2)\left(e + p^*\right)$	22
$\dot{w} = \psi_1\left(No^d - No^s\right) + \psi_2 \dot{m}$	23
$No^s = \Phi_1 k^p + \Phi_2 k^g + \Phi_3 k^h + \Phi_4 k^{cap} + \Phi_5 em$	24
External Sector	
$\dot{f} = \alpha_1 (x^n - m^n) + \alpha_2 r^* f + \alpha_3 (o^x + po) - (1 - \alpha_2 - \alpha_3)(e - p)$	25
$o^x = \xi o^a$	26
Definitions	
$c = e - w$	27
$l = m - w$	28
$T = x^n - m^n$	29
$m^n = m^{com} + i^{cap}$	30

[a] A dot (.) above a variable signifies its rate of change.

Libya, *International Financial Statistics (IFS) Yearbook* published by the International Monetary Fund (IMF), *Annual Statistical Bulletin* published by the Organization of Petroleum Exporting Countries (OPEC), and *World Development Indicators* (WDI) issued by the World Bank.

Table 2
EXPLANATION OF SYMBOLS USED IN THE MODEL

Endogenous Variables			
No^d	Aggregate demand for nonoil output	m	Nominal money supply
c^p	Private consumption	π	Inflation rate
i^p	Private investment	p	Consumer price level
k^{p*}	Desired private capital stock	w	Domestic nominal wage
g	Total government spending	m^{com}	Consumption of nonoil imports
c^g	Government consumption expenditure	y	Total real income
x^n	Nonoil exports	y^p	Permanent real income
m^n	Nonoil imports	f	Foreign asset stocks
T	Nonoil trade balance	o^x	Oil exports
No^s	Aggregate supply for nonoil output	c	Real exchange rate
w^p	Real private sector wealth	l	Real money balance
k^p	Private capital stock		**Exogenous Variables**
k^{cap}	Imported capital stock	e	Nominal exchange rate
k^s	Actual public capital stock	o^a	Oil production
k^h	Human capital stock	po	World oil price (in foreign currency)
k^{s*}	Desired government physical capital stock	p^*	Price of nonoil imported goods
k^{h*}	Desired human capital stock	y^*	World real income
k^{cap*}	Desired imported capital stock	No^{sp}	Permanent nonoil income
i^g	Government investment spending on physical capital	o^p	Permanent oil income
i^h	Government investment spending on human capital	r^*	World nominal interest rate
i^g	Government investment spending on imported capital	r	Domestic nominal interest rate
t^x	Total tax revenue	em	Employment

The empirical estimation of the behavioral equations of the macroeconomic model developed by I. Ali and C. Harvie[9] was conducted by using robust and contemporary estimation procedures, namely, the auto-regressive distributed lag (ARDL) model (see B. Pesaran and M. Pesaran, and M. Pesaran et al.).[10] However, before the model was estimated, it was necessary to verify the following: (1) stationarity of time series and identifying the structural-break points, utilizing the two-break minimum Lagrange multiplier (LM) unit root test,[11] and (2) investigating the existence of a long-run relationship among the variables in the behavioral equations using the F-test (see table 3). Once a long-run cointegrating relationship was found to exist, the next step was to estimate the long-run elasticities. The parameters obtained from estimation of the behavior equations and those calculated from available data are summarized in table 4.

Table 3
TESTING FOR THE EXISTENCE OF A LONG-RUN RELATIONSHIP AMONG THE VARIABLES[a]

Equation	**95% Lower Bound**	**95% Upper Bound**	**90% Lower Bound**	**90% Upper Bound**	**Computed F-Statistic**
$F(c^p/No^s, w^p, D_{83}, D_{2000})$	7.1331	8.1223	5.9643	6.8483	8.5036
$F\left(x^n/\left(e+p^* - p\right), y^*, D_{78}, D_{2000}\right)$	7.2027	8.0224	5.9599	6.8090	9.5687
$F\left(m^{com}/y, \left(e - p^* - p\right), D_{87}, D_{2003}\right)$	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
$F\left(\dot{w}/No^d - No^s\right), \dot{\pi}$	2.8906	4.1355	2.2636	3.3349	6.7978
$F\left(No^s/k^p, k^g, k^h, em, k^{cap}, D_{89}\right)$	3.6605	5.0006	3.0991	4.2756	6.2444
$F\left(\dot{f}/T, r^*, f, (o^x + po), (e - p)\right)$	4.0285	5.3829	3.3851	4.6270	5.9057

[a] Critical values are obtained directly from the empirical results generated by Microfit 5.

Simulation Results from Decreased Oil Prices and Oil Production

The efficiency of the model is not confined to the extent of its quality when estimating the behavioral equations, but also how it works and its performance as a full system. This can be known through the conducting of a dynamic simulation process, which provides us with a full solution to the model. The model was simulated by using a program called "Dynare," which is designed for solving and simulating deterministic and stochastic dynamic general equilibrium models (see S. Adjemian et al.),[12] and it is also suitable for a small-open oil-exporting economy such as that of Libya.

The numerical simulations were conducted to analyze possible macroeconomic effects upon the key macroeconomic variables, particularly government revenues and expenditures arising from the exogenous shocks from decreased oil prices and oil production. The focus was placed on identifying the steady state properties of the model as well as the adjustment process toward the long-run steady state arising from an oil-related shock for a number of key macroeconomic variables. These variables are government revenues, government spending, the government budget, foreign assets, real income, nonoil GDP, price level, the real exchange rate, and oil exports.

The prediction of government revenue generated from the oil sector depends, *inter alia*, on oil prices and the produced and exported quantity of oil. Oil prices began to decline from about U.S. $100 per barrel at the beginning of the third quarter of 2014 to about U.S. $47 per barrel at the end of January 2015. Oil production has fallen from about 1.5 million barrels per day (bpd) in 2012 to about 450,000 bpd at the end of January 2015. The suggested scenarios for fluctuating oil prices and output and their impact upon a number of key macroeconomic

Table 4
PARAMETER VALUES[a]

Parameter	Value	Parameter	Value	Parameter	Value
β_1 ***	1.00	θ_1 **	0.30	ε_7 ***	1.00
β_2 ***	1.00	θ_2 **	0.20	τ ***	0.20
β_3 ***	1.00	θ_3 **	0.20	μ_1 ***	0.60
β_4 ***	0.75	β_{12} **	1.00	μ_2 ***	0.10
β_6 *	0.60	β_{13} *	0.90	ψ_1 *	0.65
β_7 *	0.30	β_{14} *	0.45	ψ_2 *	0.40
γ ***	0.50	β_{15} *	0.50	Φ_1 *	0.10
δ *	0.80	β_{16} *	0.75	Φ_2 *	0.50
β_8 **	0.70	β_{17} *	0.25	Φ_3 *	0.40
β_9 **	0.30	ν **	0.70	Φ_4 *	0.30
β_{10} **	0.15	ε_1 *	0.80	Φ_5 *	0.20
β_{11} **	0.15	ε_2 *	0.35	α_1 *	0.15
φ ***	0.50	ε_3 *	0.10	α_2 *	0.50
σ ***	0.50	ε_5 ***	1.00	α_3 *	0.35
λ ***	0.50	ε_6 ***	1.00	ξ ***	0.80
				rs ***	0.05

[a] *= estimated coefficients obtained using autoregressive distributive lag (ARDL) as contained in table 3; ** = calculated by the authors based on available data; and *** G. M. Cox and C. Harvie, "Resource Price Turbulence and Macroeconomic Adjustment for a Resource Exporter: A Conceptual Framework for Policy Analysis," *Energy Economics,* vol. 32, no. 2 (2010), pp. 469–89, and C. Harvie and A. Thaha, "Oil Production and Macroeconomic Adjustment in the Indonesian Economy," *Energy Economics*, vol. 16, no. 4 (1994), pp. 253–70.

variables were based on logical and practical facts of political, economic, and security circumstances in Libya and in the international oil markets. The following represent possible scenarios for changes in oil prices and production and their impact on the most important macroeconomic variables.

Scenario A: This represents the worst case scenario, where oil production amounted to about 450,000 bpd in January 2015. This is due to the armed conflict on oil fields and ports in the Oil Crescent area in east of Libya. Since the Oil Crescent accounts for about 75 percent of all Libyan oil exports, the estimated decrease in oil production is about 70 percent. Also, for this scenario, we assume that oil prices fell to around U.S. $45 per barrel with a decreasing oil production rate of about 55 percent.

Scenario B: This scenario is based on the assumption that the conflict in the Oil Crescent area will be ended and production levels will gradually return to a pre-conflict level of about 1.5 million bpd, with the assumption that oil prices increase to around U.S. $55 per barrel. Also, several companies that extract light oil are expected to leave the oil market as a result of the high cost of extraction, which is estimated to be about U.S. $60 per barrel. This would reduce the oil supply and, in turn, cause an increase in oil prices. The production levels are expected to be 450,000, 800,000, 1 million, and 1.5 million bpd for the first, second, third, and fourth quarter of 2015, respectively. Therefore, this scenario assumes a 45-percent decrease in oil prices and, on average, a 37-percent decrease in oil production.

Scenario C: This scenario assumes the same oil production level predicted in scenario B, with an expected increase in oil prices to around U.S. $65 per barrel due to expected continual decline in oil supply. Therefore, this scenario assumes a 35-percent decrease in oil prices and a 37-percent decline in oil production.

The long-run steady state properties of all the above scenarios are summarized in table 5, displaying the deviations of the steady state values of the key macroeconomic variables, in percentage terms, from their presumed initial base values. Also, the impact of each shock upon the adjustment path of key macroeconomic variables of interest is summarized in figures 1A through 1I. The horizontal axis measures the time periods, while the vertical axis for each diagram measures the percentage deviation of each variable from its initial or base value. Each figure contains the three scenarios: A, B, and C.

Figure 1A
THE IMPACT OF OIL SHOCKS ON GOVERNMENT REVENUE
(percentage deviation from base line)

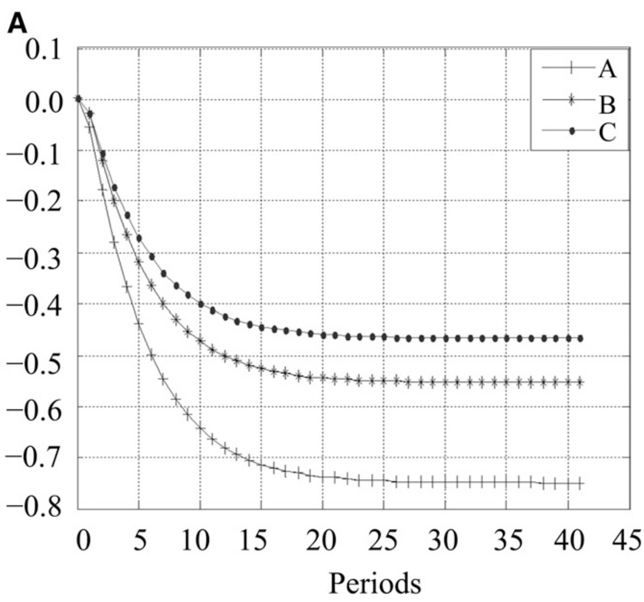

Figure 1B
THE IMPACT OF OIL SHOCKS ON GOVERNMENT SPENDING
(percentage deviation from base line)

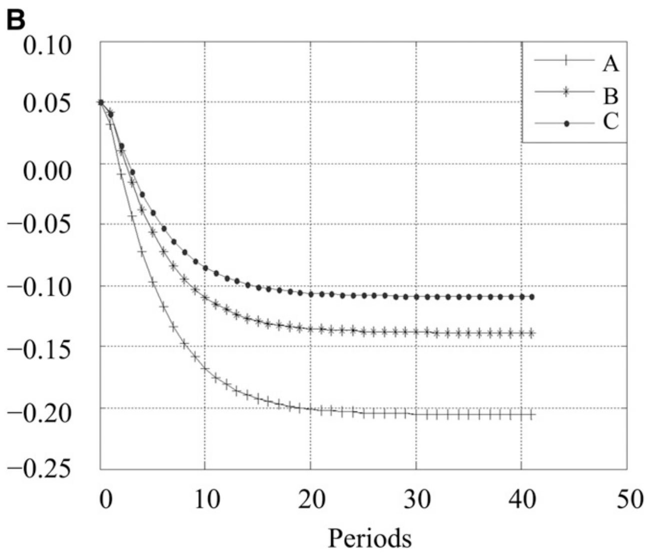

Figure 1C
THE IMPACT OF OIL SHOCKS ON BUDGET DEFICITS
(percentage deviation from base line)

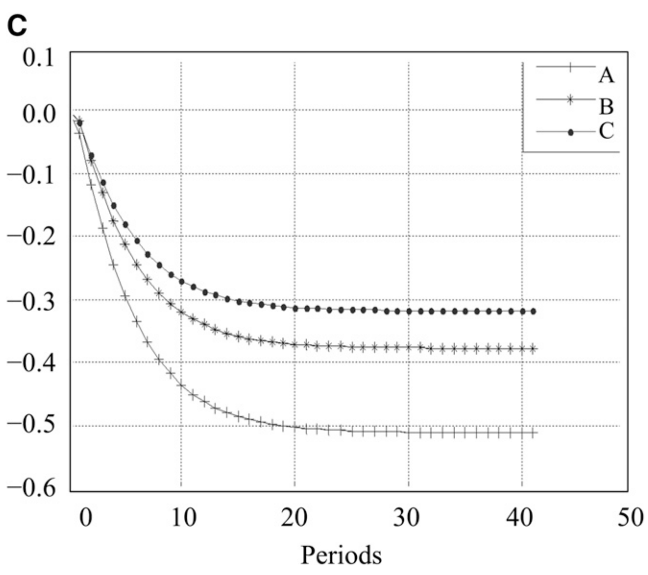

Figure 1D
THE IMPACT OF OIL SHOCKS ON FOREIGN ASSETS
(percentage deviation from base line)

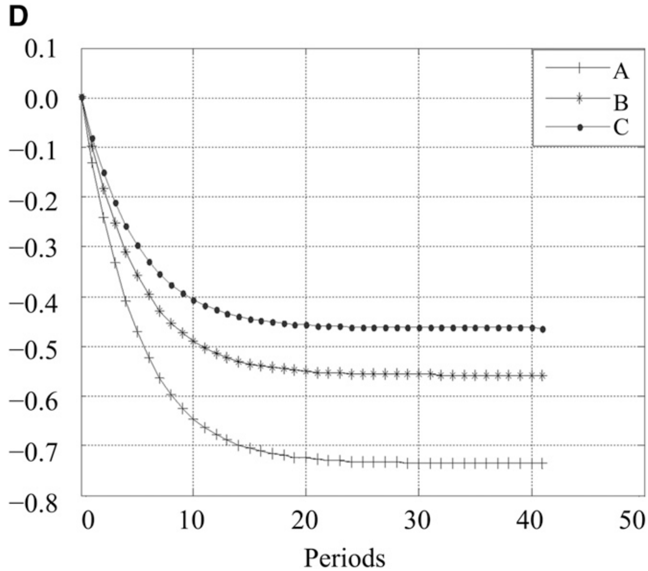

Figure 1E
THE IMPACT OF OIL SHOCKS ON OIL EXPORTS
(percentage deviation from base line)

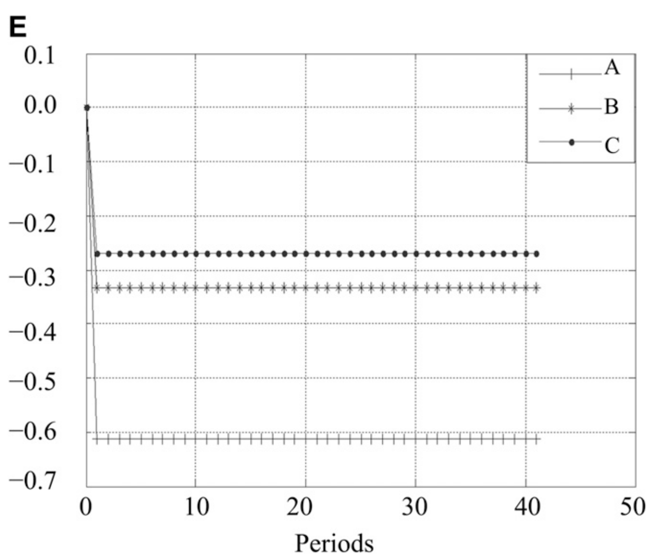

Figure 1F
THE IMPACT OF OIL SHOCKS ON PRICE LEVEL
(percentage deviation from base line)

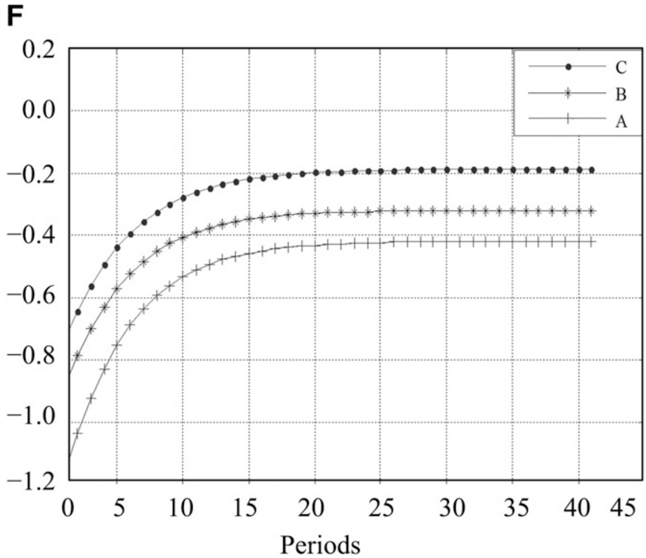

Figure 1G
THE IMPACT OF OIL SHOCKS ON REAL EXCHANGE RATE
(percentage deviation from base line)

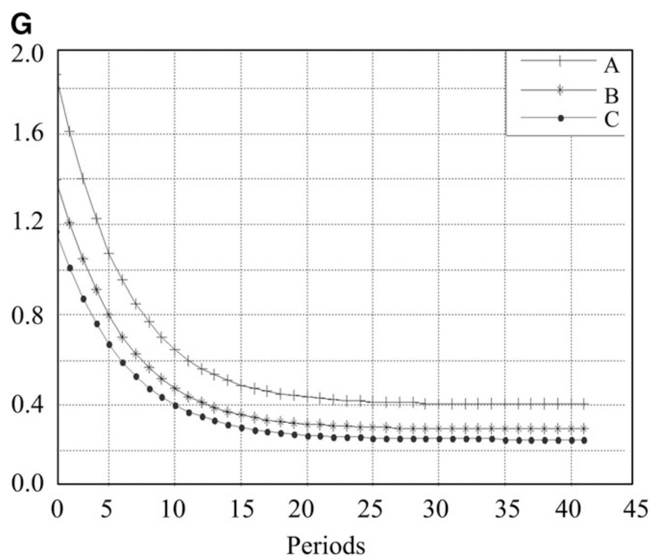

Figure 1H
THE IMPACT OF OIL SHOCKS ON REAL INCOME
(percentage deviation from base line)

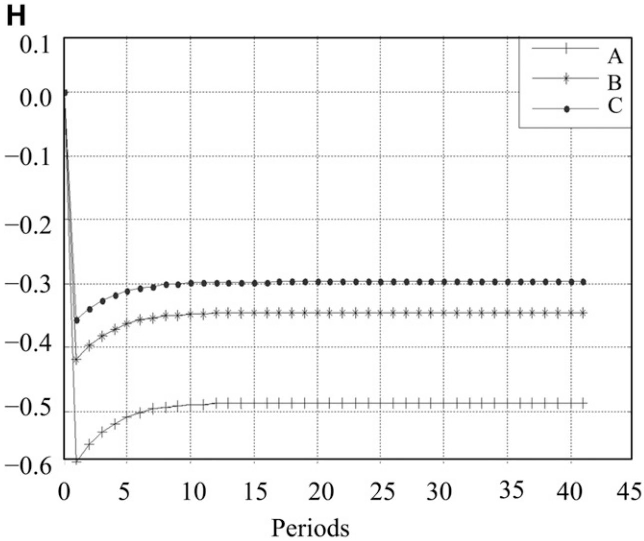

Figure 1I
THE IMPACT OF OIL SHOCKS ON NONOIL INPUT
(percentage deviation from base line)

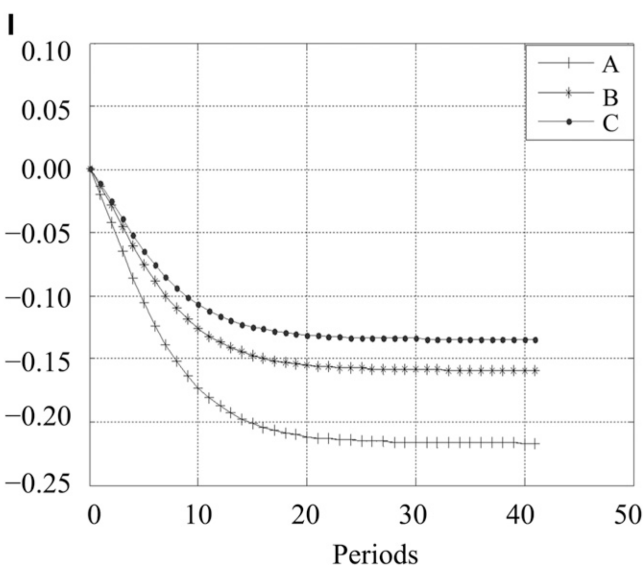

Table 5
STEADY STATE PROPERTIES OF THE SIMULATION RESULTS FROM THE MODEL[a]
(percentage deviation from the base line)

% Decline	Government Revenues	Government Spending	Government Budget	Foreign Assets	Real Income	Nonoil GDP	Price Level	Real Exchange Rates	Oil Exports
Scenario A Oa= 70 Op= 55	72	27	45	70	50	22	40	40	62
Scenario B Oa= 37 Op= 45	47	18	32	46	33	14	30	30	33
Scenario C Oa= 37 Op= 35	41	15	26	39	28	12	20	22	28

[a] Oa = oil production and Op = oil price.

The findings presented in table 5 and figures 1A through 1I show that the directions of changes of the macroeconomic variables of interest arising from three possible oil-related shocks are analogous. However, the magnitudes of the deviations differ, although they are comparable for all of the variables.

Government Budget (Government Revenue and Spending): The simulation results in table 5 and figure 1A show that a 55-percent decrease in oil prices and a 70-percent decrease in oil production lead to a decrease in government revenue continuously throughout the adjustment process toward long-run steady state in all scenarios, where the decline in government revenue is lower than its base value by 72 percent in the worst-case scenario (A), whereas it decreased by about 47 percent and 41 percent in scenarios B and C, respectively.

During the oil-sector negative shock period, the government decreases its expenditures to retain its balanced budget policy, resulting in decreased demand for both nonoil and imported goods—see equation (1). The government spending, as illustrated by figure 1B, is assumed to be reduced by about 27 percent in scenario A, thus, the budget deficit will be about 45 percent less than its base value. While in scenarios B and C government spending is supposed to be reduced by about 18 percent and 15 percent, respectively, which means that the predictable budget deficit will be about 32 percent less than its base value in scenario B and 26 percent less than its base value in scenario C (figure 1C).

Price Level and the Real Exchange Rate: The reduction in government revenue and spending would reduce the demand for tradable and non-tradable goods.

This would result in a lower domestic price level during the early stage of the adjustment path and a depreciation of the real exchange rate (see figure 1G). Afterward, the real exchange rate appreciates gradually toward its long-run steady state. A depreciation of the real exchange rate during the short run will have a significant influence upon the adjustment of a number of key macroeconomic variables, particularly nonoil exports, nonoil imports, and, therefore, the nonoil trade balance (which is not shown here) and, consequently, upon the domestic economy as a whole. The depreciation of the real exchange rate of the Libyan dinar will improve the nonoil trade balance.

Current Account (Foreign Assets): Figure 1D demonstrates the expected development in foreign assets arising from the oil-related shocks, where it shows that the decline in oil prices and production lead to de-accumulation of foreign asset stocks continuously throughout the adjustment process toward long-run steady state in all scenarios, signifying continual decline in the oil trade balance and current account surpluses. The decline in current account surplus arises from an immediate decrease in oil exports as it consists of more than 95 percent of total exports. As shown in table 5 and figure 1D, foreign assets are expected to decline by 70 percent in scenario A, 46 percent in scenario B, and 39 percent in scenario C.

The decline in foreign assets balances will result in a decline in the money supply and its growth, which, in turn, would place additional downward pressure on domestic prices and thus further depreciation of the real exchange rate. This eventually will help to reduce the nonoil trade deficit.

Real Income: Table 5 and figure 1H indicate that real income decreases continuously throughout the adjustment process toward the long-run steady state, with most of the decrease in real income occurring very early in the adjustment process. It is adversely influenced directly by a decrease in oil price and production and also by decline in nonoil output—see equation (17). In the long-run steady state, real income is approximately 50 percent lower than its base value in the worst case scenario A, 33 percent in scenario B, and 28 percent in scenario C, as indicated in table 5. On the demand side, a decrease in real income reduces nonoil imports, which, in turn, contributes to an improvement of the nonoil trade balance. However, the decline in capital imports may adversely affect the nonoil GDP, which relies on imported capital.

Nonoil GDP: It is noted that nonoil output supply will continuously decline throughout the period of the adjustment process toward the long-run steady state where it is lower than its base value by about 22 percent in scenario A, 14 percent and 12 percent in scenarios B and C, respectively, as shown in table 5 and figure 1I. The major contributory factors to this adverse development throughout the adjustment process include: the decrease in government investment spending on infrastructure, foreign capital imports, and human capital formation—see equation (24).

On the demand side, declining nonoil output decreases demand through private investment and private consumption—see equations (2) and (4). Also, a decrease in nonoil output supply will negatively affect total real income, which reduces imports, thereby possibly leading to easing the deficit in the nonoil trade balance. Moreover, the decline in nonoil GDP would negatively affect the amount of indirect taxes collected by the government from nonoil economic activities, which may further exacerbate government budget deficits.

Concluding Remarks

The main objective of this study was to analyze the effects of fluctuations in oil prices and production on the most important macroeconomic variables, particularly the government budget, using a general dynamic macroeconomic model for the Libyan economy developed by I. Ali and C. Harvie.[13] Three main scenarios have been assumed for the anticipated changes in oil prices and production and their impact on a number of significant macroeconomic variables. A sharp decline in oil price and production leads to a decrease in government revenue, government spending, and this brings about considerable budget deficits. The decline in oil prices and production also has negatively affected other economic variables such as foreign assets, gross domestic income, nonoil GDP, oil exports, and the current account. Furthermore, the oil-related shocks may lead to lower domestic prices and subsequent real exchange-rate depreciation of the Libyan dinar, which would improve the performance of the nonoil trade balance. However, the economy is challenged by another crisis resulting from the closure of its sea, air, and border ports. This has led to a decline in the flow of imported goods and, thus, caused a shortage in domestic supply. Consequently, this situation would generate an increase in the domestic price level, which may offset the reduction in the domestic price level resulting from decreasing oil prices and production.

Fiscal policy has an important role to play in alleviating adverse effects arising from decreased oil prices and oil production, and particularly upon the budget deficit. This crucial role can be in the form of addressing excess government consumption expenditure in certain areas such as public sector wages and salaries, which contribute to about half of budget and administrative expenses. In addition, oil revenue during the oil boom periods should be utilized to enhance nonoil sector productivity by developing the physical infrastructure, accumulating foreign technology, and investing in a highly skilled, well-educated and healthy labor force. This strategy, during the short and long run, will enhance the resilience of the Libyan economy to negative oil shocks by promoting the diversification of the economy toward other nonoil tradable and labor-intensive sectors such as that of agriculture and manufacturing. This, in turn, will increase the revenue generated from nonoil economic activities in the form of taxes and customs, and facilitate a strengthening of the overall budgetary position.

NOTES

[1] International Monetary Fund (IMF), *IMF Country Report–Libya* (Washington, D.C.: IMF, 2012).

[2]For more details about the impact of oil-sector rehabilitation upon key macroeconomic variables in Libya after the uprising of 2011, see I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era," *Economic Modelling,* vol. 32, issue C (2013), pp. 273–85.

[3]I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era."

[4]I. Ali and C. Harvie, "Oil-Related Shocks and Macroeconomic Adjustment under Different Nominal Exchange Rate Policy: The Case of Libyan Economy," *Journal of Energy and Development*, vol. 40, no. 1 (2015), pp. 23–50.

[5]R. Dornbusch, "Exchange Rate Dynamics," *Journal of Political Economy,* vol. 84, no. 6 (1976), pp. 1161–176; W. H. Buiter and M. H. Miller, "Monetary Policy and International Competitiveness: The Problem of Adjustment," *Oxford Economic Papers*, vol. 33, no. 0 (1981), pp. 143–75; R. K. Eastwood and A. J. Venables, "The Macroeconomic Implications of a Resource Discovery in an Open Economy," *Economic Journal,* vol. 92, no. 366 (1982), pp. 285–99; W. H. Buiter and D. D. Purvis, "Oil, Disinflation and Export Competitiveness: A Model of the Dutch Disease," in *Economic Interdependence and Flexible Exchange Rates*, eds. J. Bhandari and B. Putnam (Cambridge, Massachusetts: MIT Press, 1982); J. P. Neary and S. Van Wijnbergen, "Can an Oil Discovery Lead to a Recession? A Comment on Eastwood and Venables," *The Economic Journal*, vol. 94, no. 374 (1984), pp. 390–95; C. Harvie and L. Gower, "Resource Shocks and Macroeconomic Adjustment in the Short and Long Run," *The Middle East Business and Economic Review*, vol. 5, no. 1 (1993), pp. 1–14; C. Harvie and A. Thaha, "Oil Production and Macroeconomic Adjustment in the Indonesian Economy," *Energy Economics*, vol. 16, no. 4 (1994), pp. 253–70; and G. M. Cox and C. Harvie, "Resource Price Turbulence and Macroeconomic Adjustment for a Resource Exporter: A Conceptual Framework for Policy Analysis," *Energy Economics,* vol. 32, no. 2 (2010), pp. 469–89.

[6]I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era" and "Oil-Related Shocks and Macroeconomic Adjustment under Different Nominal Exchange Rate Policy: The Case of Libyan Economy."

[7]In the Cox-Harvie 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.

[8]I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era" and "Oil-Related Shocks and Macroeconomic Adjustment under Different Nominal Exchange Rate Policy: The Case of Libyan Economy."

[9]I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era."

[10]B. Pesaran and M. H. Pesaran, *Time Series Econometrics using Microfit 5.0* (Oxford, U.K.: Oxford University Press, 2009), and M. H. Pesaran, Y. Shin, and R. J. Smith, "Bound Testing Approaches to the Analysis of Level Relationship," *Journal of Applied Econometrics*, vol. 16, no. 3 (2001), pp. 289–326.

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[12]S. Adjemian, H. Bastani, M. Juillard, F. Karame, J. Maih, F. Mihoubi, J. Pfeifer, M. Ratto, and S. Villemot, "Dynare: Reference Manual-Version 4," Dynare Working Paper no. 1, Centre pour la Recherche Économique et ses Applications (CEPREMAP), Paris, 2011.

[13]I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era."

[14]For more discussion of the model see I. Ali and C. Harvie, "Oil and Economic Development: Libya in the Post-Qaddafi Era," and "Oil-Related Shocks and Macroeconomic Adjustment under Different Nominal Exchange Rate Policy: The Case of Libyan Economy."

[15]Nonoil output can be considered as a good that either can be consumed domestically or exported and is an imperfect substitute for the foreign nonoil imported good.

[16]A dot (.) above a variable signifies its rate of change.

[17]W. H. Buiter and D. D. Purvis, op. cit.

[18]C. Harvie, "Oil Shocks and the Macroeconomy: A Short- and Long-Run Comparison," *The Journal of Energy and Development*, vol. 18, no. 1 (1994), pp. 59–94.

[19]W. H. Buiter and D. D. Purvis, op. cit.

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

[21]C. Harvie, "The Macroeconomic Effects of Oil Shocks under Fixed and Flexible Exchange Rates — a Comparison," *OPEC Review*, vol. 25, no. 13 (1993), pp. 259–78, and C. Harvie and A. Thaha, op. cit.

[22]J. A. Frenkel and C. A. Rodriguez, "Exchange Rate Dynamics and the Overshooting Hypothesis," NBER Working Papers no. 0832, Cambridge, Massachusetts, National Bureau of Economic Research (NBER), 1982.

[23]Inclusion of the public capital stock is attributed to the assumption that it is complementary to that of the private capital stock in nature (see D. Aschauer, "Is Public Expenditure Productive?" *Journal of Monetary Economics*, vol. 23, no. 2 (1989), pp. 177–200; D. Aschauer, "Does Public Capital Crowd out Private Capital?" *Journal of Monetary Economics*, vol. 24, no. 2 (1989), pp. 171–88, and C. J. Morrison and A. E. Schwartz, "State Infrastructure and Productive Performance," *American Economic Review*, vol. 86, no. 5 (1996), pp. 1095–111).

[24]C. Harvie and L. Gower, op. cit., and C. Harvie, "Oil Shocks and the Macroeconomy: A Short- and Long-Run Comparison."

Appendix

A BRIEF DISCUSSION OF THE MODEL

The model utilized in this paper is basically the same as that extensively discussed by I. Ali and C. Harvie.[14] Equilibrium in the model depends upon equilibrium in the product market, assets market, and foreign trade sector. The product market is discussed first.

Equations (1) to (18) describe the *product market*. Equation (1) describes the total demand for nonoil 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), and the nonoil trade balance consisting of nonoil exports (x^n) and nonoil imports (m^n). The parameters (β_i) represent the elasticities of spending in each category. The parameters are based on the contribution of a Dinar spent on private consumption and investment, total government spending, nonoil exports, and nonoil imports to the demand for nonoil output. The parameters are set to 1 indicating that a Dinar spent in any of these components contributes equally to nonoil product demand.

Private consumption expenditure is given by equation (2). It depends positively upon nonoil output supply and private sector wealth. The production of nonoil output represents income generated by the public and private sectors, although most nonoil output is produced by the public sector in Libya.[15] Equation (3) describes private sector gross investment, which equals the change in the stock of private capital[16] and is based on the partial adjustment hypothesis. This partial adjustment arises from costs of adjusting the actual physical capital stock (k^p), to the desired capital stock (k^{p*}). 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 nonoil output—see equation (4)—where the parameter δ is set to be 0.8.

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 as shown in equation (6), and government development expenditure. Government development spending is divided into three parts: government development spending on physical capital—for example, infrastructure—(i^g), government development spending on human capital—for example, education and health care—(i^h), and that devoted to imported capital—for example, imported foreign technology—(i^{cap}). Equation (5) parameters are based on the relative weight of each of these spending components in total government spending. 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 public capital stock to their policy determined levels. The policy determined levels are determined by oil revenue, as given by equations (10), (11), and (12). 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. The summation of these parameters is one, as all oil revenue goes to the government and this is totally disbursed in the previous four ways.

Equation (13) identifies the budgetary stance, which is government expenditure (g) less tax revenues (t^x). In Libya the government issues bonds to the central bank only, therefore equation (13) shows that any excess of government expenditure over tax revenue must be financed by borrowing domestically from the Central Bank of Libya (CBL). Tax revenue is generated from two sources: oil production and nonoil production—equation (14). The parameter (β_{13}) in equation (14) is set to 0.90 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.

The nonoil trade balance is disaggregated into nonoil exports less nonoil imports as shown in equation (15) and identity equation (30). Equation (15) specifies that nonoil exports (x^n) depend positively upon the real exchange rate ($e + p^* — p$) and world real income (y^*), which is assumed to be exogenous. Nonoil imports are also disaggregated into nonoil consumption imports (m^{con}) and nonoil capital imports (i^{cap}). Equation (16) identifies nonoil consumption imports, which depends negatively upon the real exchange rate and positively on domestic real income (y). Equation (9) identifies nonoil 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 (15) and (16) were empirically estimated using the ARDL approach (see table 4).

Real and permanent income (y^p) definitions, first used by W. Buiter and D. Purvis,[17] are given by equations (17) and (18). Real income, as identified in equation (17), depends upon nonoil output (No^s), oil production (o^a) that is assumed to be exogenous, the world price of oil (po), that is also exogenous, the real exchange rate as emphasized here, and the exogenously determined price of nonoil imported goods (p^*). Equation (18) represents permanent income, which depends on exogenous permanent nonoil output (No^{sp}), exogenous permanent oil output (o^p), the world price of oil, the real exchange rate, and price of nonoil imported goods (see C. Harvie, 1994).[18] The parameters in identities (17) and (18) 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 nonoil production in total current and permanent income, is the same in real and permanent income and constant through time (see W. Buiter and D. Purvis).[19] The share of oil output in domestic real income ($1 - \nu$) 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.

The asset market is encapsulated by equations (19) through (21). The behavioral equation (19) describes the demand for real money balances (the nominal money stock m deflated by the consumer price level p). It depends positively upon real nonoil income (No^s), representing a transactions demand, and negatively upon the interest rate representing an asset demand. The interest rate is subject to regulation by policymakers in Libya and it is no longer a good proxy for the cost of holding money. Therefore, the rate of inflation is utilized, besides the interest rate, as a proxy variable for the opportunity cost of holding money in the Ali-Harvie model. The nominal money supply is assumed to be endogenous as the nominal exchange rate is fixed. The estimated parameters of equation (19) are shown in table 4.

Domestic private sector real wealth (w^p) is given by equation (20) and consists of three components. The first component is private capital stock, which is owned entirely by the private sector. The second major component is real money balances, which consists of cash, deposits, and savings of the private sector. The final component is permanent nonoil income equivalent to that of permanent nonoil output.[20] The parameters in equation (20) are set to 1 indicating the equal importance of each of the components to total private sector wealth.

Equation (21) shows the money growth equation. It indicates the assumption of a fixed exchange rate combined with imperfect capital mobility. Since a fixed exchange rate is assumed for the case of Libya the money supply and its growth is endogenously determined. It 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 C. Harvie, 1993, and C. Harvie and A. Thaha),[21] as shown in equation (21*):

$$\dot{m} = d\dot{c}e + f\dot{e}s \tag{21*}$$

$d\dot{c}e$ is exogenously determined by the government and is assumed for simplicity to be equal to zero. Changes in foreign exchange reserves arise from developments in the current account ($\dot{f}$) and from capital flows due to differences in the domestic and foreign nominal interest rate ($r - r^*$), as shown in equation (21**), where τ denotes the sensitivity of capital flows to interest rate differentials, representing the degree of capital mobility. The value of coefficient τ can range from zero to infinity. The greater is τ the greater is international capital mobility, while the smaller is τ the smaller is international capital mobility.[22] The parameter τ is chosen to be 0.2 in this base model, which is indicative of the substantial control over capital mobility exercised by the government.

$$f\dot{e}s = \tau(r - r^*) + \dot{f} \tag{21**}$$

By substituting equation (21**) into equation (21*), equation (21) is obtained.

Equations (22) through (24) define *the price level and aggregate nonoil output supply.* Price and inflationary expectations developments are given by equations (22), (23), and (24). Equation (22) defines the consumer price level, which is a weighted average of nominal wages, the domestic cost of oil, and the domestic cost of the world nonoil imported good. The weights used in the consumer price index in equation (22) are approximated, based on Libyan data. Adjustment of nominal wages is generated by an expectations augmented Phillips curve as given by equation (23). Two possible adjustment sources are considered. These being excess demand for nonoil goods relative to its available supply ($No^d - No^s$), and core inflation (π). Core inflation depends upon developments in the monetary growth rate—equation (21). The estimated parameters of equation (23) are contained in table 4.

Aggregate nonoil output supply is endogenously determined as given by equation (24). It depends positively on the public capital stock,[23] human capital stock, private capital stock, imported capital stock, and employment. Government investment is divided into three parts: capital that affects nonoil output through physical capital stock accumulation, capital that affects nonoil output through human capital formation, and capital imports. The estimated parameters of equation (24) are shown in table 4.

The external sector consists of the current account and the oil trade balance. Developments in the current account are given by equation (25a) (see, for example, C. Harvie and L. Gower, and C. Harvie (1994)).[24]

$$\dot{f} + e - p = \alpha_1 T + \alpha_2 (r^* f + e - p) + \alpha_3 (o^x + po + e - p) \tag{25a}$$

where (o^x) represents net exports of oil. Re-arranging equation (25a) and expressing this in terms of changes in foreign exchange reserves, equation (25) is obtained. This shows that changes in foreign exchange reserves, as reflected in the current account balance ($\dot{f}$), depends positively upon the nonoil trade balance—as given by equation (29)—foreign interest income ($r^* f$), net oil exports and on the real exchange rate ($e - p$). In the long-run steady state the current account balance must be zero, otherwise further wealth effects will arise requiring further macroeconomic adjustment. Equation (25) is as in the Cox-Harvie model. The estimated parameters of this equation are contained in table 4.

Equation (26) indicates that net oil exports are exogenously determined, being dependent upon government policy toward the domestic usage or export of oil production. The parameter in equation (26) has been selected as 0.80, indicating a more export oriented policy.

Finally, equations (27) through (30) define four variables that are used extensively throughout this study. Equation (27) defines the real exchange rate as used in this study, equation (28) defines real money balances, equation (29) defines the nonoil trade balance, and equation (30) defines nonoil imports.