

## **A Macro-econometric Model for the Sudan Economy**

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**Abstract:** This study aims at building a macro-econometric model for the Sudan economy mainly for the sole purpose of policy analysis. The model conforms to the previous attempts in relying on the conventional income-expenditure approach. However, it differs from them in certain aspects. It covers a rather extended period from 1960 to 2005. The model contains 14 equations covering the monetary sector, public sector, real sector, external sector, labor sector, and prices. The equations of the model are identified, and the three stages least squares is used to estimate the model. Also, unit root test has been used to avoid problem of spurious regression. The model passes all the required tests and is employed to conduct sound policy analysis.

**Keywords:** Macro-econometric model, Three stages least squares, Policy analysis, Sudan

**JEL Classifications:** C15, C30; E60

### **1. Introduction**

Sudan has been experiencing economic difficulties which assumed a crisis proportion since the late seventies and through the eighties. Those difficulties vary in scope and content. They involve slow or negative Gross Domestic Product (GDP), accumulating debts, mounting inflation, and severe public and balance of payments deficits. To restore the economic imbalances, Sudan has adopted a set of stabilization policies initiated by the International Monetary Fund (IMF) in the mid seventies and structural adjustment programs (SAP) sponsored by the World Bank in the early eighties. In spite of the strict implementation of these programs, they had not produced the desired effects. Sudan's external debt has soared reaching 26.8 billion dollars in 2004. Budget deficit has exceeded 6% of GDP. Price inflation has rocketed 65%. Capacity utilization underwent acute reduction. To counteract this critical situation, the government initiated a three year National Economic Salvation Program (NESP) 1990/91-1992/93 intended to augment the growth rate of the economy.

In view of increasing globalization, pressing competitive pressures and vulnerability of the Sudan economy to the vagaries of the world market, both internal and external shocks are expected to roam the Sudanese economic scene.

This raises a number of questions:

- Confronted with such external shocks, can the government alleviate persistent budget deficits without compromising the growth objectives of the adjustment program?
- To what extent does the Central Bank of Sudan capable of controlling money supply and hence inflation in view of the persistent budget deficit, rising debt interest payments and modest current account surpluses?
- In association with the previous questions, to what extent does the monetary authority capable of stabilizing the exchange rate?
- In view of the deficit financing, is there a concrete evidence of crowding out effects?
- To what extent do the foreign trade sector policies ameliorate the current account and enhance the non-oil export sector?
- Is it possible to maintain the stability of the economy given the volatility in oil prices and hence government revenue?
- To enhance growth and development what types of structural and institutional reforms the government should seek?
- Responding to the growing concern for a systematic understanding of the interplay between the economy and noneconomic factors, does the cultural and social values of the Sudanese society have a significant bearing on the functioning of the economy?

To seek answers to these questions, this necessitates a formal model framework with explicit character. The explicit model framework, in spite of its shortcomings, is preferred to the implicit one. A quantitative model, for instance, not only provides a theoretical structure for understanding the linkages among the principal macroeconomic variables, but also provides, in broader order of magnitudes, a systematic sense of signs and sizes of the relevant parameters and the transmission of shocks from one sector to another, and the feedback effects to the originating sector.

In Sudan, until recently, such policy exercises had been carried out by the General Economic Policies and Programs Directorate of the Ministry of Finance and National Economy and the Central bank of Sudan through employing simple models e.g. Two-Gap model and simple version of the Financial Programming of the IMF. These models have not been adequate to capture all features of the Sudan economy.

## 2. Literature Review

The first official attempt to construct elaborate macroeconomic model for the Sudan Economy dated back to the year 1955/56. An input-output model was constructed based on specific assumptions about the technical coefficients of inter-industry. The model was considered as experimentation attached to and used the information furnished by the first population census for the Sudan. In view of data limitations and precision of such types of models, further attempts had not been iterated.

The second endeavor was concerned with the projection of the main economic indicators for the formulation of development plans and programs using mainly an ad hoc accounting approach and two-gap models. They do not assume elaborate relationships between the variables. They try only to set up approximate magnitudes and obtain a consistent set of social accounts based on certain assumptions i.e. trial and error, Arabi (2002).

The third attempt was that in the fiscal year 1986/87 in which macro-econometric model was built comprising sub-models representing the essential sectors of the economy i.e. agriculture,

industry, transport, social services, private sector, balance of payments, and public finance were specified and estimated individually. These sectoral models are combined into comprehensive model. Unfortunately this endeavor ended into failure due to the disappointing results obtained. Various reasons led to this failure. The most important, among others, were the lack of precise and an adequate data, use of inappropriate estimation techniques and indulgence in specification errors.

In 1990/91 a two-gap model was built to assist in the formulation of a comprehensive ten year strategic plan. This attempt was impeded by the limitations of the two-gap model. This limitation was due to its speculative nature emanating from the injection of untested forecasted values.

In addition to the above official attempts initiated by the Ministry of Finance and National Economy, private endeavors using elaborate models, single equation models including error-correction models by the IMF staff, were all obstructed by debility of the required data.

Marzouk (1976) model was the first published model for the Sudan economy. It was primarily used to predict the future path of key variables. Marzouk adopted the conventional way of constructing macro-econometric models by dividing the economy into main blocks.

Marzouk model covered the period 1956-1974, and contained 62 variables: 42 endogenous and 20 exogenous. The number of behavioral equations is 21 and the remaining 21 are identities. The model was estimated by single equation methods.

Mohamed-Ahmed and Fadlalla (1984) built a macro-econometric model around the national income identity. The model contains 18 equations, 10 behavioral equations and 8 are identities. The main purpose of the model was to forecast the magnitude of certain key macroeconomic variables of Sudan's Six-year Plan.

### **3. Objective, Methodology and Sources of Data**

This study is motivated by two driving needs. The first is the absence of an operational macroeconomic model for the Sudan economy that captures the current SAP environment and other new developments. The second need is to use the model to evaluate and analyze the internal consistency of some proposed fiscal and monetary policies.

As the nature of the study dictates, the methodology used is primarily quantitative. To be specific, sophisticated econometric techniques are used:

- Unit root analysis to detect the stationarity of macroeconomic series in order to avoid spurious regression.
- Stability tests to enhance the predictability power of the model.
- Exploratory data analysis (EDA) techniques using summary statistics and analytical graphs to investigate any outlier and influential points in the data before embarking on the estimation stage
- An estimation technique which mainly involves three stages least squares (3SLS) to ensure joint estimation of the entire parameters of the model.
- Sensitivity analysis to ensure the robustness of the estimated parameters and the sensitivity to different model specifications

The time horizon of the study has been limited to the period 1960-2005, due to the fact that observations beyond the year 2005 are mostly estimates. Data are collected from different sources, and are mainly of secondary nature.

## 4. The Model

It is a common practice to start building macro-econometric models around the basic Keynesian income-expenditure identity, where its main building blocks contain the basic components of final expenditure representing the demand side of the economy. Having that in mind, the model will be developed to answer some of the questions posed earlier, and hence to bear the following features:

- Open medium sized model in which external and internal shocks determine macro-econometric outcomes
- Reflects the duality nature of Sudan economy in which a traditional sector coexist with a modern sector
- Combines elements of the Keynesian framework to present evaluation of short-term stabilization on issues and the neoclassical long-term growth properties
- Reflects some issues related to Sudan's debt profile and government policy responses to internal and external shocks
- Captures the economy's recent dependence on the volatile oil sector.

There are two strands of thought regarding the specification of macro-econometric modeling. The first places greater emphasis on economic theory as the driving force while the second argues that theories do not work well in explaining the functioning of a developing economy. Hence, it emphasizes the structural feature of the economy.

**Table 1** Six blocks of the model

In specifying the model, four approaches are taken into considerations: general to specific, bottom-up, exploratory data analysis (EDA), and sensitivity analysis. This eclectic approach makes it possible to combine the theoretical considerations with the available empirical observations in order to extract the maximum of information from the available data. Admittedly, in addition to the degree of subjective judgment it involves, this eclectic approach also poses the danger of data mining. To guard against such pitfall, adjusted statistical tests are carried out to mitigate their deleterious effects<sup>1</sup>.

Block	Components	Equations
A	Domestic Absorption	- Private consumption expenditure - Private investment expenditure - Government revenue and expenditure
B	External sector	- Exports - Imports
C	Monetary sector	- Money supply - Money demand - Financial repression - Real exchange rates - General price level
D	Real sector	- Value added for agriculture - Value added for industry - Value added for services
E	Labour market	- Demand for labour - Total wages
F	Debt overhang	-Total debt

The objective is to develop an adequate model that fits the data most satisfactorily and ensure the validity of the estimated coefficients.

### 4.1 Building Blocks of the Model

The model was constructed upon six building blocks as depicted in Table 1 above.

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<sup>1</sup> True level of significance instead of nominal as approximated by Lovell

Based on the eclectic experimentation approach, the chosen equations for the proposed model are specified as the following:

$$\begin{aligned}
 Ck &= c_1*dis+c_2*inf+c_3*tx+u_1 \\
 Ipk &= c_4*credit + c_5*inf + c_6*growth + c_7*ipk_{.1}+u_2 \\
 Inf &= c_8*seign+c_9*xdot+c_{10}*inf_{.1}+u_3 \\
 P &= c_{11}*xdot+c_{12}*msdot+c_{13}*vdot+c_{14}*ydot+u_4 \\
 Revk &= c_{15}*ecok+c_{16}*sock+c_{17}*dvk+c_{18}*gk_{.1}+ u_5 \\
 Gxk &= c_{19}*dc1+c_{20}*war+c_{21}*revk+u_6 \\
 Msdot &= c_{22}*inf +c_{23}*xdot+u_7 \\
 Export &= c_{24}*opn+c_{25}*rer+c_{26}*export_{.1}+u_8 \\
 Import &= c_{27}*capacity + c_{28}*agg+c_{29}*wcpi+[ar_1=c_{30}]+u_9 \\
 Labf &= c_{31}*taxk+c_{32}*dfl+c_{33}*labf_{.1}+u_{10} \\
 Wk &= c_{34}*prodk+c_{35}*taxk+c_{36}*dfl+[ar_1=c_{37}]+u_{11} \\
 Agr &= c_{38}*agg+c_{39}*xgk+c_{40}*dfl+u_{12} \\
 Industry &= c_{41}*gfcf+c_{42}*agr+c_{43}*industry_{.1}+u_{13} \\
 Fd &= c_{44}*msdot+c_{45}*xdot+[ar_1=c_{46}]+u_{14}
 \end{aligned}$$

Definition and classification of variables are given in Appendix 1.

#### 4.2 Estimation of the Model

An elaborate model was specified in the previous subsection. It consist of a set of 14 equations covering almost all sectors of the economy. Both the order and the rank conditions were applied to ascertain whether the equations of the model are identified or not [see Appendix 2]. All equations are overidentified. It is our contention that a system method is required to estimate the parameters of the model. This can be justified by the fact that a system method usually takes into account the entire structure and at the same time the restriction that this structure might impose on the magnitudes of the parameters. Hence, the three stages least squares (3SLS) estimation procedure was chosen. The results of the estimated equations are given in Appendix 3.

#### 4.3 Analysis and Discussion of the Results

To analyze the model technically in order to establish its statistical and econometric adequacy, a number of techniques and tests are used.

Judging by the overall statistical and econometric diagnostic tests which are applied, it seems that, in general, the results are relatively reasonable. The signs and magnitudes of the estimated coefficients are to considerable extent compatible with a priori theoretical expectations. Yet in view of the data mining, resulting from the adopted experimental approach, one can not claim that the results are entirely precise<sup>2</sup>. However, in general, the model seems reasonably adequate to serve the intended objectives.

Now, an attempt will be made to highlight the results of the individual functions of the model:

##### 4.3.1 Private Consumption

Real disposable income has significant and positive effect on private consumption. The magnitude of its coefficient is consistent with those estimated for developing countries with similar economic conditions. This suggests that current disposable income is stringent borrowing constraint that effectively limits inter-temporal smoothing of consumption. Admittedly, inflation as a major source of economic instability, leads to depletion of real wealth, which in turn increases

<sup>2</sup> Knowing the consequences of data mining, an effort was made for such problem e.g. detecting specification errors by a number of tests.

precautionary saving. Surprisingly this is not the case in Sudan, the coefficient of the general prices is positive which means that inflation induces more consumption. The set of explanatory variables explain 94 per cent of the total variation. Durbin Watson test for serial correlation is inconclusive.

### 4.3.2 Private Investment

Real bank credit to the private sector plays a positive and significant effect on private investment. This asserts the fact that the small size of the financial market renders the private investor to resort to bank credit. Inflation has a positive sign as in the case of private consumption. Inflation is supposed to lead to depletion of real wealth thus increasing precautionary saving as alluded to above. This in turn compels private investors to increase borrowing for new investment. Despite the gradual opening up of Sudanese financial sector since the 1990's due to deepening policies, still the mobilization of savings for more credit is not adequate. Both the changes in real GDP and lagged investment have positive effects, which indicate the operation of acceleration principle. The included explanatory variables explain about 60 per cent of total variation in private investment function. Due to the presence of the lagged dependent variable in this equation, Breusch-Godfrey test for serial correlation is used instead of Durbin-Watson, it rejects the presence of serial correlation. Despite the slight improvement in the investment climate in the Sudan as its Doing Business rank moved up from 174 (out of 1972) in 2007, to 194 in 2008 [see World Bank Report 2008], still concerted efforts are needed to render the investment climate more conducive to local and foreign investors.

### 4.3.3 Inflation and General Price Growth Rates

From the two equations specified to explain the phenomenon of inflation and the price growth rate, real income growth rate has the expected significant negative effect on general price inflation. By contrast, money supply growth rate presumes significant and positive impact on general inflation. The growth rate of velocity of circulation is similarly has positive impact on general inflation. On the other hand, money printing has statistically significant positive effect on inflation while the growth rate of exchange rate has slight negative effect on both equations. The adjusted  $R^2$  indicates that the explanatory variables explain more than 80 per cent in the two equations.

### 4.3.4 Public Sector Equations

The public sector is represented by two equations, namely, total revenue and total expenditure. The signs of the estimated parameters for all the explanatory variables included in the total revenue function are positive. Hence components of the total expenditure affect partially real revenue. Provision of economic services lead to increased general revenue, such services, in turn assist in increasing the efficiency of the economic entities for mobilizing the internal resources. Development spending, on the other hand, augments the economic capacity, hence generating more income and more revenue collection. The set of explanatory variables explains about 60 per cent of the variation in total revenue. Durbin-Watson indicates the presence of autocorrelation. Total revenue has significant positive effect on total expenditure as the government revenue constitutes the main source of financing public expenditure [almost 80 per cent]. The relaxation of domestic credit barriers shows significant impact on public expenditure. The government resorts regularly to the Central Bank to finance its deficit. The dummy variable that used as a proxy for war carries significant and positive coefficient, the matter that asserts the role of war in expanding government spending. The set of explanatory variables explains about 65 per cent of the total variation in public spending. Durbin-Watson rejects the hypothesis of serial correlation.

### 4.3.5 Money Supply Growth Rate

Turning now to the monetary sector, the two explanatory variables included in the equation of the money supply growth rate, namely inflation and the exchange rate growth rate have positive

impact on. Both variables explain about 70% of total variations. The Granger causality test reveals a uniform directional causation between money supply and prices movement (Ahmed et al, 2011).

#### 4.3.6 Foreign Trade Sector Equations

The foreign trade sector is represented by two equations, namely, total export and total imports. In the total export equation, both the real exchange rate and openness have positive impact on total export. On the other hand, real total consumption relates positively to real imports. An increase in total consumption expenditure increases the demand for goods and services, which is partially satisfied from total production and the rest from importation. The world consumer price index is negatively related to the total import. The set of explanatory variables explains more than 86 per cent of the total variation in of foreign trade sector. No evidence of serial correlation is noticed according to Durbin-Watson.

#### 4.3.7 Labor Sector equations

Both productivity and direct taxes shows a significant positive effect in the wage equation. The two variables explain 57 per cent of total variation. Durbin-Watson rejects the hypothesis of serial correlation.

#### 4.3.8 Agriculture and Industry Value Added Equations

In the agriculture value added equation, export of goods variable produces a negative sign. This result might be justified by the fact that Sudan's exports are predominately primary in nature i.e. raw form. That is they are subject to further processing outside the confines of the country, hence value added is generated elsewhere. The aggregate demand has the correct positive sign. The equation explains 95 per cent of the total variation. Focusing now on the industry value added, gross fixed capital formation in real terms shows significant and positive effect on total value of the industrial sector. Agriculture value added has a negative impact on the industrial value added. To explain this result, the same line of reasoning might be presented here for explaining the negative sign of the agriculture value added. This reveals the fact that the linkage between the industrial sector and the agriculture sector is almost negligible. The two variables in the industry valued added equation explain 97 per cent of the total variation. Breusch-Godfrey test is used to reject the hypothesis of serial correlation.

#### 4.3.9 Foreign Debt Growth Rate Equation

The size of foreign debt in the Sudan grows to an alarming proportion since the 1980's, forcing the country into downward spiral of negative basic transfers especially during the period 1980-2000. To shed light on this debilitating dilemma, a foreign debt growth rate equation is introduced in the model. Two explanatory variables are used, namely, money supply growth rate and exchange rate growth rate. The growth rate of money supply was found to have negative relationship with foreign debt growth rate, while the exchange growth rate produces a positive sign for the attached parameter. The two variables explain 82 per cent of total variation in the foreign debt growth rate.

## 5. Recommendations

Based on the findings of the study we suggest some recommendations. These recommendations are more oriented towards the supply side.

- Careful design of demand restrain policies that target total consumption should be taken into consideration in order to avoid negative impact on total production.
- To expand the productive capacity of the economy, foreign loans should be directed toward production rather than consumption.

- Pursuit of an outward strategy could realize the optimum mix of internal resources accompanied by importation of the recent and compatible technology to attain the planned growth rates. Besides the production that depends on export promotion, the situation requires the necessity of encouraging the promotion and production of local technology especially in the field of quick yielding projects.
- Training plans and programs purporting to prove productivity are completely lacking. The government failed to enunciate a coherent training policy and adopted a piecemeal approach that was not particularly effective. Formulation of such training policies is a peremptory.
- To curb excessive influx of rural migrants, programs of integrate rural development should be promoted.
- More financial deepening is required to mobilize saving in order to enhance investment and accelerate the pace of economic growth. In spite of the financial reforms so far undertaken, the banking sector is still inherently weak, vulnerable to exogenous shocks and political instability.
- To broaden and deepen macroeconomic reforms, tariff reform should be undertaken further to reduce the number of tariff rates and rationalize their structure.
- While international effort is needed to relief the debt crises of the developing countries still in Sudan prudent fiscal and monetary measures are required to help ease the problem.

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### Periodicals:

*Annual Report*: Bank of Sudan (2010), Khartoum, Sudan.

*Economic Survey*: Ministry of Finance and Economy (2010), Khartoum, Sudan.

*International Financial Statistics*: IMF (2009).

*National income Accounts* Central Bureau of Statistics (2008), Khartoum, Sudan.

*Statistical Book*: Central Bureau of Statistics (2008), Khartoum, Sudan.

*Ten –Year- Strategy 1991-2000*: Ministry of Finance and Economy (1991), Khartoum, Sudan.

*World Tables*: World Bank (2009).

## Appendix 1 Variables definition and classification

<i>Variable</i>	<i>Abbreviation</i>	<i>Type of Variable</i>
<b>Private Consumption</b>	<b>CK</b>	<b>Endogeneous</b>
Disposable Income	DIS.	Independent
Inflation rate	INF	Independent
<b>Private Investment</b>	<b>IPK</b>	<b>Endogeneous</b>
Domestic Credit to Private Sector	CREDIT	Independent
Change in Real GDP	GROWTH	Independent
<b>Inflation Rate</b>	<b>INF.</b>	<b>Endogeneous</b>
Growth Rate of Exchange Rate	XDOT	Independent
Money Printing (seignorage)	SEIGN	Independent
<b>Growth Rate of General Price</b>	<b>P</b>	<b>Endogeneous</b>
Growth Rate of Exchange Rate	XDOT	Independent
Growth Rate of Money Supply	MSDOT	Independent
Growth Rate of Velocity of Circulation	VDOT	Independent
Growth Rate of Real GDP	YDOT	Independent
<b>Total Revenues</b>	<b>REVK</b>	<b>Endogeneous</b>
Expenditure on Economic Sector	ECOK	Independent
Expenditure on Social Sector	SOCK	Independent
Development Expenditure	DVK	Independent
Total Expenditure in the previous year	GXX(-1)	Independent
<b>Total Expenditure</b>	<b>GXX</b>	<b>Endogeneous</b>
Domestic Credit to the Public Sector	DC1	Independent
Dummy Variable represents Civil War	WAR	Independent
Total Revenue	REVK	Independent
<b>Growth Rate of Money Supply</b>	<b>MSDOT</b>	<b>Endogeneous</b>
Growth Rate of Exchange Rate	XDOT	Independent
Inflation Rate	INF.	Independent
<b>Total Exports</b>	<b>EXPORTK</b>	<b>Endogeneous</b>
Openness	OPN	Independent
Real Exchange rate	RER	Independent
<b>Total Imports</b>	<b>IMPORTK</b>	<b>Endogeneous</b>
Capacity to Import	CAPACITY	Independent
Terms of Trade	TERMS	Independent
Aggregate Demand	AGG	Independent
World Consumer Price Index (CPI)	WCPI	Independent
<b>Demand for Labor</b>	<b>LABF</b>	<b>Endogeneous</b>
Direct Tax	TAXK	Independent
General Price Level	DFL	Independent
<b>Total Wages</b>	<b>WK</b>	<b>Endogeneous</b>
Labor Productivity	PRODK	Independent
General Price Level	DFL	Independent
Direct Tax	TAXK	Independent
<b>Agriculture Value Added</b>	<b>AGR.</b>	<b>Endogeneous</b>
Aggregate Demand	AGG	Independent
Export of Goods	XGK	Independent
General Price Level	DFL	Independent
<b>Industry Value Added</b>	<b>INDUSTRY</b>	<b>Endogeneous</b>
Lagged Industry	INDUSTRY(-1)	Independent

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Variables definition and classification (Continue)

Agriculture Value Added	AGR.	Independent
Gross Fixed Capital Formation	GFCF	Independent
<b>Growth Rate of Foreign Debt</b>	<b>FD</b>	<b>Endogeneous</b>
Growth Rate of Money Supply	MSDOT	Independent
Growth Rate of Exchange Rate	XDOT	Independent

**Appendix 2** Identification and order condition

C	G	Dc1	I	ip	Ms	im	l	w	rv	sv	dis	dfl	inf	xd	s	D1	wr	ec	sc
1	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0
0	0	0	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0
0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0
0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0

**Continuation**

dv	Vd	Yg	Cm	rlv	ak	rer	Expy	Trend	Mpw	O	agr	x	Industry(-1)
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	1	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	1	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1	0	1	0	0
0	0	0	0	0	0	0	1	1	0	1	0	0	0
0	0	0	0	0	0	0	0	0	1	0	0	0	1

**Note:** g = number of included endogenous variables  
 G = number equations  
 K = number of included exogenous variables  
 k = number of excluded exogenous variables

**Appendix 3** The estimated results of the Model**Private Consumption**

	Coefficient	Std. Error	t-Statistic	Prob.
Disposable Income	0.93	0.02	50.55	0.00
General Price Level	0.01	0.00	8.12	0.00
Total Tax	-0.62	0.17	-3.73	0.0002
R-squared	0.94	Mean dependent var	5156	
Adjusted R-squared	0.94	S.D. dependent var	1810	
S.E. of regression	460.84	Sum squared resid	7857700	
Durbin-Watson stat	1.49			

**Private Investment**

	Coefficient	Std. Error	t-Statistic	Prob.
Credit	0.27	0.08	3.60	0.00
Inflation	5.79	1.27	4.57	0.00
Growth	0.30	0.08	3.96	0.00
Lagged Dependent Variable	0.36	0.09	3.87	0.00
R-squared	0.63	Mean dependent var	703	
Adjusted R-squared	0.59	S.D. dependent var	444	
S.E. of regression	282.81	Sum squared resid	2719328	
Durbin-Watson stat	1.88			

**Inflation**

	Coefficient	Std. Error	t-Statistic	Prob.
Money Printing (Seignorage)	1.82	0.19	9.61	0.00
Growth of Exchange Rate	-0.06	0.02	-2.65	0.01
Lagged Dependent Variable	0.36	0.06	5.90	0.00
R-squared	0.85	Mean dependent var	34	
Adjusted R-squared	0.84	S.D. dependent var	37	
S.E. of regression	15.02	Sum squared resid	8351	
Durbin-Watson stat	2.41			

**General Price Growth Rate**

	Coefficient	Std. Error	t-Statistic	Prob.
Exchange Rate Growth Rate	-0.04	0.00	-9.63	0.00
Money Supply Growth Rate	1.05	0.01	70.51	0.00
Velocity Growth Rate	1.47	0.02	64.97	0.00
GDP Growth Rate	-1.15	0.05	-25.16	0.00
R-squared	0.994125	Mean dependent var	31.92147	
Adjusted R-squared	0.993636	S.D. dependent var	37.92173	
S.E. of regression	3.025233	Sum squared resid	329.4733	
Durbin-Watson stat	1.603794			

**Total Revenue**

	Coefficient	Std. Error	t-Statistic	Prob.
Expenditure on Economic Sector	1.193389	0.311305	3.833504	0.0001
Expenditure on Social Sector	0.511394	0.07352	6.955874	0.00
Development Expenditure	0.437396	0.127811	3.42221	0.0007
Lagged Total Expenditure	0.242965	0.065561	3.70591	0.0002
R-squared	0.59	Mean dependent var	787	
Adjusted R-squared	0.55	S.D. dependent var	207	

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S.E. of regression	138.77	Sum squared resid	654695
Durbin-Watson stat	1.04		

### **Total Expenditure**

	Coefficient	Std. Error	t-Statistic	Prob.
Domestic Credit	0.117775	0.019949	5.903913	0.00
War	118.0509	33.15248	3.560847	0.0004
Total Revenue	0.92715	0.053409	17.35941	0.00
R-squared	0.663899	Mean dependent var	1014.725	
Adjusted R-squared	0.646209	S.D. dependent var	240.0107	
S.E. of regression	142.7591	Sum squared resid	774446.4	
Durbin-Watson stat	1.936156			

### **Money Supply Growth Rate**

	Coefficient	Std. Error	t-Statistic	Prob.
Inflation	0.72	0.05	13.92	0.00
Exchange Rate Growth Rate	0.10	0.02	5.27	0.00
R-squared	0.70	Mean dependent var	35	
Adjusted R-squared	0.69	S.D. dependent var	29	
S.E. of regression	16.37	Sum squared resid	10181	
Durbin-Watson stat	1.41			

### **Total Exports**

	Coefficient	Std. Error	t-Statistic	Prob.
Openness	9.43	1.61	5.86	0.00
Real Exchange Rate	55.99	21.85	2.56	0.01
Lagged Exports	0.44	0.07	6.11	0.00
R-squared	0.82	Mean dependent var	585	
Adjusted R-squared	0.81	S.D. dependent var	186	
S.E. of regression	80.66	Sum squared resid	227701	
Durbin-Watson stat	2.17			

### **Total Imports**

	Coefficient	Std. Error	t-Statistic	Prob.
Capacity to Import	1.12047	0.113973	9.830996	0.00
Aggregate Demand	0.250749	0.035904	6.983907	0.00
World CPI	-14.28265	2.669592	-5.350124	0.00
AR(1)	0.631104	0.106406	5.931078	0.00
R-squared	0.836424	Mean dependent var	989.6184	
Adjusted R-squared	0.821553	S.D. dependent var	385.2981	
S.E. of regression	162.7614	Sum squared resid	874212.5	
Durbin-Watson stat	2.113584			

### **Demand for Labor**

	Coefficient	Std. Error	t-Statistic	Prob.
Direct Tax	0.001979	0.000714	2.769283	0.0058
General Price Level	5.31E-06	6.94E-07	7.64951	0.00
Lagged Labor Force	0.991226	0.01586	62.49872	0.00
R-squared	0.99342	Mean dependent var	6.317012	
Adjusted R-squared	0.993064	S.D. dependent var	2.817729	
S.E. of regression	0.23467	Sum squared resid	2.037595	
Durbin-Watson stat	2.823614			

**Total Wages**

	Coefficient	Std. Error	t-Statistic	Prob.
Productivity	3.95	0.32	12.36	0.00
Direct Tax	-6.32	1.39	-4.54	0.00
General Price	0.01	0.00	4.94	0.00
AR(1)	0.49	0.11	4.65	0.00
R-squared	0.60	Mean dependent var	2006	
Adjusted R-squared	0.57	S.D. dependent var	745	
S.E. of regression	488.92	Sum squared resid	8127291	
Durbin-Watson stat	2.31			

**Agriculture Value Added**

	Coefficient	Std. Error	t-Statistic	Prob.
Aggregate Demand	3.95	0.32	12.36	0.00
Exports of Goods	-6.32	1.39	-4.54	0.00
General Price	0.01	0.00	4.94	0.00
R-squared	0.95	Mean dependent var	1865	
Adjusted R-squared	0.95	S.D. dependent var	787	
S.E. of regression	174.25	Sum squared resid	1062708	
Durbin-Watson stat	1.54			

**Industry Value Added**

	Coefficient	Std. Error	t-Statistic	Prob.
Gross Fixed Capital Formation	3.95	0.32	12.36	0.00
Agriculture	-6.32	1.39	-4.54	0.00
Lagged Industry Value Added	0.01	0.00	4.94	0.00
R-squared	0.97	Mean dependent var	1024	
Adjusted R-squared	0.97	S.D. dependent var	442	
S.E. of regression	74.18	Sum squared resid	192602	
Durbin-Watson stat	2.03			

**Foreign Debt Growth Rate**

	Coefficient	Std. Error	t-Statistic	Prob.
Money Sply Growth Rate	-0.33	0.12	-2.74	0.01
Exchange Growth Rate	0.50	0.04	12.16	0.00
AR(1)	0.39	0.12	3.38	0.0008
R-squared	0.82	Mean dependent var	21	
Adjusted R-squared	0.82	S.D. dependent var	58	
S.E. of regression	25.05	Sum squared resid	23837	
Durbin-Watson stat	0.91			