CHAPTER 4

MODEL SPECIFICATION AND ESTIMATION TECHNIQUES

4.1 INTRODUCTION

One of the deficiencies of the Keynesian demand-side macro models is the failure to simultaneously address the two fundamental problems associated with stagflation. In achieving a stable macroeconomic environment that will lead to an improvement in both the economic growth rate and the living standard of the people, a policy must be targeted that will lead to low inflation and low unemployment. The previous chapter has identified the failure of any government intervention in achieving a pro-poor economic growth in an economy characterised by huge supply constraints. The review of the historical performance of the Nigerian economy presents significant socio-economic constraints as the primary impediment to achieving the developmental objective of poverty alleviation. These constraints prompted the development of a useful macroeconomic model that will address the long-term equilibrium outcomes of output, employment, inflation and poverty.

However, it is crucial to develop a macro-econometric model for the Nigerian economy that will provide a useful policy analysis to alleviate poverty, with major focus on capturing the specific features and uniqueness of the country. The important implication of this model is to address the divergence between growth and poverty. The purpose of this chapter is therefore to present a macro-econometric model that is constructed and estimated for the Nigerian economy.

The chapter is divided into five sections. The second section identifies the different models developed in the study, while the third section presents the core structural equations estimated in the models. Estimation techniques and methodology used in the study are presented in the fourth section. The fifth section concludes the chapter.

4.2 MODEL SPECIFICATION

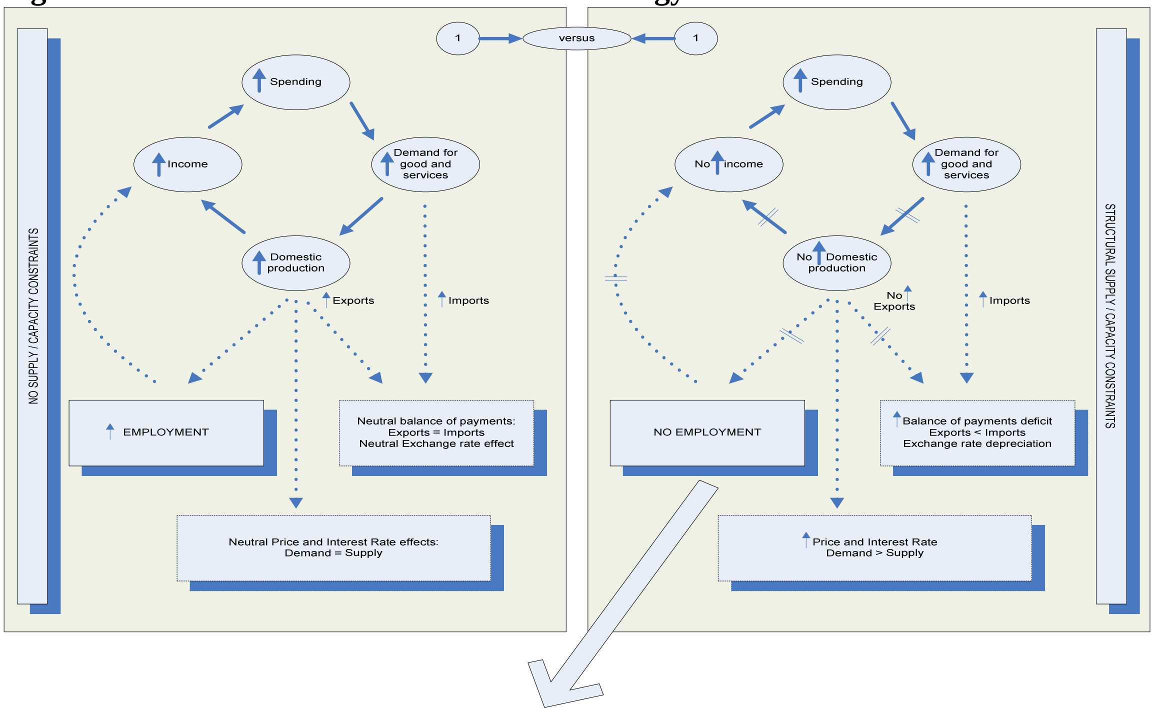
As mention earlier, the focus of the structural macro-econometric model developed in this study is to:

- Test the hypothesis of existing structural supply constraints versus demand-side constraints impeding the growth and development of the country

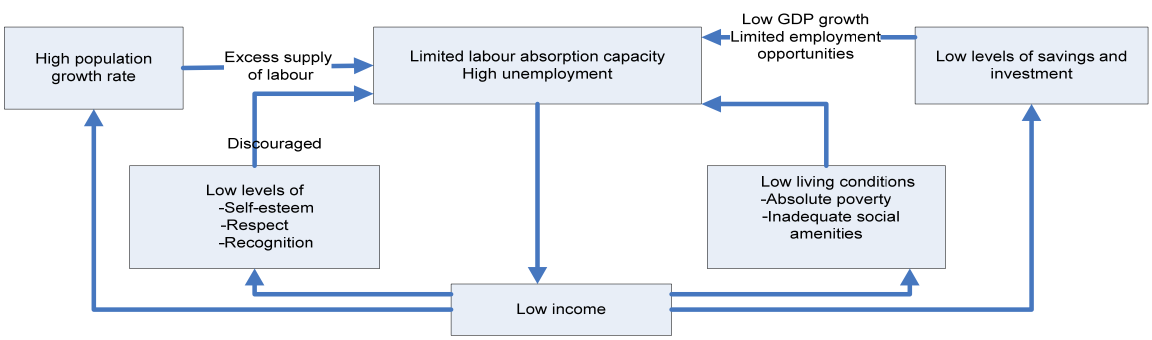
- Analyze different policy simulations in order to determine the optimal policy options for the country

This is achieved by testing two different economic environments implying two different model closures in which policy interventions may have different economic impacts. These scenarios are presented in figure 4.1 below:

Figure 4.1: Demand-side Fuelled Growth Strategy



Poverty Trap



Source: Focus, 2007 (Adopted from the Todaro Model)

Government policy intervention (i.e. monetary or fiscal policy) targeted towards propelling Gross Domestic Product (GDP) will be more effective in an economic environment without structural constraints impeding the capacity of the economy to increase labour employment. As shown in figure 4.1, an expansionary monetary or fiscal policy in an economic environment with no capacity constraints will translate into higher GDP and a better income distribution among the owners of factors of production. However, in an economic environment faced with huge structural capacity constraints, domestic production will fail to meet domestic demand. This will result into GDP being fuelled by an increased domestic expenditure instead of increased domestic production, and hence will fail to achieve a better income distribution among the owners of factors of production.

An economic environment with limited capacity to absorb more labour will generate a poverty trap with depressing socio-economic implications. Figure 4.1 shows the socio-economic implications of rising unemployment as a result of structural supply constraints. This leads to a low income level and high poverty among the majority of the population, thereby limiting access to various economic and social services. It further leads to a low level of self-esteem and respect and many will be discouraged and lose hope in the system, resulting in higher unemployment as many will remain unemployed 'by choice'. Due to low-level income, household saving will be low, resulting in low investment-output-employment. Therefore, unemployment and poverty becomes a self-fulfilling prophecy which requires an innovative intervention targeted at eliminating the significant structural impediments (Focus, 2007).

Against these backgrounds, the study develops two separate models[15]:

Model A

Supply-side orientated (Demand-side marginalized) model, representing an economy with structural constraints. In this model Gross Domestic Product (GDP) is estimated in order to detect the constraints that could be an impediment to the growth and development of the country. In this type of economy the limited capacity to absorb labour in the system will result in high and increasing levels of unemployment with depressing socio-economic and growth implications.

Model B

Demand-side orientated (Supply-side marginalised) model, representing an economy with limited or no supply constraints. In this model, GDP is generated following the Keynesian

[15] The empirical analysis gives detailed analysis on how these models have been constructed and closed.

identity. In this type of economy, any government intervention through fiscal and monetary policy instruments will be effective in absorbing labour and also attracting investment capital into the system.

A comparison of the two models is expected to give solid support to the hypothesis that the Nigerian economy has been faced with huge socio-economic constraints impeding the development of the country.

4.3 CORE STRUCTURAL EQUATIONS

As mentioned earlier, the study captures both the short-run and long-run dynamic properties of the economy. Four sectors of the economy were captured and include the real sector, the external sector, the monetary sector, and the Government (public) sector. The long-run core structural equations estimated from the four sectors of the economy are presented as follows:

4.3.1 The real sector

This sector consists of the aggregate supply, the aggregate demand and the price block. The aggregate supply determines the real domestic output by estimating the production function, the domestic investment, labour demand, real wages and technological progress (total factor productivity). The aggregate demand determines the aggregate household real consumption expenditure in the economy while the price block estimates the producer and consumer prices.

4.3.1.1 Aggregate supply

Modelling the Nigerian production function

High unemployment and poverty, low levels of productivity, and inadequate real investment has been major features of the Nigerian economy over the years. The endogenous growth models (i.e. Romer, 1990) which are concerned with endogenising technological progress became popular in the literature in recent decades. These models see technological progress as an engine for growth in any economy. This is against the neoclassical assumption that growth occurs due to the exogenous improvement in technology.

The structure of any economy's production function determines the degree to which its level of poverty and unemployment can be reduced. The oil sector comprises the most important component of the production structure of the Nigerian economy, since over 90 per cent of the country's total revenue is generated by this sector. However, it has not been possible to translate into an employment generating sector. The labour absorption rate in the Nigerian oil sector is negligible. This may be due to the capital intensive nature of the production function. Against this background, the Nigerian production function is modelled based on the following principles:

(i) Adopting the idea of the endogenous growth theories by endogenising the technological progress;

(ii) Appling the Kalman filter to the production function specification to make the technological progress time variant; and

(iii) Modelling the production function in two disaggregated functional forms, based on the structure of the economy.

Ample empirical evidence in the area of the neoclassical growth model has dominated the literature in the recent past. Its main assumption (which could also be regarded as the main limitation to the model) is the hypothesis that technological progress grows at a constant rate over time. The new growth theories strongly argue against this mechanism by explaining technological progress in terms of the role played by human capital.

An attempt is made to model the Nigerian production function by employing the state-space model (Kalman filter) to determine the evolution of the Solow residual that is estimated from a simple Cobb-Douglas production function. The state-space model regained its popularity in economic literature during the 1980s (i.e. Lawson, 1980; Harvey *et al.*, 1987). The development of these models was first witnessed in Wiener (1949) and Kalman (1960) who were control engineers in radar and aircraft technology. The application of the state-space model with stochastically time-varying parameters (coefficient of the technological progress is allowed to vary over time) is adopted in this study to model the Nigerian production structure. An extensive econometrics application of the state-space models can be found in Hamilton (1994: 372 to 408).

The dynamic representation of the state-space model of a *(n×1)* vector y_t, is given by the following system of equations:

$$y_t = a(x_t) + [H(x_t)]' \xi_t + w_t \qquad (4.1)$$

$$\xi_{t+1} = F(x_t)\xi_t + v_{t+1} \qquad (4.2)$$

where $a(x_t)$ describes an *(n×1)* vector-value function, $H(x_t)$ an *(r×n)* matrix-value function, and $F(x_t)$ denotes a *(r×r)* matrix whose elements are function of x_t. ξ_t is a *(r×1)* vector of unobserved state variables (i.e state vector). The *(n×1)* and *(r×1)* disturbance vectors w_t and v_t are assumed to be independent white noise. The first equation is known as the observation (or measurement) equation and the second is known as the state (or transition) equation. Detailed description of the state-space representation of a dynamic system can be found in Hamilton (1994: 372) and has also been adopted by Du Toit *et al*. (2008).

Following the Kalman filter representation above, the Nigerian production function is modelled as follows:

$$Y_t = \xi_t K_t^{\alpha} N_t^{\beta} e^{w_t} \qquad 0<\alpha<1;\ 0<\beta<1 \qquad (4.3)$$

$$\xi_t = \xi_{t-1} + v_t \qquad v_t \sim N(0,Q) \qquad (4.4)$$

where

Y_t = Real GDP in period t

K_t = Real capital stock in period t

N_t = Total employment in period t

w_t, v_t = Stochastic disturbance terms

ξ_t = The time varying constant, representing technological progress.

Specifically, the Nigerian production structure remained a difficult phenomenon to analyse. The benefits of oil production over the years have not really sunk down to the rest of the economy where the majority of the population still suffers from poverty and high unemployment. The Nigerian populace can therefore be regarded as living in two different economies: the first economy, which is the oil sector, and the second economy, which is the rest of the economy. The first economy comprises less than five per cent of the population, but controls over 90 per cent of the country's resources. The second economy on the other hand, comprises more than 95 per cent of the population, is highly marginalised, consists of a large numbers of poor and unemployed and does not benefit from the abundant oil resources of the country.

As a result, the study disaggregates the production function into two groups to measure the real effects of any policy measure or exogenous shock on the targeted (poor) population:

(i) The oil sector, and

(ii) The rest of the economy

Domestic investment (Real gross capital formation)

The aggregate capital stock at the end of period *t*, is referred to as the net capital stock, assuming a constant depreciation rate (δ). This is expressed as:

$$K_t = (1-\delta)K_{t-1} + I_t \tag{4.5}$$

where K_t and K_{t-1} are the capital stocks at the end of the current and previous period respectively, δ is the rate of depreciation and I_t is the gross investment. δK_{t-1} is the replacement investment, and net investment ($K_t - K_{t-1}$) equals total investment, minus replacement investment ($I_t - \delta K_{t-1}$). Therefore, the following identity holds for gross investment:

Gross investment = replacement investment + net investment

The theories of investment behaviour mostly relate the demand for new plant and equipment to the gap between the desired or optimal amount of capital and the actual amount of capital (Du Toit, 1999:81). Combining these two aspects of investment behaviour, the gross investment can be expressed as:

$$I_t = \lambda_t (K_t^* - K_{t-1}) + \delta K_{t-1} = \lambda_t K_t^* + (\delta - \lambda_t) K_{t-1} \qquad (4.6)$$

where λ_t is the speed of adjustment between K_t^* and K_{t-1}, and K_t^* is the desired or optimal capital at the end of the current time period (see Du Toit, 1999: 81 for a detailed exposition).

Different approaches, such as the Keynesian model, cash flow model, and the neoclassical model (Jorgenson approach) have been used in modelling the investment behaviour. This study considered the neoclassical approach (Jorgenson, 1963) to be the most suitable approach in estimating the domestic investment function, since it incorporates all cost minimising and profit maximising decision making processes by firms. This approach has also been adopted in Du Toit (1999), Du Toit and Moolman (2004) and Pretorius (1998).

Labour demand and real wage determination

In modelling the labour market, a labour demand equation and a wage adjustment equation are defined and estimated. The demand for labour has been analysed in many theoretical and empirical studies varying from country to country, i.e. Pehkonen, (1992), Darby and Wren-Lewis, (1991), Appelbaum and Schettkat, (1995), and Disney and Kiang, (1990). These studies focus on economic variables (such as output, labour productivity and labour cost) as the major determinant of employment. The socio-economic impact on labour demand has not been explored thoroughly in literature. Chletsos (2005) investigates the socio-economic determinants of labour demand in Greece using an autoregressive distributed lag framework. The role played by the socio-economic variables included in his estimation is found to be statistically significant.

The labour demand framework utilised in this study also incorporates the socio-economic activity as a determinant factor and this is specified as:

$$N_t^d = f(rw_t, Y_t, SE_t) \qquad (4.7)$$

where N_t^d is the labour demand, rw_t is the real wage rate defined in terms of consumer prices, Y_t is the level of output or GDP, and SE_t is socio-economic activity. The last mentioned variable is discussed in paragraph 4.3.5.

The real wage rate equation follows Allen and Nixon (1997:147) and is specified in this study as:

$$rw_t = f(labprod_t) \qquad (4.8)$$

where $labprod_t$ is the labour productivity[16]. Labour productivity is expected to influence the real wage rate since the prospect of a rise in real wages will be an incentive for workers to increase their productivity. Therefore, labour productivity will have a positive influence on real wages. Labour productivity is also disaggregated into two components (oil and the rest of the economy) and these will also depend on the total economy's labour productivity.

Technological progress (total factor productivity)

Endogenising technological progress has not been very popular in economic literature over the years. There is a large body of empirical literature that tends to explain the process of growth in a single or cross-country setting, but very little evidence has been found in respect of total factor

[16] The rate of unemployment is excluded from the specification due to data limitation.

productivity (Senhadji, 2000). In line with the endogenous growth theory, the problem of how best to represent technological progress was investigated by Budd and Hobbis (1989) who applied their analysis to the UK production function. Two main sources of technological advances were identified in their paper, namely through domestic research effort or by importing new technology from abroad. The macro determinants of total factor productivity in Pakistan were also investigated in Khan (2006). These determinants are broadly categorised into macroeconomic stability, openness of economy, human resource development and financial sector development[17].

Against this background (which are in line with new growth theories) technological progress (ξ) can be defined as:

$$\zeta_t = f(ms_t, hd_t, fd_t) \tag{4.9}$$

where ms_t is a form of macroeconomic stability (proxied by consumer prices), hd_t is the human development variable (proxied by poverty level), and fd_t represents the level of financial development proxied by financial constraints. These variables are expected to influence the growth of technology in Nigeria since the developing economies are characterised by these factors.

4.3.1.2 Aggregate demand

<u>Household real consumption expenditure</u>

The theoretical underpinning of the household real consumption expenditure follows the permanent income and life-cycle hypothesis. The specification of the household consumption expenditure follows the notion that liquidity-constrained consumers make consumption choices based only on their disposable income and that their rate of time preference is equal to their rate of return. On the other hand, the unconstrained consumers base their decision on total lifetime

[17] There is a closer similarity between the Pakistan economy and the Nigerian economy than the UK economy.

resources with the marginal propensity to consume fluctuating over time to capture consumption smoothing (Pauly, 2004). Therefore, the long-run household consumption is a function of real disposable income, real wealth and the real interest rate. This is specified as:

$$hh\_rcon\exp_t = f(hh\_dis\_inc_t, rwealth_t, r\text{int}_t) \qquad (4.10)$$

where $hh\_rcon\exp_t$ is household real consumption expenditure, $hh\_dis\_inc_t$ is household real disposable income, $rwealth_t$ is real wealth, and $r\text{int}_t$ is the real rate of interest.

4.3.1.3 Prices

<u>Consumer and producer prices</u>

The price system helps to achieve a good coordination and communication system in a pure market economy, enabling the various sectors to interact efficiently. This system operates on the principle that everything bought and sold has a price. Through the price system, producers and consumers transmit valuable information to each other, helping to keep the economy in balance. In a neoclassical profit-maximising framework with imperfect market competition, prices are set by firms as a mark-up on their marginal cost of production proxied by average or unit costs (Layard and Nickell, 1986: 142). This is illustrated as

$$P^p = m * AC \text{ and } m = \frac{1}{1 - \frac{1}{\eta}} >; \; m' \geq 0 \qquad (4.11)$$

where P^p is the production prices, m is the mark-up factor, AC is the average or unit cost of production and η is the price elasticity of demand. The mark-up factor can be specified in terms of a demand pressure variable such as expected demand relative to actual output, since this depends on the price elasticity of demand and the short-run demand position (Du Toit, 1999: 150).

Following Layard and Nickell, production prices can be specified as

$$P_t^p = f(w_t, cu_t, ucc_t) \tag{4.12}$$

where w_t is the nominal wage rate, cu_t is the capacity utilisation, and ucc_t is the nominal user cost of capital.

Consumer prices are directly related to production prices and can be specified as

$$C_t^p = f(P_t^p, imp_t^p, excessd_t, exch_t) \tag{4.13}$$

where C_t^p is the consumer price, imp_t^p is the import price of consumption goods, $excessd_t$ is the excess demand, and $exch_t$ is the nominal exchange rate (expressed in terms of domestic to foreign currency).

4.3.2 The external sector

The external sector identifies the major components in the current account of the balance of payment and the variation in the level of exchange rate. It estimates the real exports of goods and services, the real imports of goods and services and the naira/ U.S. dollar nominal exchange rate.

Real exports of goods and services

The demand for real exports of goods and services in the long run is mainly driven by the level of world income and relative prices of goods and services. The fluctuations in the exchange rate are also expected to have an influence in the long run specification of real exports, but depend on the productive structure of that particular economy[18]. Fluctuations in world oil prices are

[18] In the case of Nigeria, exchange rate is not expected to have any influence on the long-run determination of real exports. This is due to the unproductive nature of the Nigeria economy and the fact that over 90 percent of its exports/foreign exchange earnings comes from oil.

therefore expected to have a significant impact on the Nigeria's exports. The Nigerian real exports function is therefore specified as

$$r\exp_t = f(wY_t, relp_t, oil\_p_t) \qquad (4.14)$$

where $r\exp_t$ is the real exports of goods and services, wY_t is the real world (proxied by U.S.) GDP, $relp_t$ is the relative price of goods and services (the ratio of domestic prices to U.S. prices), and oil_p_t is the world oil price.

Real imports of goods and services

The long-run demand for real imports of goods and services is mainly driven by the level of domestic income and relative prices of goods and services. The fluctuations in the exchange rate are also expected to have a significant impact on the long-run specification of real imports for Nigeria since imports dominate a large component of the country's consumption expenditure. The Nigerian real imports function is therefore specified as

$$rimp_t = f(Y_t, relp_t, exch_t) \qquad (4.15)$$

Nominal exchange rate

The underlining theory behind the specification of the nominal exchange rate equation follows Dornbusch (1976 and 1980) and Frankel (1979). These studies assume that prices are sticky in the short-run and explain the prolonged departure of the exchange rate from the long-run Purchasing Power Parity (PPP). Against this background, the nominal exchange rate is specified as follows

$$exch_t = f(relY_t, relMs_t, relp_t) \qquad (4.16)$$

where $relY_t$ is the relative income (the ratio of domestic GDP to U.S. GDP), and $relMs_t$ is the relative money supply (the ratio of domestic money supply to U.S. money supply).

4.3.3 Monetary sector

The essence of modelling the monetary sector in this study is to elicit information regarding the extent to which monetary variables feed the rest of the economy[19]. The model estimates the interest rate while assuming that the supply of money is exogenously determined in the system. This is done by following the principle that monetary authority does not directly control interest rates. The monetary policy instrument used by the Central Bank of Nigeria over the years is the monetary aggregate.

Nominal interest rate

The nominal interest rate equation is assumed to be an inverted money demand function. This can be derived from the money demand equation as:

$$RMs_t = f(Y_t, \text{int}_t) \Rightarrow \text{int}_t = f(RMs_t, Y_t) \qquad (4.17)$$

where RMs_t is the real monetary aggregate and int_t is the nominal interest rate (lending rate).

4.3.4 The government sector

In this study, the government sector is assumed to be exogenously determined. Total government expenditure is divided into three major components: expenditures on social development, government transfer payments and other government expenditures. These components of government expenditures are seen as some of the main catalysts in breaking through the socio-economic constraints that have been the major impediments in reducing the level of poverty in the country.

[19] However, the role of monetary policy in Nigeria has over the years been quite insignificant. This may be due to the fact that the country's financial system has still not yet been integrated into the domestic and global environment.

Government revenue is excluded in the study, since more than over 90 per cent of revenue comes from oil production, which has been captured extensively in the study. Tax revenue plays an insignificant role in the economy.

4.3.5 Other behavioural equations in the model

In order to fully detect the socio-economic impediments facing the country over the years, the study endogenises some of the variables used to explain the equations identified above. The study further estimates the level of socio-economic activity in the country, poverty, agricultural production, infrastructural development and household disposable income. These variables are expected to be driven mainly by some institutional factors imbedded in the economy.

Socio-economic activity

GDP has popularly been used in the literature as a measure of a country's socio-economic progress, neglecting other aspects of development such as education and health. The value of a nation's economic activity is expected to be reflected positively in the well-being of its citizens. That is to say that those who produce the resources should see how it is channelled to appropriate ends. This should be determined by the producers rather than being spent on debt service, exporting to safer havens, or used to build prestigious facilities of little use which are mostly the dominant features of GDP (Lind, 1993). Therefore, an appropriate indicator for socio-economic development will be a broader measure which includes other social aspects of life that provide a decent living.

Since socio-economic progress is expected to translate into a good state of well-being of the people, socio-economic activity can therefore be specified as

$$SE_t = f(hh\_dis\_inc_t, govt\exp_t, fr_t) \qquad (4.18)$$

where $hh\_dis\_inc_t$ is household real disposable income, $govt\exp_t$ is a form of government expenditure channelled towards social development, and fr_t is the level of infrastructural development. These variables are expected to positively influence the socio-economic activity in Nigeria.

Household disposable income

Disposable income is directly related to real wages and can be specified as

$$hh\_dis\_inc_t = f(rw_t, transfer_t) \tag{4.19}$$

where $transfer_t$ is a form of transfer payment from the government to the people.

Poverty

The economy-wide Computable General Equilibrium (CGE) models have in recent years dominated the literature in analysing poverty. The Social Accounting Matrix (SAM) provides both the database and logical framework for the CGE models to gain its strength in literature (Robinson and Lofgren, 2005). Other recent extensions of CGE models have incorporated financial sectors and these models can differ in terms of the kind of policy issues they address[20].

Analyses of macro-poverty linkages have gained substantial ground among policy makers over the last few years. The impacts of specific macroeconomic policies (i.e. fiscal policy, inflation, and financial liberalisation) on poverty have recently started dominating literature[21]. This study attempt to explain poverty using some important macroeconomic variables and this can be specified as

$$poverty_t = f(C_t^p, hh\_dis\_inc_t, govt\exp_t, fr_t, agricprod_t) \tag{4.20}$$

where $poverty_t$ is the level of poverty, $agricprod_t$ is the level of agricultural production.

[20] See Robinson and Lofgren (2005); Willey (1992); and Agenor (2004) for more comprehensive treatment of CGE models.
[21] Gunter et al (2005) summarises some important macro-poverty debates that have just recently emerged.

Agricultural production

The level of agricultural production is determined by the availability of natural resources (i.e. land), environmental conditions, level of infrastructural development and some form of production prices in the economy. This can be represented as

$$agricprod_t = f(land_t, ec_t, p_t^p, fr_t) \tag{4.21}$$

where $land_t$ is the availability of land for agricultural production, and ec_t is an environmental condition such as rainfall. These variables are expected to influence agricultural production significantly.

Provision of infrastructure

The role of adequate infrastructure in economic development cannot be overemphasised. Capital stock provides the public goods and services which have various positive effects on economic activities and the living standard of households (Yoshino and Nakahigashi, 2000). Empirical studies (i.e Mitsui and Inoue, 1995) have identified infrastructure as one of the main driving forces of production and this has also been investigated in the economic growth theory, for example, Barro (1997) and Easterly and Rebelo (1993)[22].

The level of a country's infrastructural development will increase the production activities and improve the standard of living of its citizens. Likewise, the increase in the level of production activities will in turn necessitate more infrastructural expansion. Therefore, the effect of infrastructure in this study is twofold:

(i) It increases the level of GDP

(ii) It serves as a catalyst in reducing poverty

[22] See Ayogu (2007) for a survey of theoretical literature on infrastructure and growth.

This means that infrastructure plays a dual role in the Growth-Poverty linkage. The challenge of long-term development is to design economic policies that are geared towards investment in infrastructure. Lack of basic infrastructural expansion and misappropriation of government expenditure earmarked for infrastructural development have been major features of the Nigerian economy over the years since its independence. However, government's role in the provision of public infrastructure remains seminal.

The provision of infrastructure in Nigeria is modelled as a function of economic activities and the level of government effectiveness (good governance). This can be represented as:

$$fr_t = f(Y_t, ge_t) \quad (4.22)$$

where ge_t is a governance indicator representing the level of government effectiveness.

4.4 ESTIMATION TECHNIQUES

In view of the above discussion, the production function and other behavioural equations are estimated using Engle and Granger (1987) techniques. This procedure is widely accepted in the macro-econometric literature as it avoids the common problem of spurious regressions that gives an incorrect impression of an existing long-run relationship between two or more variables. As laid out in Enders (2004:335), Engle and Granger proposed a four-step procedure to determine whether two I(1) variables are cointegrated:

Step 1: The variables are tested for their order of integration. Cointegration requires that two variables be integrated of the same order and if these variables are all stationary, then it is not necessary to proceed since the standard OLS regression can be applied to stationary variables. The Augmented Dickey-Fuller test is used to establish the order of integration of the data. Since the actual data generating process is not known, it is better to test the hypothesis γ=0 using the general model:

$$\Delta y_t = a_0 + \gamma y_{t-1} + a_2 t + \sum_{i=2}^{p} \beta_i \Delta y_{t-i+1} + \varepsilon_t \qquad (4.23)$$

The testing procedure suggested by Dolado *et al*. (1990) as also briefly laid out in Enders (2004:213) is adopted in testing for the unit root of all the series. All variables are in natural logarithmic form except for variables that may contain negative values.

The maximum lag structure that is used follows Said and Dickey (1984) who suggested a lag order equal to $T^{1/3}$ with T the number of observations. Therefore, the maximum lag structure of 4 is used in the testing procedure. Nevertheless, there is no strict specification on the number of lags to be used in the testing regressions. Perron (1989) suggests starting with eight lags at a 10 per cent level of significance. This procedure will result in low power of the test but may not affect the size of the test.

Step 2: After determining the order of integration of the variables in the equation and they are found to be non-stationary. The next step is to estimate the long-run equilibrium relationship of the variables in the equation. To determine if the variables have a long-run relationship (cointegrated), the residuals of the estimated equation are tested for stationarity. If the residuals displayed stationarity, one can conclude that there is a long-run relationship among the variables in the equation. Enders (2004:337) suggested the use of critical values for Engle-Granger cointegration test when estimating a cointegrating equation. This follows the MacKinnon (1991) response surface values.

Enders (2004:336) also suggested considering the estimation of the autoregression of the residuals without intercept.

$$\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \varepsilon_t \qquad (4.24)$$

where $\hat{e}_t$ are the residuals of the estimated regression. The null hypothesis is a_1=0. Therefore, the stability condition suggests that -2< a_1 <0 before one can conclude that the residuals are stationary.

Step 3: After a suitable long-run estimation is found and if all the variables are found to be cointegrated, then an error-correction model can be estimated using the residuals from the long-run regression. Engle and Granger proposed the following procedure in estimating the error-correction model:

$$\Delta y_t = \alpha_1 + \alpha_y \hat{e}_{t-1} + \sum_{i=1} \alpha_{11}(i)\Delta y_{t-1} + \sum_{i=1} \alpha_{12}(i)\Delta z_{t-1} + \varepsilon_{yt} \quad (4.25)$$

where Δ is the first difference operator of a variable, $\hat{e}_{t-1}$ is the lagged residuals from the long-run equation, α_y is the speed of adjustment coefficient and y_{t-1} and z_{t-1} is the lagged dependent variable and all other variables that may have transitory effects on output. Given that equation (4.25) contains only stationary variables (first differenced), all the test statistics used in the traditional OLS regressions can be applied.

Step 4: This step is performed to assess the appropriateness of the error-correction model. This is done by first performing the diagnostic test to detect if the residuals of the error-correction equation are stationary. In the situation where the residuals are found to be non-stationary, Enders (2004:338) suggests that the model should be re-estimated by adjusting the lag length until it produces stationary residuals. Secondly, check the speed of adjustment coefficient α_y which shows an important implication for the dynamics of the system. The coefficient is expected to be negative and the absolute value must not be too large to enable the system to speedily return to equilibrium.

4.5 CONCLUSION

Following the Engle-Granger (1987) estimation techniques, this chapter has explained the explicit specifications of the macro-econometric model developed in this study. The specifications have been inferred from both the theoretical fundamentals and the underlying structure of the Nigerian economy analyzed in the previous chapters. Two separate models testing the hypothesis of existing structural supply constraints versus demand-side constraints. The Nigerian production function has been specified in two folds using a Kalman filter approach. The oil sector belongs to the first economy and the rest of the economy is regarded as the second economy. The majority of the poor also form part of the second economy. The model identified four major sectors in the economy which are: the real sector, the external sector, the monetary sector and the government sector. Other behavioural equations are also specified and estimated in order to explicitly determine the feedback of a policy change on the entire system. The empirical analysis and results of the various estimations are discussed in the next chapter.

CHAPTER 5

EMPIRICAL ANALYSIS

5.1 INTRODUCTION

Based on the theoretical underpinnings of the various equations discussed in the previous chapter, this chapter provides the empirical analysis. First, it estimates and analyses the results of the production functions and all other structural equations in the models. Second, it creates a fully dynamic system model by combining the production functions and all other structural equations. This enables a link between the endogenous variables in the system. Last, the dynamic response characteristics are analysed by applying the various exogenous and policy shocks to some selected variables.

As discussed earlier, the models developed in this study seek to test the hypothesis of existing structural supply constraints versus demand-side constraints impeding the growth and development of Nigeria. However, the two models have different closures but some of the equations estimated are different[23]. The Engle-Granger estimation technique is also adopted in this study. Since the analysis of growth and poverty are generally based on long-term perspectives, major emphases are placed on the long-run equations of the model.

Detailed descriptions of all the data (their sources and calculations) used in the study and their order of integration are presented in Appendix 1 and 2. All the estimated long-run and short-run equations outputs, their simulation path and statistical properties (i.e cointegration residuals and diagnostic tests) are presented in Appendix 3 to 5.

[23] More detail distinction between the two models is presented in Section 5.3.

5.2 ESTIMATION RESULTS (MODEL A): SUPPLY-SIDE ORIENTATED

As discussed earlier, this model represents a typical economy (such as Nigeria) with structural supply constraints. In this model the demand-side of the economy is being marginalised based on the assumption that the productive capacity of the economy is being impeded by some socio-economic constraints facing the country. The oil sector is the dominant driver in the nation's production function and therefore prompts an estimation of a separate oil sector production function. In this model the major macroeconomic variables detected to be a determinants factor in explaining some stochastic equations used the rest of the economy variables (disaggregated variables) where poverty and unemployment is prevalent.

The price blocks serve as a linkage between the demand-side and the supply-side of the economy through capacity utilisation and the excess demand variables included in the production price and consumer price equations respectively[24]. The results of the various estimations are presented inline with the four major sectors discussed in chapter four.

5.2.1 The real sector

5.2.1.1 Aggregate supply

<u>Production function for the Nigerian economy</u>

The aggregate production function for the total economy and oil sector is estimated using the Kalman Filter specification[25]. The unknown parameters of the system are estimated along with the state vectors which are assumed to follow an autoregressive process that evolved over time. All variables are in natural logarithm and are integrated of order 1 (see Appendix 2).

The observation equations of the production functions are first estimated. A time-varying parameter representing technological progress is allowed for in the aggregate production function for the total economy. In order to capture well the production function in the oil sector

[24] The definition of these variables can be seen in Appendix 5.
[25] The rest of the economy production function is calculated from the identity rgdp_rest = rgdp – rgdp_oil.

all the parameters are allowed to be time-variant[26]. Constant returns to scale are enforced and the long-run results of the production functions are presented as:

Total economy:

$$\ln\_rgdp_t = 0.18 \ln\_rk\_stock2_t + (1-0.18)\ln\_labor\_f_t + sv\_tfp\_tot_t \qquad (5.1)$$

Oil Sector

$$\ln\_rgdp\_oil_t = sv\_rk\_stock2\_oil1_t * \ln\_rk\_stock2_t + (1 - sv\_rk\_stock2\_oil1_t) * \ln\_labor\_f_t + sv\_tfp\_oil1_t + sv\_dum\_oil1_t * dum_t \qquad (5.2)$$

0.7 (Final Value)

The long-run results from the Kalman filter estimation for the total economy production function shows that the estimate of the elasticity of output with respect to capital is about 0.2 which means that the elasticity of output with respect to labour will be 0.8. This result reflects the minimal use of capital stock in the production structure of the Nigerian economy. These estimates are in line with the growth accounting exercise presented in Chapter 3 and also similar to the findings of Du Toit (1999) when estimating a production function for the South African economy[27]. The time varying technology as explained in Section 5.2.5 is found to have similar trend with the result of the growth accounting exercise presented in Chapter 3.

Kalman filter estimation for the oil sector production function reflects the intensity of capital stock that is used in the production process. Since this parameter is allowed to vary over time, the final value of the estimate of the elasticity of output with respect to capital is 0.7 and the

[26] The Eviews estimation outputs for all the equations in the model (long-run and short-run) are presented in Appendix 3

[27] The t-statistics in long-run equation can be ignored and the use of this in performing the significance tests in the cointegrating equation should be avoided (Enders, 2004:339).

average estimate over the period is 0.8. This means that the elasticity of output with respect to labour will be 0.3 and 0.2 in the final state and on the overall average respectively. It is found necessary to include a dummy variable in the long-run equation of the oil sector production function to capture periods of oil price shocks. The time varying technology as explained in the previous section is found to increase for most of the period.

The cointegration tests on the production functions were carried out by testing for stationarity in the residuals and the results revealed stationary residuals. This implies that the variables are cointegrated.

The Error Correction Model (ECM) captures the short-run dynamics of the Nigerian production structures. Apart from the long-run variables, real wages and consumer inflation are found to play a significant role in the short-run adjustment process in both the total economy and oil sector production functions. Oil prices also have a significant impact on the oil sector in the short-run. The coefficients of the lagged residual from the long-run are negative and significant, showing the dynamic adjustment towards the long-run equilibrium path. This shows that about 14 per cent and 30 per cent of any disequilibrium is corrected for every year in the total economy and the oil sector respectively. The short-run equations passed all the required diagnostic tests; thus confirming that the equations are well-specified and do not violate the Gaussian or classical linear regression assumptions.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

Domestic investment (real gross capital formation)

As discussed in the previous chapter, the investment function of the Nigerian economy is estimated using the neoclassical approach. This approach is seen to be consistent with a supply-side model since it incorporates the cost-minimising and profit-maximising decisions of firms. Based on the neoclassical theory of investment, the level of interest rates, output, cost of capital and tax policies are the main driving forces that optimise a firm's capital stock.

The link between investment and capital stock can be captured empirically by either estimating capital stock and deriving investment subsequently, or estimating investment and the subsequent derivation of capital stock (Du Toit, 1999: 91). This study adopted the estimation of investment and the domestic investment in Nigeria is modelled as a function of output, user cost of capital, capacity utilisation, and the level of political instability (governance indicator). The long-run result is presented below as:

$$\ln\_gcf_t = 0.97\ln\_rgdp_t - 0.1\ln\_ucc_t + 0.32pi_t + 0.5\ln\_cu\_tot_t - 0.35dummy\_m_t - 0.5dum_t \tag{5.3}$$

The long-run equation is consistent with a priori expectation and the residuals from the regression were tested for stationarity and the null hypothesis of no cointegration was rejected. The results show that 1 per cent increases in output and capacity utilisation are associated with an increase of about 0.97 per cent and 0.5 per cent in domestic investment respectively, while a rise in the user cost of capital by 1 per cent causes domestic investment to decline by about 0.1 per cent. Political instability is also included in the estimation as a measure of governance. The result reveals that a more stable political environment will attract more foreign direct investment into the country. This result is not surprising since political instability has been one of the dominant features of the Nigerian economy over the years and also a source of the decline in domestic investment[28]. Dummy variables are also included in the estimation to capture the periods of military rule and oil price shocks.

Estimates from the ECM capture the short-run dynamic properties. The dynamic adjustment towards the long-run equilibrium path is shown by the coefficient of the lagged residuals from the long-run which is negative and significant. This shows that about 54 per cent of any disequilibrium is corrected for every year. The oil prices, capital flows, exchange rates, and producer inflation play a major role in the short-run adjustment processes of the Nigerian investment function. In order to determine whether the ECM is well-specified, the required

[28] Political instability is not in its natural logarithms due to negative values in the series (see data description for more details).

diagnostic tests were carried out and the results revealed no violation of the Gaussian or classical linear regression assumptions.

The dynamic simulation of the long-run and short-run equations reveal a very good fit of the estimated model (Appendix 4).

<u>Labour demand and real wage determination</u>

The role played by labour in the Nigerian production function also warrants proper investigation. With a large population of about 140 million currently, the country's economically active population constitutes more than 50 per cent of the total population of which about 70 per cent are in the labour force. This is an indication that there is still a considerable number who are unemployed/not employable.

The labour demand which is a function of output and real wage is estimated by augmenting it with socio-economic activity as discussed in the previous chapter. Since wage and employment data for Nigeria are not available, the labour force is however used as a proxy for employment. The socio-economic index is used as a proxy for socio-economic activity which follows Lind (1993)[29]. Two dummy variables capturing periods of military rule and oil price shocks are included as additional explanatory variables. As discussed earlier, since the rest of the economy constitute the majority of the poor and unemployed, the GDP in the rest of the economy is used in the estimated labour demand function. The long-run result is however, presented as:

$$\begin{aligned} \ln\_labor\_f_t &= 0.7\ln\_rgdp\_rest_t - 0.6\ln\_rwage\_lf_t + 0.9\ln\_se\_index\_b_t \\ &- 0.1dum_t - 0.2dummy\_m_t \end{aligned} \qquad (5.4)$$

The estimation result is consistent with the expected sign and it reveals that a 1 per cent rise in real wages will influence employment negatively by about 0.6 per cent while output and socio-economic activity will have a positive influence on employment. The socio-economic activity is found to be very significant economically in explaining the labour demand in Nigeria. This

[29] Detailed description and calculation of all the data are presented in Appendix 1.

reveals that an increase in socio-economic activity by one per cent will result in about 0.9 per cent increase in labour employment. The residual from the long-run equation was tested for stationarity and the null hypothesis of no cointegration was rejected[30].

The short-run dynamics of labour demand in Nigeria is revealed by using the Error Correction Model (ECM). Capital stock, government expenditure on social development, consumer inflation, import prices and exchange rate are found to play a significant role in the short-run adjustment process. The coefficient of the lagged residual in the long-run is negative and significant, showing the dynamic adjustment towards the long-run equilibrium path. The short-run equation passed all the required diagnostic tests which has confirmed the equation as well-specified and that it does not violate the Gaussian or classical linear regression assumptions[31].

The dynamic simulations of the long-run and short-run equations reveal a very good fit of the estimated model (Appendix 4).

The real wage equation for the Nigerian economy is expected to be driven by labour productivity. Again, labour productivity in the rest of the economy is used in the long-run equation. The long-run result of the real wage equation is therefore presented as:

$$\ln\_rwage\_lf_t = 0.75\ln\_labprod\_rest_t - 0.2dummy\_m_t + 0.1dum_t + 3.2 \quad (5.5)$$

The result shows that the labour productivity in the rest of the economy has a positive impact on the real wages. This means that a 1 per cent increase in the labour productivity in the rest of the economy causes real wages to rise by about 0.8 per cent. The residual from the long-run equation was tested for stationarity and the null hypothesis of no cointegration was rejected.

Capturing the short-run dynamics of the real wage equation, the coefficient of the lagged residuals from the long-run are negative and significant, indicating the dynamic adjustment towards the long-run equilibrium path. About 18 per cent of any disequilibrium is corrected for

[30] Due to the softness of the data most of the long-run equations in the model passed the Engle-Granger cointegration test at nearly 10 percent.
[31] All the diagnostic tests are reported in the ECM estimation output presented in the Appendix.

every year. Apart from the long-run explanatory variables socio-economic activity, government transfers, level of openness of the economy also influence the short-run adjustment process significantly. The ECM passed all the required diagnostic tests confirming a well-specified equation.

The estimated long-run and short-run equations are simulated together and the fitness of the model revealed very robust parameter estimates (Appendix 4).

Technological progress (total factor productivity)

The role played by technology in the growth process of a nation cannot be overemphasised. Technology was the primary catalyst to any nation's economy transformation. The assumption that technological progress occurs at constant rate is very common in the growth literature (especially the exogenous growth theories). This may not be a very realistic assumption. A time-varying technological progress that is adopted in this study using the Kalman filter procedure reveals the weakness of this assumption. It clearly shows the upward and downward trend in the evolution of technology in Nigeria. The method follows a similar trend with the technology from the growth accounting exercise calculated for each period as explained in the previous chapter.

Technology in the oil sector (as represented by the generated series) of the Nigerian economy has experienced an upward trend especially between the mid-1970s and early 1990s. This is not surprising since oil is the main source of export revenue to Nigeria which also requires a high level of technology and innovations in extracting it. The downward trend experienced from the mid-1990s can be attributed to the social unrest in the Niger-Delta that disrupted the production of oil.

Based on the above background, technological progress in the total economy and the oil sector is modelled following the theoretical specification presented in the previous chapter.

Total economy:

Total factor productivity for the total economy is modelled as a function of the level of poverty which also captured the human development component of the economy. The level of financial development is captured by the level of financial constraints (financing of domestic investment) and the domestic investment in the country. The long-run result is presented as:

$$\begin{aligned} &\ln\_tfp\_tot_t = -0.28\ln\_povertyd\_index_t + 0.13\ln\_gcfgdp_t + 0.03\ln\_finconstr_t \\ &+ 0.41 dum\_tfp_t - 4.5 dumtfp_t + 9.4 \end{aligned} \tag{5.6}$$

The result shows the important role played by the human development variables in the long-run technological progress in Nigeria. An increase in the level of poverty by 1 per cent causes a 0.3 per cent decline in total factor productivity. The ratio of domestic investment to GDP and the level of financial constraints will have a positive influence on technology of about 0.1 per cent and 0.03 per cent respectively. The two dummy variables captured the structural break found in the total factor productivity series. These were also significant for determining the long-run technological process. The long-run equation was tested for cointegration and the null hypothesis of no cointegration was rejected.

Capturing the short-run dynamics the ECM passed all the diagnostic tests which suggests that no assumption of the classical regression model has been violated. The dynamic adjustment towards the long-run equilibrium path is found to be negative and significant showing that about 25 per cent of any disequilibrium is corrected for every year. Socio-economic activity is found to play an important role in the short-run adjustment process.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

Oil sector:

Since the oil sector is characterised as the first economy, the human development variable plays an insignificant role in determining its long-run technological progress. A major difficulty is however encountered in modelling the technological progress in the oil sector. The financial development sector and oil prices are expected to have a big influence on this aspect of the economy. The oil sector total factor productivity is modelled as a function of certain financial variables. The availability of domestic credit, the level of foreign direct investment and oil prices are seen as major forces driving technology in the oil sector. The long-run result is presented as:

$$\ln\_tfp\_oil_t = 0.95\ln\_dcredit_t + 0.05\ln\_fdi_t + 0.3\ln\_oil\_p_t + 2.6dummy\_m_t - 13.1 \qquad (5.7)$$

The long-run equation is consistent with a priori expectation and the residuals of the regression were tested for stationarity and the null hypothesis of no cointegration was rejected. The results show that a rise of domestic credit by 1 per cent will cause total productivity in the oil sector to rise by about 0.95 per cent and as the foreign direct investment increases by 1 per cent total productivity rises by about 0.05 per cent. Oil prices are expected to have a positive impact on the technology in the oil sector with about a 0.3 per cent increase when the oil price rises by one per cent. The dummy variable capturing the oil price shocks is found to be significant in the long-run equation[32].

The short-run dynamic properties are also shown from the Error Correction Model (ECM). Capital stock, socio-economic activity, some form of government expenditure, and capacity utilisation in the oil sector are found to be significant in the short-run adjustment process. The coefficient of the lagged residual from the long-run is negative and significant, showing that about 32 per cent of any disequilibrium is corrected for every year. The short-run equation passed all the required diagnostic tests which have revealed that the equation is well-specified and does not violate the Gaussian or classical linear regression assumptions.

[32] The rest of the economy total productivity function is calculated from the identity tfp_rest=tfp_tot-tfp_oil.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

5.2.1.2 Aggregate demand

Household real consumption expenditure

The long-run relationship of the household consumption in Nigeria is captured by the level of household disposable income, real wealth (proxied by real M2) and the real interest rate. These variables are expected to influence the consumption pattern of households positively. The real interest rate coefficient is positive and significant, conforming to theory. This is in contrast with most empirical studies applied to the developing countries. The long-run result is presented as:

$$\ln\_hh\_rconexp_t = 0.97\ln\_hh\_rgdp\_rest + 0.004\ln\_rm2_t + 0.01 r\text{int}_t + 0.14 dummy\_m_t + 0.18 dum_t \quad (5.8)$$

The result conforms to theory and the inclusion of the two dummy variables tends to capture the periods of military rule and oil price shocks. The result shows that a 1 per cent increase in household disposable income and real money supply will lead to about 0.97 per cent and 0.004 per cent increase in household consumption expenditure while a 1 unit rise in the real rate of interest will lead to about 0.01 per cent increase in household consumption. The stationarity test on the residual from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

Capturing the short-run dynamics of the consumption function, the coefficient of the lagged residuals from the long-run is negative and significant, showing the dynamic adjustment towards the long-run equilibrium path. About 91 per cent of any disequilibrium is corrected for every year. Apart from the long-run variables the lagged value of the household consumption expenditure also play an important role in the short-run. The ECM passed the entire diagnostic test revealing a well-specified model.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

5.2.1.3 Prices

Consumer and producer prices

Price settings are seen as a key decision for firms operating under a profit-maximising or cost-minimising framework. The pricing structure links together the various sectors in the economy and also provides an additional advantage to be able to explain the high inflationary pressure that the country has been experiencing since 1970. As discussed in the previous chapter, models of production and consumption prices are estimated.

The Nigerian consumer price index is expected to be influenced by production prices, import prices and the exchange rate, which are captured by the producer price index, import price index and Naira per U.S dollar nominal exchange rate respectively. The level of excess demand in the economy is also found to have a long-run impact on the consumer prices. The long-run result is presented as:

$$\ln\_cpi_t = 0.96\ln\_ppi_t + 0.8\ln\_imp\_p_t + 0.9\ln\_exch_t + 0.2\ln\_excessd + 0.5dummy\_m_t - 0.3dum\_oil_t - 7.4 \qquad (5.9)$$

Most importantly is the magnitude of the coefficients of the producer prices and exchange rate which indicate about 0.9 per cent increase in consumer prices when the two variables rise by 1 per cent each. The results confirmed the economic significance that production prices, import prices and exchange rate has on the consumer prices in Nigeria. The depreciation of the Naira is expected to put pressure on consumer prices, likewise an increase in the production prices and import prices. Dummy variables capturing the military rule and the oil sector are found to be significant in explaining consumer prices. The stationarity test on the residual from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

Capturing the short-run adjustment process as revealed from the ECM. Apart from the long-run variables nominal wage, GDP, capital flows, and government transfers are found to have been significant in the short-run. The dynamic adjustment towards the long-run equilibrium path is found to be negative and significant revealing that about 5 per cent of any disequilibrium is corrected for every year. The diagnostic tests carried out from the ECM shows that the model is well-specified and has not violated any of the assumptions of the classical linear regression model.

The dynamic simulation of the long-run and short-run equations of the Nigerian consumer prices confirms a very good fit of the estimated model (Appendix 4).

However, it is assumed that the producer prices are influenced by nominal wages and the cost of capital (proxy by interest rate). Oil price and the level of capacity utilisation have also significantly affected the Nigerian production prices in the long-run. All these variables have a positive influence on the production prices. The long-run result is presented as:

$$\ln\_ppi_t = 0.01\ln\_wage_t + 0.1\ln\_oil\_p_t + 0.5\ln\_cu\_tot_t + 0.2\ln\_\text{int}_t + 4.5 \qquad (5.10)$$

The result shows that the level of capacity utilisation has a slightly higher impact on production prices than other variables in the long-run. The stationarity test on the residual from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

The dynamic adjustment towards the long-run equilibrium path is found to be negative and significant, revealing that about 29 per cent of any disequilibrium is corrected for every year. The ECM passed all the diagnostic tests and no assumption of the classical linear regression model has been violated.

The dynamic simulation of the long-run and short-run equations of the Nigerian producer prices reveals a good fit of the estimated model (Appendix 4).

5.2.2 The external sector

Real export of goods and services

The long-run real export demand is estimated as a function of world income, relative prices and the fluctuations in the level of oil prices. As mentioned earlier, the exchange rate which measures the level of competitiveness in the economy does not have any long-run relationship in the Nigerian export demand function, instead oil prices plays a significant role in the long-run. The long-run result is presented as:

$$\ln\_r\exp_t = 0.75\ln\_rgdpus_t - 0.20\ln\_relcpi_t + 0.34\ln\_oil\_p_t \qquad (5.11)$$

The result conforms to theoretical specification. A 1 per cent increase in world income and oil prices will lead to about 0.8 per cent and 0.3 per cent increase in real exports while a 1 per cent rise in relative prices is expected to reduce real exports by about 0.2 per cent. World income and oil prices are found to have a greater impact on the export function than relative prices. This is expected since U.S. is the major trading partner of Nigeria especially in the export of crude oil. A rise in the domestic prices relative to U.S prices will lead to a fall in the country's export demand. Stationarity test on the residuals from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

Capturing the short-run dynamics of the export demand function, the coefficient of the lagged residuals from the long-run is negative and significant showing the dynamic adjustment towards the long-run equilibrium path. About 55 per cent of any disequilibrium is corrected for every year. The nominal exchange rate is however, found to play a significant role in the short-run dynamics of the Nigerian export demand. In addition, the level of production prices also has a significant influence on export in the short-run. The ECM passed the entire diagnostic test revealing a well-specified model.

The dynamic simulation of the long-run and short-run equations confirms a very good fit of the estimated model (Appendix 4).

Real import of goods and services

The long-run real imports demand is determined by the level of domestic income (GDP), relative prices and the nominal exchange rate. The nominal exchange rate plays a significant role in the Nigerian import demand function since imports constitute the majority of the country's consumption expenditure. The long-run result is presented as:

$$\ln\_rimp_t = 1.4\ln\_rgdp_t + 0.21\ln\_relcpi_t - 0.21\ln\_exch_t - 0.48dum_t - 0.32dummy\_m_t - 6.4 \quad (5.11)$$

The depreciation of the exchange rate by 1 per cent will lead to about 0.2 per cent decrease in imports as it becomes more expensive to purchase foreign goods, while a rise in the domestic prices relative to U.S prices by 1 per cent will increase imports by the same magnitude as the U.S goods will become cheaper. Domestic income is found to play a much greater role in the import equation indicating about 1.4 per cent rise in imports if domestic income should increase by 1 per cent. The inclusion of the two dummy variables tends to capture the periods of military rule and oil price shocks. The stationarity test on the residuals from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

The short-run dynamics of the import demand function was captured and the coefficient of the lagged residuals from the long-run was found to be negative and significant, showing the dynamic adjustment towards the long run equilibrium path. About 58 per cent of any disequilibrium is corrected for every year. Apart from the long-run variables the lagged values of the real imports, the fluctuation in oil prices play an important role in the short run. The ECM passed the entire diagnostic test revealing a well-specified model.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

Nominal exchange rate

As analysed in the previous chapter, the long-run nominal exchange rate is estimated following the Dornbusch (1980) and Frankel (1979) methods. The relative interest rate is found not to have any significant impact in the long run. This confirms the insignificant role played by the monetary policy over the years in the Nigeria economy. The long-run result is presented as:

$$\ln\_exch_t = -1.11\ln\_relrgdp_t + 0.78\ln\_relm2_t + 0.38\ln\_relcpi_t - 0.68dum_t + 8.5 \qquad (5.12)$$

The long run result shows the sensitivity of exchange rate to both domestic and foreign income. As the level of domestic income increases by 1 per cent relative to foreign income, the Naira will appreciate by about 1.1 per cent, while an increase in relative money supply and prices by 1 per cent will lead to the depreciation of the Naira by about 0.8 per cent and 0.4 per cent respectively. The dummy variable representing the periods of oil price shocks plays a significant role in the long run specification. The stationarity test on the residuals from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

Capturing the short run dynamics, the ECM passed all the diagnostic tests and this suggests that no assumption of the classical regression model has been violated. The dynamic adjustment towards the long-run equilibrium path is found to be negative and significant, showing that about 30 per cent of any disequilibrium is corrected for every year. Apart from the long-run variables, oil prices and relative remittances from abroad also play an important role in the short-run adjustment process.

The dynamic simulation of the long-run and short-run equations displays a very good fit of the estimated model (Appendix 4).

Foreign direct investment

The long-run foreign direct investment is determined by the level of GDP (market size), price level, level of openness of the economy and the fluctuations in the nominal exchange rate. The result from the estimation is presented as:

$$\ln\_fdi_t = 0.68\ln\_rgdp_t - 0.5\ln\_cpi_t + 0.1\ln\_open_t + 0.29\ln\_exch_t + 1.17dummy\_m_t + 0.9dum_t \qquad (5.13)$$

The result revealed the significant role played by GDP in attracting foreign investment into the country and how the level of macroeconomic instability (price level) can slowdown the flow of foreign investment. A 1 per cent increase in GDP will lead to about 0.7 per cent increase in foreign direct investment and hen consumer prices increases by 1 per cent the level of foreign direct investment declines by about 0.5 per cent. The depreciation of the exchange rate by 1 per cent will lead to an increase in the flow of foreign investment by about 0.3 per cent as this will serve as a signal for a reduced cost of capital while the level of openness of the economy will also give way to more foreign investment in the country. The inclusion of the two dummy variables which represent the periods of military rule and oil price shocks plays a significant role in the long-run. The stationarity test on the residuals from the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

The dynamic adjustment towards the long run equilibrium path is found to be negative and significant, revealing that about 60 per cent of any disequilibrium is corrected for every year. The lagged values of foreign direct investment and the level of domestic investment are found to have played an important role in the short-run. The ECM passed all the diagnostic tests and no assumption of the classical linear regression model has been violated.

The dynamic simulation of the long-run and short-run equations confirms a good fit of the estimated model (Appendix 4).

5.2.3 The monetary sector

Nominal interest rate

The long run nominal interest rate equation is estimated as a function of real GDP, money supply, and the discount rate. Since the discount rate is directly linked to the lending rate and has been the main monetary policy tool used by the Central Bank to determine bank lending rates it is included in the long run specification of the nominal interest rate (Pauly, 2005). The result from the long-run estimation is presented as:

$$\ln\_\text{int}_t = 0.49\ln\_rgdp_t - 0.26\ln\_rm2_t + 0.78\ln\_dis\_rate_t - 7.69 \quad (5.14)$$

The result shows that an increase in GDP by 1 per cent is associated with an increase in interest rate by about 0.5 per cent since the higher GDP will result in increased transaction demand for money. The increase in real money supply by 1 per cent will lead to a reduction in interest rate by about 0.3 per cent. The link between the discount rate and interest rate is confirmed from the positive relationship shown in the result. The stationarity test on the residuals of the long-run equation was carried out and the null hypothesis of no cointegration was rejected.

The short-run dynamics of the nominal interest rate function was captured and the coefficient of the lagged residuals from the long-run was found to be negative and significant showing the dynamic adjustment towards the long-run equilibrium path. About 72 per cent of any disequilibrium is corrected for every year. Apart from the long-run variables the lagged values of the nominal interest rate is found to play an important role in the short-run. The ECM passed the entire diagnostic test revealing a well-specified model.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

5.2.4 Other behavioural equations in the model

Socio-economic activity

The importance of capturing the socio-economic aspect of the macroeconometric model of the Nigerian economy is to be able to see the impact of any policy scenario on the welfare of its citizens and in general the development of the nation. As specified in the previous chapter, socio-economic activity in Nigeria is influenced by the level of household disposable income, government expenditure on social development and some level of infrastructural development which is captured by electricity production per capita. These factors are expected to positively affect the social aspect of economic livelihood of Nigerian population. Again, household disposable income in the rest of the economy is used since the majority of the poor population belongs to this class. The long-run result of socio-economic activity is presented as:

$$\ln\_se\_index\_b_t = 0.03\ln\_hh\_rgdp\_rest_t + 0.03\ln\_r\exp social_t + 0.02\ln\_eleppop_t + 0.04dummy\_m_t - 0.5 \qquad (5.15)$$

The results show that the household disposable income and government expenditure on social development will have similar impact on the socio-economic activity. That is to say that, a 1 per cent increase in household disposable income or government expenditure will cause socio-economic activity to rise by 0.03 per cent. Electricity production per capita is found to have slightly lower impact of about 0.02 per cent and a dummy variable capturing the military rule is found to be significant in explaining socio-economic activity in the long-run. Based on the stationarity test on the residuals from the long-run equation, the null hypothesis of no cointegration was rejected.

Capturing the short-run dynamics the ECM reveals that the model has passed all the diagnostic tests which suggest that no assumption of the classical regression model has been violated. The dynamic adjustment towards the long-run equilibrium path is found to be negative and significant, showing that about 33 per cent of any disequilibrium is corrected for every year.

Apart from the long-run variables, capital flows, GDP, and the level of poverty are some of the factors that played an important role in the short-run adjustment process.

Simulating the dynamics of the long-run and short-run equations of socio-economic activity in Nigeria shows a very good fit of the estimated model (Appendix 4).

Disposable income

Household disposable income as discussed in the previous chapter is expected to be influenced mainly by real wages and some form of government transfer payments. The long-run result is present as:

$$\ln\_hh\_rgdp\_rest_t = 0.9\ln\_rwage\_lf_t + 0.1\ln\_transfer_t + 0.1dummy\_m_t - 1.2E-07dumoil_t + 3.5 \quad (5.16)$$

The long-run equation is tested for cointegration based on stationarity of the residuals and the null hypothesis of no cointegration was rejected. The result shows that a 1 per cent increase in real wages will lead to 0.9 per cent rise in real household disposable income and if government transfer payments should increase by 1 per cent, real household disposable income will increase by 0.1 per cent.

The dynamic adjustment towards the long-run equilibrium path is shown by the coefficient of the lagged residuals from the long-run which is negative and significant. This shows that about 26 per cent of any disequilibrium is corrected for every year. Capital stock, production prices, and agricultural production are found to play an important role in the short-run adjustment process. In order to determine whether the ECM is well-specified the required diagnostic tests were carried out and the results reveal no violation of the Gaussian or classical linear regression assumptions.

The dynamic simulation of the long-run and short-run equations reveals a very good fit of the estimated model (Appendix 4).

Poverty

The explanation of poverty using a macro-econometric model is fairly rare in the literature. As mention earlier, the microeconomic literature have dominated most of the analysis on poverty and the CGE models which focus on the general economy have a strong micro-foundation. The main focus of this part of the study is to build a macroeconomic model which can explain the rising poverty levels the Nigerian economy has been plagued with over the years. The divergence between growth and poverty has been a major feature of most of the developing countries and a focus on the production structure of these economies is deeming necessary in order to alleviate the high poverty levels.

The long-run poverty function as discussed in the previous chapter is expected to be influenced by some form of macroeconomic instability, (proxy with inflation) food production, the level of household disposable income, the level of aid that flow into the country, and the level of infrastructural development. These variables with the exception of inflation are expected to have a negative relationship with the level of poverty. The long-run result is presented as:

$$\ln\_povertyd\_index_t = 0.24\ln\_cpi_t - 0.54\ln\_index\_agric_t - 0.15\ln\_hh\_rgdp\_rest_t - 0.02\ln\_aidpop_t - 0.1\ln\_eleppop_t + 3.03 \quad (5.17)$$

The result shows that an increase in consumer inflation by 1 per cent will cause poverty to rise by 0.24 per cent. The level of agricultural production is found to have the highest impact on the level of poverty with a 0.5 per cent decline in poverty when food production rises by 1 per cent. Household's disposable income and electricity production per capita are also found to be significant in determining the long-run poverty path. The level of aid per capita will lead to an improvement in the standard of living. This is inline with poverty trap view of aid reliance as a catalyst for growth and poverty reduction. Some, like Kraay and Raddatz (2006) are however sceptic of this popular notion. The residual from the long run equation was tested for stationarity and the null hypothesis of no cointegration was rejected.

Capturing the short run dynamics of the poverty equation, the coefficient of the lagged residuals in the long run is negative and significant showing the dynamic adjustment towards the long-run equilibrium path. About 10 per cent of any disequilibrium is corrected for every year. Apart from the long-run explanatory variables the level of employment and capital flows also play a major role in the short-run adjustment process. The ECM however, passed all the required diagnostic tests revealing a well-specified equation.

The estimated long-run and short-run equations are simulated together and the fitness of the model revealed very robust parameter estimates (Appendix 4).

Provision of infrastructure

As discussed earlier, the level of infrastructural development will be a catalyst to achieve economic growth and simultaneously improve the living standard of the general society. Likewise will the increasing level of economic activities calls for a need to expand existing infrastructure. There has been a decay of infrastructure in the Nigerian society over the years and this has been a major setback in achieving the potential level of economic growth and developmental objectives.

Substantial investment in infrastructure, especially in the power sector and road is essential at this stage in the Nigerian economy. Electricity generation and distribution remains a serious aspect of infrastructural building that is impeding development in Nigeria and government performs a significant role in this sector. The long run infrastructural function as a proxy for electricity production is expected to be influenced by the level of output and some form of good governance (government effectiveness). These variables are expected to have a positive influence on the level of infrastructural development. The long-run result as presented in Appendix 3 (Table 27) can be shown as:

$$\ln\_elep_t = 1.4\ln\_rgdp_t + 0.9ge_t + 0.4dum_t - 13.6 \qquad (5.18)$$

The results shows that an increase in economic activities (output) by 1 per cent will require an expansion of infrastructure by 1.4 per cent, while an improvement in government efficiency by 1 unit will cause a 0.9 per cent rise in the level of infrastructure[33]. The residual from the long-run equation was tested for stationarity and the null hypothesis of no cointegration was rejected.

The dynamic adjustment towards the long-run equilibrium path was found to be negative and significant, revealing that about 36 per cent of any disequilibrium is corrected for every year. Cost of capital and socio-economic activities are some of the additional variables that played important roles in the short-run adjustment process. The ECM passed all the diagnostic tests and no assumption of the classical linear regression model was violated.

The estimated long run and short run equations were simulated simultaneously and the fitness of the model revealed a very robust parameter estimate (Appendix 4).

Agricultural production

As discussed in the previous chapter, agricultural production in Nigeria is expected to be influenced by the availability of natural resources (i.e. land), environmental condition (i.e. rainfall) and some form of production price in the economy. Due to a lack of available data on environmental conditions the long-run agricultural production function is captured by production prices, the availability of land for farming and the level of infrastructural development. These variables are expected to have a significant influence on agricultural production. The long-run result is presented as:

$$\ln\_index\_agric_t = -0.14\ln\_ppi_t + 0.58\ln\_land_t + 0.4\ln\_elep_t - 0.56dum_t - 0.17dummy\_m_t \qquad (5.19)$$

The residual from the long-run equation was tested for stationarity and the null hypothesis of no cointegration was rejected. The results revealed that a 1 per cent rise in production prices will add to the cost of producing food and this will lead to a fall in food production by about 0.14 per

[33] Government Effectiveness is not in its natural logarithms due to negative values in the series (see data description for more details).

cent. The rise in the availability of arable land for farming will have a positive and greater impact on food production by about 0.6 per cent likewise will the level of infrastructural development boost food production by about 0.4 per cent.

Capturing the short-run dynamics of the agricultural production equation, the coefficient of the lagged residuals from the long run is negative and significant, showing a dynamic adjustment towards the long run equilibrium path. About 19 per cent of any disequilibrium is corrected for every year. Apart from the long-run explanatory variable the level of capital stock, openness of the economy, political instability and some form of aid also play a major role in the short run adjustment process. The ECM however, passed all the required diagnostic tests, revealing a well-specified equation.

The estimated long-run and short-run equations are simulated together and the fitness of the model revealed a very robust parameter estimate (Appendix 4).

5.3 ESTIMATION RESULTS (MODEL B): DEMAND-SIDE ORIENTATED

In this model an economy with limited or no structural supply constraints is presented. The notion is that the supply-side of the economy is being marginalised based on the assumption that the productive capacity of the economy is not being impeded by socio-economic constraints.

The core distinction between this model (Model B) and the previous model (Model A) is that the Gross Domestic Product (GDP) is generated following the Keynesian demand identity. Therefore, it does not call for a need to disaggregate the production function into the oil sector and the rest of economy. This means that some major macroeconomic variables detected to be determinant factors in explaining some stochastic equations are not disaggregated. The model however re-estimated the equations where the rest of economy macro variables are present. The results of these equations are presented below. All other equations are the same as in Model A.

Labour demand and real wage determination

The labour demand equation is re-estimated as a function of total GDP, real wages, and socio-economic activities. The long-run result is presented as:

$$\ln\_labor\_f_t = 0.8\ln\_rgdp_t - 0.8\ln\_rwage\_lf_t + 0.1\ln\_se\_index\_b_t \qquad (5.20)$$

Using the total economy's output (GDP) the impact of socio-economic activity on labour employment is much lower than when output is disaggregated revealing about 0.1 per cent rise in employment when economic activities increases by 1 per cent. But real wages in this model have a slightly greater impact than in Model A recording about 0.8 per cent decline in employment when real wages rises by 1 per cent. The residual from the long-run equation were tested for stationarity and the null hypothesis of no cointegration rejected.

Capturing the short term dynamics, capital stock, government expenditure on social development, consumer inflation, import prices, and exchange rate are also found to play a major role in the short-run adjustment process. The coefficient of the lagged residual from the long run is negative and significant, showing the dynamic adjustment towards the long-run equilibrium path. The short run equation passed all the required diagnostic tests which have revealed that the equation is well-specified and does not violate the Gaussian or classical linear regression assumptions.

The dynamic simulation of the long and short run equations reveals a very good fit of the estimated model (Appendix 4).

The real wage equation is captured by labour productivity in the total economy and the long-run result is presented as:

$$\ln\_rwage\_lf_t = 0.98\ln\_labprod\_tot_t - 0.1dummy\_m_t + 0.1dum_t \qquad (5.21)$$

Labour productivity in the total economy seems to have a greater impact on real wages in this model than Model A showing about 0.98 per cent increase in real wages when productivity rises by 1 per cent. The residual from the long run equation was tested for stationarity and the null hypothesis of no cointegration rejected.

Capturing the short run dynamics, the coefficient of the lagged residuals from the long-run is negative and significant showing, the dynamic adjustment towards the long-run equilibrium path. Apart from long run explanatory variables, socio-economic activity, government transfers, level of openness of the economy also play a major role in the short run adjustment process. The ECM however passed all the required diagnostic tests, revealing a well-specified equation.

The dynamic simulation of the long and short run equations reveals a very good fit of the estimated model (Appendix 4).

<u>Household real consumption expenditure</u>

The household real consumption expenditure is re-estimated as a function of household disposable income in the total economy and real wealth (real M2). The level of the real interest rate is found not to play any role in this specification. The long-run result is presented as:

$$\ln\_hh\_rconexp_t = 0.65\ln\_hh\_rgdp_t + 0.16\ln\_rm2_t + 0.3dummy\_m_t - 1.4e - 07dum_t + 2.4 \qquad (5.22)$$

The level of disposable income is found to have a less impact on household expenditure (0.7 per cent) when compared with Model A while real wealth (0.2 per cent) will have a greater impact. The dummy variables capture the period of military rule and oil price shock. The residual from the long-run equation was tested for stationarity and the null hypothesis of no cointegration rejected.

Capturing the short run dynamics, the coefficient of the lagged residuals from the long-run is negative and significant, showing the dynamic adjustment towards the long-run equilibrium path. About 76 per cent of any disequilibrium is corrected for every year. Apart from long run variables, the lagged values of the household consumption expenditure also play an important role in the short run. The ECM passed the entire diagnostic test, revealing a well-specified model.

The dynamic simulation of the long and short run equations reveals a very good fit of the estimated model (Appendix 4).

Socio-economic activity

The long-run socio-economic activity is re-estimated as a function of household disposable income in the total economy, government expenditure on social development, and the level of infrastructural development. The long run result is presented as:

$$\ln\_se\_index\_b_t = 0.03\ln\_hh\_rgdp_t + 0.03\ln\_r\exp social_t + 0.02\ln\_eleppop_t + 0.04 dummy\_m_t - 0.7 \quad (5.23)$$

This is similar to the result present in Model A. The residual from the long run was again tested for stationarity and the null of no cointegration rejected.

The short run dynamics are also captured with the same variables as in Model A and this reveals the same dynamic adjustment towards the long-run. The ECM passed all the diagnostic tests, suggesting that no assumption of the classical regression model was violated. The dynamic simulation of the long and short run equations reveals a very good fit of the estimated model (Appendix 4).

Poverty

The level of poverty is re-estimated and the long run result presented as:

$$\ln\_povertyd\_index_t = 0.21\ln\_cpi_t - 0.42\ln\_index\_agric_t - 0.004\ln\_hh\_rgdp_t - 0.01\ln\_aidpop_t - 0.1\ln\_eleppop_t \quad (5.24)$$

The impact of household disposable income (0.004 per cent) on poverty in this specification is significantly less when compared to the specification in Model A. All other variables have similar impacts as presented in Model A. The residual from the long-run was again tested for stationarity and the null of no cointegration rejected.

The short run dynamics are also captured with the same variables as in Model A, revealing the same dynamic adjustment towards the long run. The ECM passed all the diagnostic tests, suggesting that no assumption of the classical regression model has been violated. The dynamic simulation of the long and short run equations reveals a very good fit of the estimated model (Appendix 4).

Disposable income

The long run household disposable income in the total economy is estimated following the same specification as in Model A. The result is however, presented as:

$$\ln\_hh\_rgdp_t = 0.97\ln\_rwage\_lf_t + 0.14\ln\_transfer_t + 0.1dum_t + 2.3 \qquad (5.25)$$

The long run equation was tested for cointegration based on stationarity of the residuals and the null hypothesis of no cointegration was rejected. The result conforms to theory and revealed about 0.97 per cent increase in disposable income when real wages rises by about 1 per cent. . .

Capturing the short-run dynamics, the coefficient of the lagged residuals from the long-run is negative and significant, showing a dynamic adjustment towards the long-run equilibrium path. ECM passed the entire diagnostic test, revealing a well-specified model.

The dynamic simulation of the long and short run equations reveals a very good fit of the estimated model (Appendix 4).

5.4 MODEL CLOSURES

Model closure reveals the important inter-linkages and feedbacks of the various macroeconomic variables and estimated equations in the system. The type of closure reveals the features of the model developed and how the various policy simulations/scenarios would feedback into the entire system. Therefore, the two models developed in this study are closed based on the following identities:

<u>Model A</u>

In this model the production function (GDP) is estimated by making the supply-side of the economy more active than the demand-side. Therefore, the price (producer and consumer) equations serve as the link between the demand-side and the supply-side of the economy through the excess demand and the capacity utilisation. This is presented as:

GDP = $f(L, K, T)$

Excess Demand = GDE / GDP

GDE = C + I + G

Capacity Utilisation = GDP / GDP_POTENTIAL

where L is the labour employment, K is the capital stock, T is the technology, GDE is the gross domestic expenditure, C is the household consumption expenditure, I is the domestic investment, G is the total government expenditure, Z is the imports of goods & services, and GDP_POTENTIAL is the potential level of GDP.

The potential level of output in the economy is estimated by using the coefficients of labour and capital from the production function with the potential level of capital stock, labour employment, and total factor productivity. These variables are generated using the Hodrick-Prescott (HP) Filter technique.

Model B

In this model the production function (GDP) is generated by following the Keynesian demand identity, making the demand-side of the economy more active than the supply-side. Therefore, the production function is not disaggregated in this model. The price equations remain the linkages between the demand-side and the supply-side of the economy through the excess demand and capacity utilisation. This is presented as:

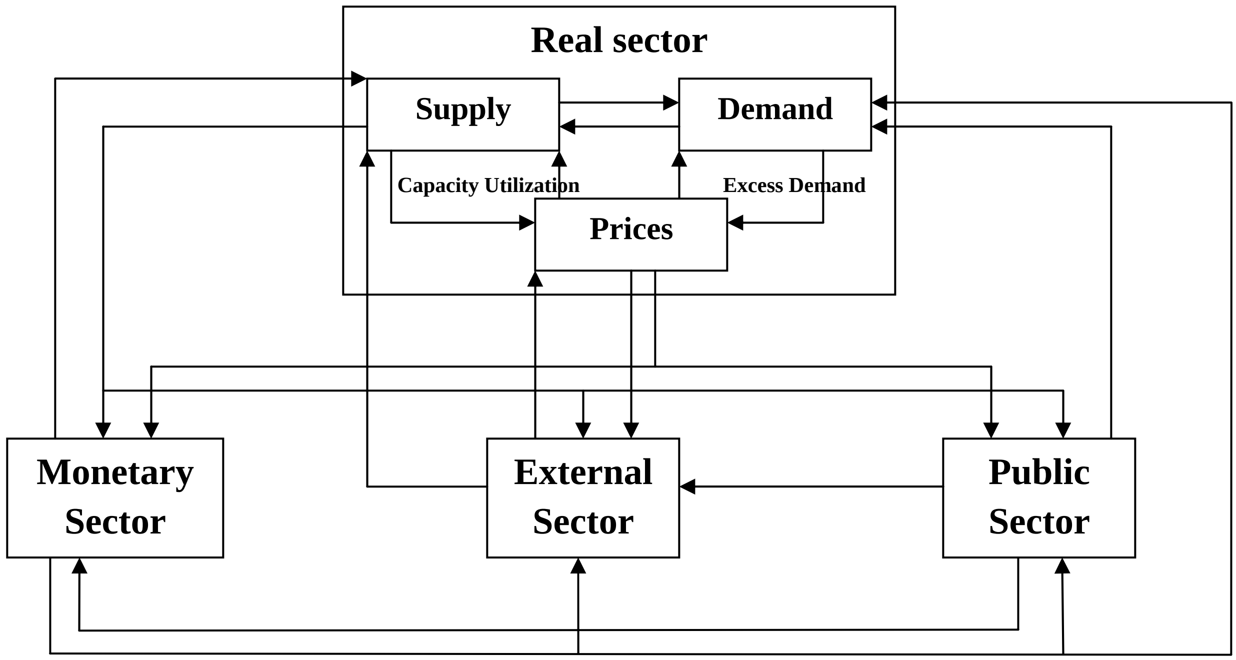
$$GDP = C + I + G + X - Z$$

$$GDE = GDP + Z - X$$

where X is the exports of goods and services, and Z is the imports of goods and services. All other identities follow as in Model A.

The summary of the entire model is presented in the form of the flow chart in figure 5.1. The chart highlights the major contemporaneous feedback processes of the interactions between the sectors investigated in the model. Details of all structural equations have been analyzed in the previous sections.

Figure 5.1: A Flow Chart of the Model



As shown in the flow chart above, the price block serves as a major linkage between the supply-side and aggregate demand-side through capacity utilisation and excess demand. Changes in these variables cause fluctuation in price, which affects production and demand and also causes changes in the other sectors of the economy. The monetary, external and public sectors are linked directly to the supply-side and demand-side of the economy through changes in the interest rate, government spending, and exchange rate. The institutional characteristics of the economy with its associated policy behaviour are incorporated through the public and monetary sector, whereas the interaction with the rest of the world is captured through the external sector.

5.5. LONG-RUN SIMULATION RESULTS: MODEL COMPARISON FOR POLICY ANALYSIS

In this section the long-run elasticities (relative percentage changes) of the two models are determined. A series of dynamic simulations are carried out by shocking a purely exogenous variable in the system to determine the elasticity for every response (endogenous) variable in reaction to the shock variable.

The elasticities are computed by comparing every response variable's baseline simulation path with its shocked simulation path. Elasticity is defined as the percentage change in the response variable relative to the percentage of the shock applied. The dynamic elasticities are determined along the simulation path, whereas elasticities at convergence are the long-run elasticity (Klein, 1983: 135).

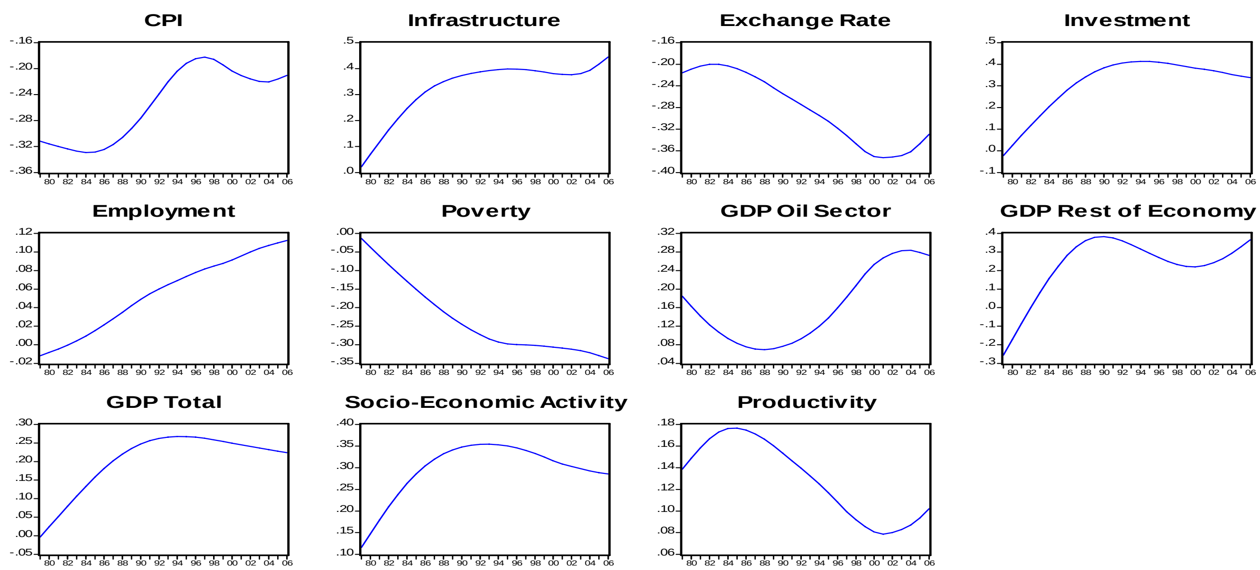
A positive shock of 10 per cent was applied to an exogenous variable from 1979 onwards to determine the shock simulation path. The model is therefore dynamically simulated and every response variable's simulation path was compared with its baseline path to determine the response elasticities. The process is repeated for every selected exogenous variable in the system.

Given the small sample size it is difficult to ensure convergence within the sample. To facilitate the detection of convergence, Hodrick-Prescott (HP) filters were applied and the smoothed dynamic elasticities were graphed. The elasticities of the major response variables for a particular shock are presented in Figure 5.2-5. Positive shocks of 10 per cent were applied to some major exogenous variables in the system. The key objective of the entire process of these macro-econometric models is to see the different impacts of a certain policy scenario on the long-term growth and poverty situation in the economy.

5.5.1. Total government expenditure shock:

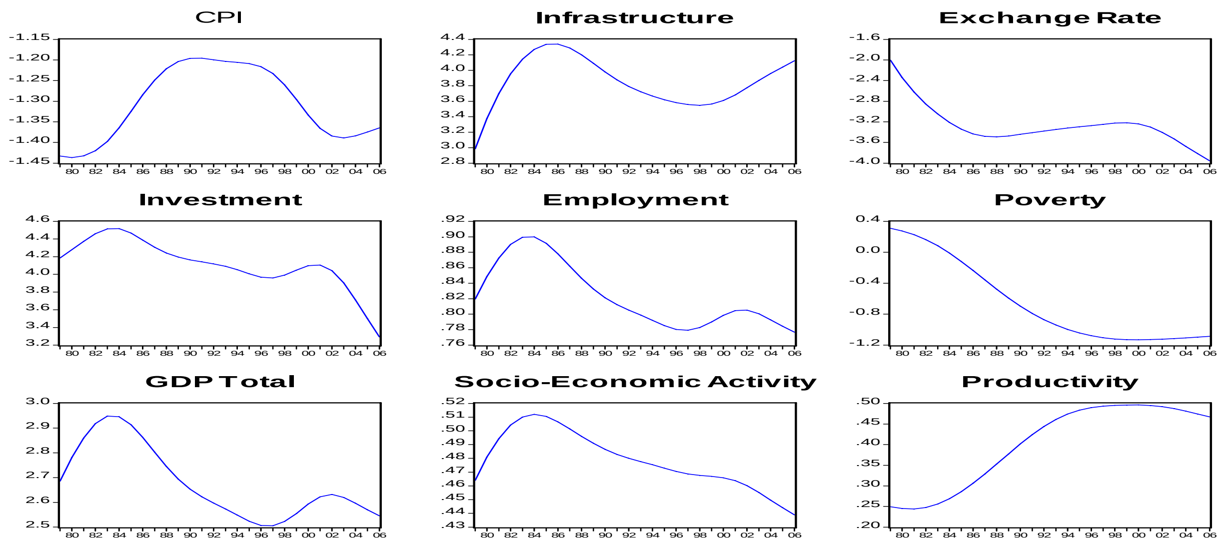
The increase in total government expenditure by 10 per cent shows a positive response on the major macroeconomic variables in both Model A and B. This impact is however more successful in an economic environment with limited supply constraints[34].

Figure 5.2A: Shock on Total Government Expenditure (Model A)



[34] The effect of a monetary shock is not analyzed due to the marginal role that monetary policy has played in stabilizing the economy over the years. This is coupled with the fact that the Nigerian financial system has not yet been well integrated into the local and global economy.

Figure 5.2B: Shock on Total Government Expenditure (Model B)



In Model A, the growth in total GDP as a result of the shock has been positive throughout the periods, reaching a high level of about 0.3 per cent. The rest of the economy's GDP is able to reveal a better positive impact than the oil sector's GDP. The expansionary fiscal policy has boosted domestic investment and the level of infrastructural development over these periods, reaching a high of about 0.4 per cent each. These have resulted into an increase in socio-economic activities, employment and productivity, which eventually lead to a decline in the level of poverty at a low of about 0.4 per cent. The growth in consumer prices has also been negative throughout the period, coupled with an appreciation of the exchange rate.

Model B produces a more successful impact of the expansionary fiscal policy. The growth in GDP, which has been positive throughout the period, reaches a high of about 2.9 per cent. A high level of about 4.5 per cent increase was recorded for domestic investment as well as the level of infrastructural development, translating into a higher positive impact in socio-economic activities, employment and productivity and leading to a lower reduction in poverty of about 1.2 per cent. A more significant improvement in the value of the currency is recorded over the long run, whereas the growth in consumer prices has also dropped drastically when compared to Model A.

Despite the rising government expenditure over the years in Nigeria, it has not significantly impacted on the general economic situation. The annual growth of the economy has not been impressive and has not translated into rising employment that could have improved the socio-economic conditions of the general populace. This is well revealed in Model A indicating some structural constraints which serves as a good representative of the Nigerian economy.

5.5.2. World oil price shock:

The oil price shock has been seen as the major external shock that can directly affect the real variables in any economy. The impact of an oil price shock should be more acutely experienced by a country like Nigeria, whose main source of revenue comes from crude oil exportation. It is expected that a rise in the oil prices should increase the productive capacity and also improve the general living standard in the country. But over the years the revenue from the oil price increases has not been translated into a significant economic growth that is pro-poor. Model B reveals a positive impact on the economy as a result of a 10 per cent rise in oil prices while in Model A, a negative impact on the economy is revealed.

Figure 5.3A: Shock on World Oil Prices (Model A)

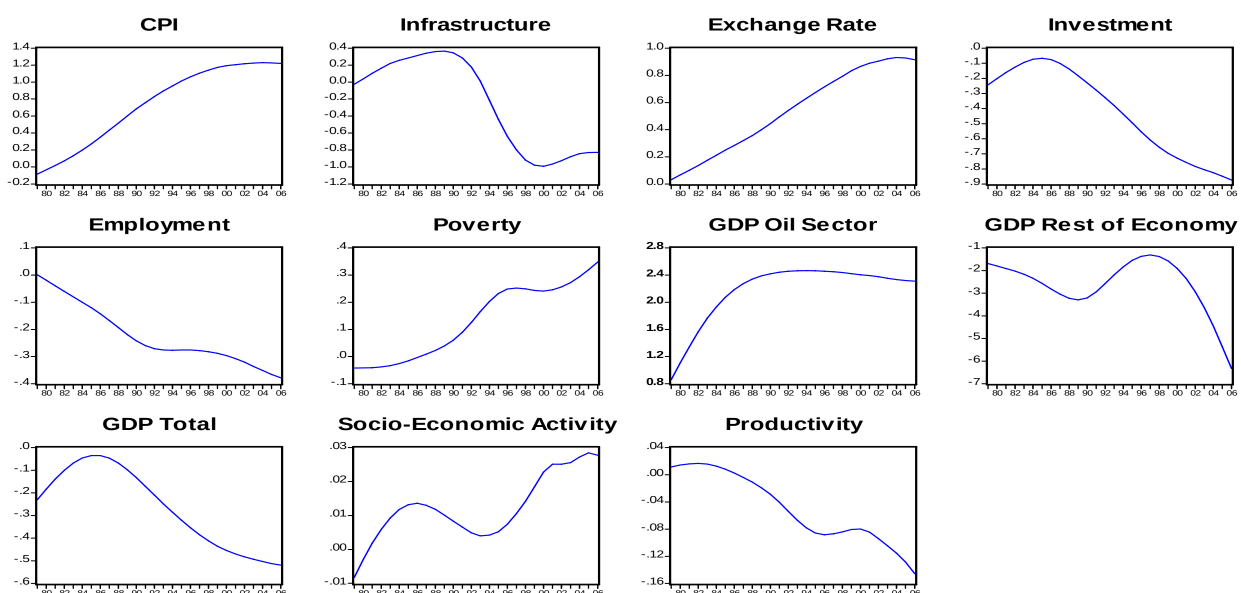
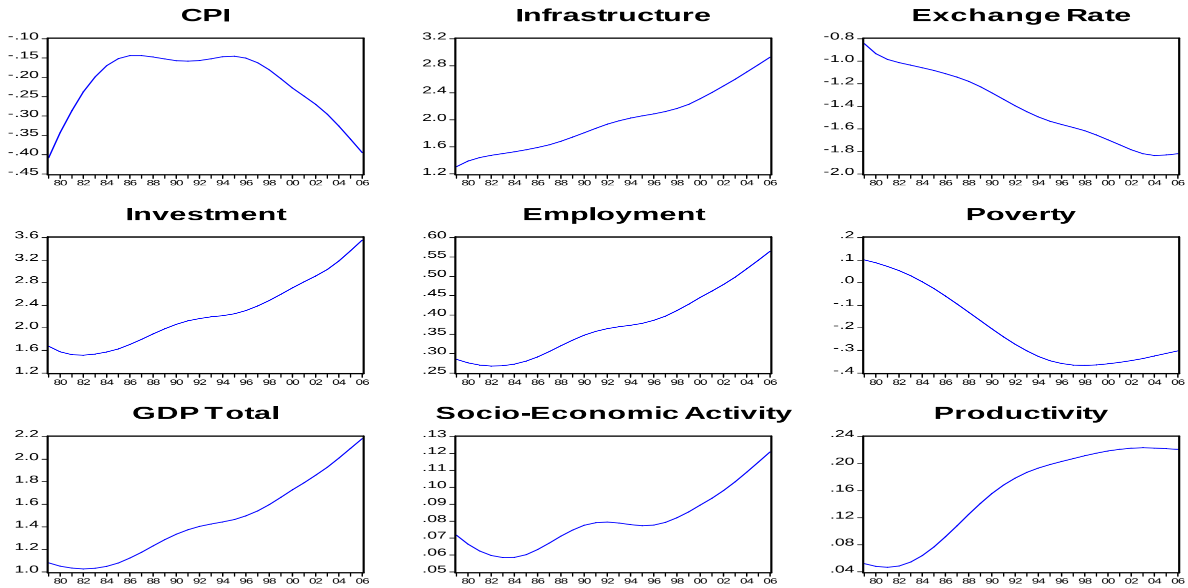


Figure 5.3B: Shock on World Oil Prices (Model B)



Except for the oil sector GDP, the growth in total GDP and the rest of the economy in Model A was negative in all the periods with a more severe impact in the rest of the economy's GDP. Irrespective of any structural constraints, the oil GDP still records a positive increase reaching a high of about 2.4 per cent. Through this effect, the domestic investment and level of infrastructural development fell by about 1 per cent each over the same period. These resulted in a decrease in employment and productivity but with a marginal and insignificant rise in socio-economic activities. This in turn led to a rise in the level of poverty which reached a high of about 0.4 per cent. Consumer prices also grew on a high of about 1.2 per cent with a depreciating exchange rate through out the period. The constraints preventing the spread of the oil revenue to increased levels of other production and improvement in the welfare can be attributed to the high import volumes of refined petroleum products in the country which had a direct impact on the production prices[35]. This trend still continues in Nigeria.

A positive impact of the oil price shock on the entire economy is shown in Model B. Growth in total GDP has been positive over the period reaching a high of about 2.2 per cent. This has translated into an increase in domestic investment and infrastructural development. Poverty

[35] Note: the country is a major exporter of crude petroleum.

decreases due to the rising level of employment, socio-economic activities, and productivity in the country. The effect of the shock on production prices is not significant in this economic environment and this has led to decreases in consumer prices over the period coupled with an appreciating exchange rate.

5.5.3. World income shock:

The shock on world GDP (proxied by U.S. GDP) is expected to have a positive impact on the domestic economy via the external sector. The depreciation of the country's exchange rate as a result of the rise in world income should lead to an additional improvement in the country exports demand. But since the country is not competitive in the global environment and the negative impact of the exchange rate on consumer prices, the level of poverty is deemed to rise over the years. This negative impact of the exchange rate on the consumer prices can be attributed to the large import component of the country's consumption pattern. This again revealed the feature of an economy that has structural constraints.

Despite this background, the impact of the rise in world income is positive on the domestic economy in Model B and with a less severity of poverty, while Model A shows a negative impact on the domestic economy with a more severe level of poverty.

Figure 5.4A: Shock on World Income (Model A)

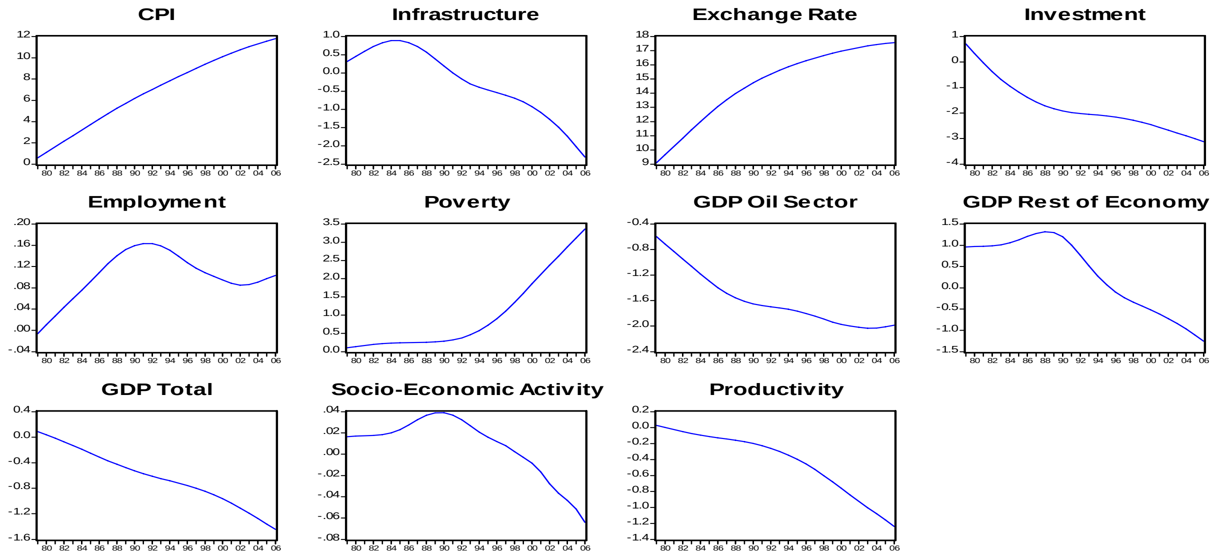
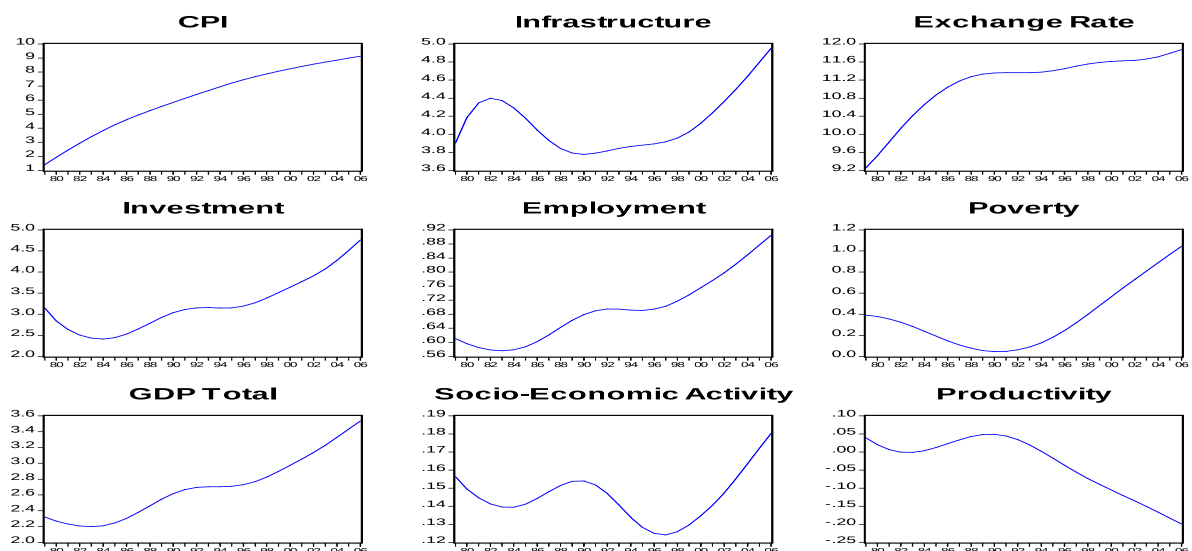


Figure 5.4B: Shock on World Income (Model B)



The shock on world income increases total GDP in Model B throughout the entire period, reaching a high of about 3.5 per cent. The domestic investment and level of infrastructural development also received a boost with a high of about 5 per cent. These changes translated into rising employment and socio-economic activity reaching a high of about 0.9 per cent and 0.2 per cent respectively. Productivity dropped over the period simply due to the inflationary effect of the shock.

The growth in total GDP is found to be negative throughout the period in Model A with a more severe impact on the oil sector GDP[36]. Domestic investment and infrastructural development also recorded a fall with a low of about 3 per cent each over the period leading to a fall in employment, socio-economic activities, and productivity.

5.5.4. Governance shock:

Good governance was the central focus of the debate among world policy makers in recent years. The major stumbling block to the implementation of many macroeconomic policies in the developing and low-income economies has been the absence of the political will imbedded in the leadership structure. The extent to which a country's governance can impact on the socio-economic environment and productive capacity cannot be overemphasised. The Nigerian governance structures have been in a poor state over the years and this has been a serious challenge in achieving the set developmental objectives. The poor effectiveness of government and the re-occurrence of political unrest had a seriously negative impact on the economy.

[36] This may be due to the significant role the oil sector plays in the country production function.

Figure 5.5A: Shock on Government Effectiveness; Worse Governance (Model A)

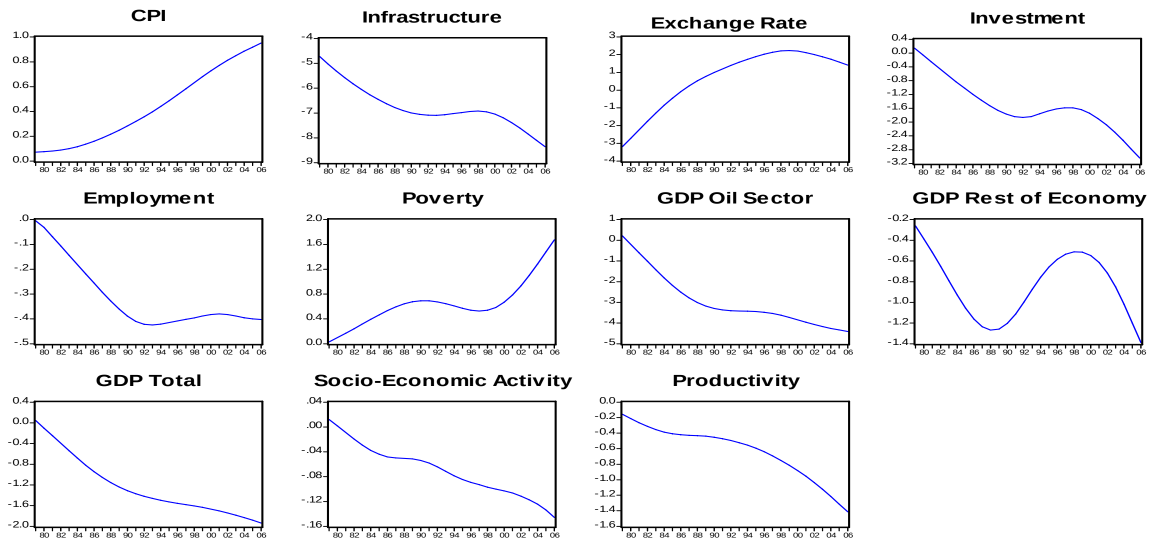
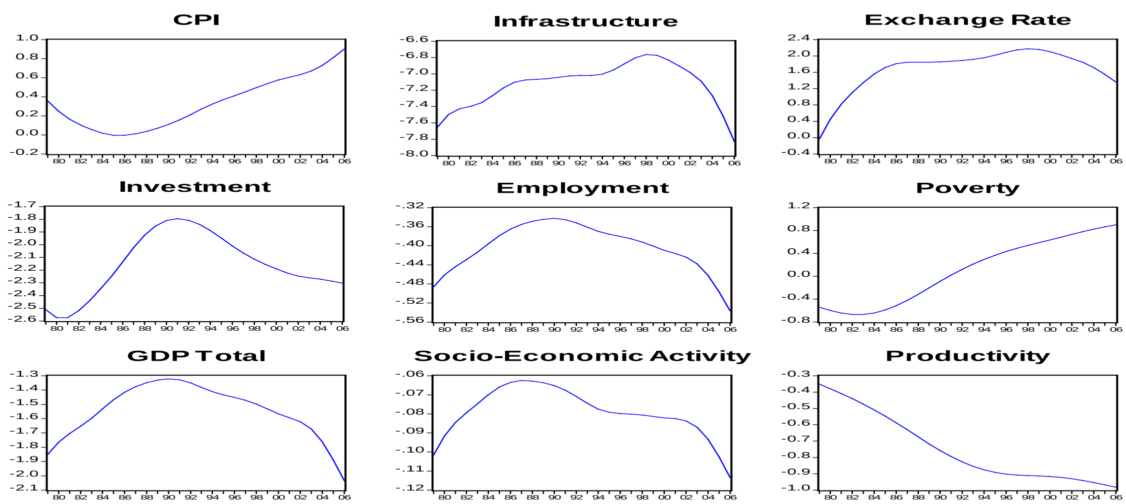


Figure 5.5B: Shock on Government Effectiveness; Worse Governance (Model B)



Irrespective of the kind of economic environment, good governance plays a crucial role in the economy. This fact is confirmed from the results in both Model A & B. A negative and similar impact of worse governance is recorded in the two economic environments[37]. The growth in total GDP has been negative throughout the period in the two models while the level of poverty has also been rising over the same period but with a more severe impact on poverty in Model A.

[37] Note: A 10 percent increase in governance reflects bad governance. See Appendix 1 for more details.

However, the role played by the effectiveness of government in the provision of infrastructure is enormous.

5.6 CONCLUSION

Based on the above analyses of the results from the various estimated structural equations, the closing of the entire macro-economy system, and the long-run response properties of the various exogenous shocks applied. Numerous economic implications have been analysed from the results of the model as revealed by the responses of the major economic variables to shocks in some exogenous variables in the system. The model has clearly revealed the implications of a certain policy option on the long-term path to achieving sustainable economic growth and a reduction in the level of poverty in the Nigerian economy. Government effort to tackle the numerous economic challenges (i.e. increased productive capacity and ensuring good governance) that will put in place correct institutions which will improve the level of socio-economic activities is crucial to the country. The various policy decisions made by the government over the years have not transformed into a significant improvement in the socio-economic conditions of the citizens and this is reflected from the simulations performed in Model A. Therefore, Model A can be regarded as the appropriate model that represents the structure of the Nigerian economy which could be used to address the various policy challenges in the economy. The next chapter provides the summary of the study and recommends policies that will ensure sustained economic growth and an improvement in the standard of living of the Nigerian population.