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Analyzing the Dynamic Nature of the Economic Factors

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Abstract

This paper uses vector autoregressive model and impulse response function to assess the external debt sustainability of Sudan. It aims to analyze the dynamic and long term effects among economic indicators and capture response of economic variable to a shock in another variable. Also, to determine the factors that impact a nation's struggle to maintain debt at sustainable levels. A precise list of indicators of indebtedness was inserted in the model. Results showed that indicators of indebtedness are predictable using measures of repayment capacity. In contrast, the domestic repayment capacities are not possible to be predicted, using indicators of indebtedness; and significantly affects the indebtedness of Sudan, hence, Policies to enhance the use of domestic resources to repay debts are recommended. As cost based indicators of indebtedness, significantly affect the exports growth, they should be maintained at a sustainable level.

Keywords: VAR, IRF, External debt, Repayment capacity, Economic Growth, Sudan

1. Introduction

An economic entity, say a nation, is likely to have income that exceeds the expenditure and at the same time, another nation's expenses might increase the level of income. In such a scenario, borrowing and lending encourage the economic growth in both nations. Debt creation makes them able to realize the output preferences and intertemporal consumption. One of the assumptions in debt creation is the fulfillment of the debt requirements by the debtor. Problems arise when the income of the debtor country is insufficient or assets that are useful in case of insufficient income are inadequate. In the existence of this problem, or even if it is not raised but only anticipated, both the creditor and debtor countries may not realize the benefits of international financial flow. Hence, nations need to involve in the risk-management procedures and to maintain the external debt at sustainable levels.

The difficult economic condition of Sudan was exacerbated by the country's export base and revenue contracting sharply. Hence, the country's debt servicing capacity is seriously reduced due to the severely affected macro-economic outlook; followed by permanent shock. A so-called zero point is achieved in an agreement between Sudan and South Sudan before the secession of South Sudan, which stated retaining all the external liabilities of Sudan after the South Sudan secession provided that; within two years from the secession, the delivery of debt relief is committed by the international community and debt relief of Sudan will be assisted by South Sudan. A pending formula will then determine the apportionment of Sudan's external debt if the commitments are not made. This paper is an application of VAR model and IRF to perform external debt sustainability analysis of Sudan. Hence, it determines the factors impacting external debt sustainability of Sudan.

Table 1: Variables of Indebtedness and Repayment Capacity for VAR model

	Variable	Full Form
Stock based indicators	EDSE	External debt stocks (% of exports of goods, services and primary income)
	EDSG	External debt stocks (% of GDP)
Cost based indicators	IPDG	Interest payments on external debt (% of GDP)
	IPDE	Interest payments on external debt (% of exports of goods, services and primary income)
Flow Based Indicators	TDSG	Total debt service (% of GDP)
	TDSE	Total debt service (% of exports of goods, services and primary income)
Other Variables	NF	Net foreign assets (current LCU)
	EG	Exports of goods and services (annual % growth)
	GG	GDP growth (annual %)
	GFCG	Gross fixed capital formation (annual % growth)
	FDI	Foreign direct investment, net inflows (BoP, current US$)

2. Literature Review

Economic growth is significantly related to the rise in a nation's savings that drives investment opportunities in the country. However, a given threshold must be achieved for adequate increment in the capital stock so that the growth will take off (Hunt, 2007, Sachs, 2002). Self-sustaining growth engendered by sufficient increases in savings as well as capital beyond a given level. 'Dual gap' theory describes how low income countries lack sufficient resources to bridge the gaps persisting in their economy. These gaps are known to be the gap between the country's exports and imports and the gap between investment in the country and domestic savings. Therefore, external resources are crucial to fill out these gaps when domestic resources are scarce (Chenery and Strout, 1965). This theory describes the reason that a nation seeks external assistance apart from utilization of domestic resources. The investment required for economic development need such a level of savings that is quite higher than the domestic savings and seeking the financial assistance, either in terms of loan or aid, is logical. Existence of a significant relationship between economic growth, investments, foreign fund, and domestic savings determine the exploitation of external funds. It is also to be determined that when a nation must borrow, this determination may follow a guide of principles. According to Ajayi and Khan, a nation must borrow till the returns that are generated using the borrowed fund are greater than the cost at which foreign fund is borrowed. Following this principle, a country can utilize foreign resources to expand the output, to enhance the productivity, and to increase the capacity through accumulation of capital and human capital (Ajayi and Khan, 2000).

When the utilization of external funds is optimum, it is not likely that the foreign debt will necessarily become a debt burden. By optimal utilization here it is meant that the marginal return on the investment in the indebted country must exceed or at least equals to cost at which the foreign resource is borrowed. Critical factors like the rate of savings, the cost of borrowing, and the returns on investment affect the capacity of the borrowing country to sustain the external debt servicing (Eaton, 1992). The studies that emphasize the behavior of borrowing nations to neglect the cost of borrowing criticized the benefits that both the borrowing and the lending country receive from external borrowing. Other than the debt servicing cost of borrowing include costs of import substitution, cost of rescheduling the debt, cost required to improve the ability to manage debt, cost of viciously cumulative debt, cost of liquidity crisis resulting from borrowing, and the costs that incur in fulfilling the terms of external loan Udom (Ubok-Udom, 1979). According to Colaco, three contexts can be used to explain the vulnerability of debt servicing in low income countries. All these factors are relevant to the case of Sudan. First factor is the imbalance between equity and debt resulting from such level of external loans that exceed the size of equity finance. Second factor is the increase in interest rate that directly hit the borrowers. This increase in interest rate results from the dramatic rise in the proportion of debt at floating interest rate. Third factor is the drastic shortfalls in maturities resulting from the decline in share of financial flows (Colaco, 1985). The increasing complexity in the financial environment essentially requires adequate debt management whose critical components are statistical analysis, accounting, regulatory environment, and policy coordination. Structural reforms and fiscal adjustment adopted in the debtor nation help in making the measures effective needed to support the process of development in the debtor nation. Decision making processes, improvement or sometimes creation of debt management structure, and anticorruption and transparency policies are included in the features of debt management(Mehran, 1985). Still the issue remains that whether sustainability of debt is assured by acquisition and management of external fund.

Macroeconomic instability and tax disincentive are the debt overhang effects of accumulated debt stock that reduces economic performance. Macroeconomic instability is related to the anticipated inflation, possible monetary expansion, and depreciation in the exchange rate, exceptional financing resulting in uncertainly, and rise in fiscal deficit. By debt disincentive, it is meant that the anticipation of large taxes in future income to cover the increasing debt burden in present discourage investments (Claessens et al., 1996b). Private investment is also found to be negatively impacted by external debt as results in the study by Iyoha, affirmed the debt overhang effect and crowding our effect of debt servicing. The author presented empirical justification that how these two damaging effects of debt servicing leads to low level of private investment in the borrowing country (Iyoha, 1997). Efficient utilization of external financing is found to be the key factor that drives the rise in economic development process. It happens that a country experiences growth in economic condition as long as the external resources are efficiently utilized but as soon as the acquisition of foreign loan become inefficient, process of economic growth slows down. Development of capital markets, restructuring the programs of sustained export promotion, and privatization are preventive measures for the severe impact of external debt on public and private investments whose major factors are global interest rates, balance of payments, and fiscal expenditure (Edo, 2002). African Forum Network on Debt and Development (2003), recognizing the impacts of increasing external debt states that integration within and across the African countries with regional groupings is de-accelerated by the reliance of Africa on northern countries for hard currencies and heavy indebtedness. For a given level of indebtedness in the future, the current level of investment is curbed by the high debt servicing in the present which is another aspect of liquidity crisis resulting from external debt(Claessens et al., 1996a). Apart the liquidity crisis, moral hazard effect is also identified as a damaging consequence of external debt. According to Arnone et al. (2005), Moral hazard is evident in countries with poor macroeconomic policies and high levels of external debt(Arnone et al., 2005).

3. Methodology

Time series data is collected for this paper, the data includes the indicators of external debt and capacity to repay of Sudan from 1970 to 2012. Time series include all the variables listed in Table 1.

3.1 Vector Autoregressive Model (VAR)

As the study employees VAR, each of the variables is endogenous and thus multiple regression equations are estimated. There are 11 equations and 11 variables in the model. The dependent variable in each equation is explained by its own value in previous two years and the values of the remaining 10 variables in the previous two years. A VAR model is a supplementary of a system of equations whose purpose is to capture the dynamic effects, thus; the 11 variables incorporated in the VAR model are together regarded as a vector V_t. Each of the variables in V_t is assumed to be demeaned before estimating the model. Hence, none of the 11 equations have intercept (constant) term. The so-called structural form of the VAR model thus becomes:

$$\alpha V_t = \beta_1 V_{t-1} + \beta_2 V_{t-2} + \ldots + \beta_k V_{t-k} + \varepsilon_t \tag{1}$$

$$E\varepsilon\varepsilon' = \textstyle\sum_\varepsilon = \begin{bmatrix} \rho_{\varepsilon 1}^2 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & \rho_{\varepsilon n}^2 \end{bmatrix} \tag{2}$$

A VAR of lag length p(VAR(p)) can be written as:

$$v_t = \alpha^{-1}\beta_1 v_{t-1} + \alpha^{-1}\beta_2 v_{t-2} + \ldots + \alpha^{-1}\beta_k v_{t-k} + \alpha^{-1}\varepsilon_t \tag{3}$$

Where, $E(\varepsilon_t) = 0$, $E(\varepsilon_t \varepsilon'_t) = \sum_\varepsilon$ for $t = \tau$; and 0 otherwise. The reduced form of equation 3 includes the past values of the dependent variable and the past values of all other variables. There are three forms of a VAR model, namely structure, recursive, and reduced. Identification of a VAR model is essential in each of the three forms. Recovery of the estimation of α, β, and $\sum_\varepsilon$ is regarded here as identification of a VAR model. Here, the model specifications are given taking only one lagged value in the VAR model for the sake of generality as inclusion of more lag values is dealt in the same way. Each variable is presented as a linear combination of the lagged values of the variable and the lagged values of the other variables in the reduced VAR model. Ordinary Least Square (OLS) method is used to estimate each of the equation presenting linear relationship. After taking the past values in account, the shock movements in the variables are regarded as error terms. Correlation in among the error terms exists if a correlation exists among the variables. The α's and the $\sum_\varepsilon$ are not easy to estimate despite of the easy estimations of $\alpha^{-1}\beta_1$, …, $\alpha^{-1}\beta_k$ and $\alpha^{-1}\sum_\varepsilon \alpha^{-1}$' in the structural form of a VAR. In a recursive VAR model, error term in each regression equation is assumed to be uncorrelated with the error terms in the preceding equations. This assumption is made on the basis that the contemporaneous values of other variables are included in some of the equations as regressors in estimating the VAR equations. The model in this paper includes 11 variables and 11 equations but here for simplicity a 2-variables 2-equations VAR model is presented to describe the specification. Once the procedure is clearly specified, model with the 11 variables will be given. Following is a simple bivariate model with Debt Stock as Y and repayment capacity as X.

$$Y_t = -\alpha_{YX}X_t + \beta_{YX}X_{t-1} + \beta_{YY}Y_{T-1} + \varepsilon_{YT} \quad \ldots \quad (4)$$

$$X_t = -\alpha_{XY}X_t + \beta_{XX}X_{t-1} + \beta_{XY}Y_{T-1} + \varepsilon_{XT} \quad \ldots \quad (5)$$

Where, structural parameters are α_{YX}, α_{XY}, β_{YX}, β_{XX}, β_{YY}, and β_{XY} and the uncorrelated structural shocks are ε_{YT} and ε_{XT} with a standard deviation ρ_X and ρ_Y. OLS cannot be used to estimate equation 4 and equation 5 because the classical assumption of no correlation between the error term and the regressors is violated. If equation 5 is estimated using OLS, the correlation between Y and the error terms exists, since:

$$\mathrm{cov}(Y_t, \varepsilon_{Xt}) = \mathrm{cov}(-\alpha_{YX}X_t + \beta_{YX}X_{t-1} + \beta_{YY}Y_{t-1} + \varepsilon_{Yt}, \varepsilon_{Xt})$$

$$= \mathrm{cov}(-\alpha_{YX}(\beta_{XX}X_{t-1} + \beta_{XY}Y_{t-1} - \alpha_{XY}Y_t + \varepsilon_{Xt}) + \beta_{YX}X_{t-1} + \beta_{YY}Y_{t-1} + \varepsilon_{Yt}, \varepsilon_{Xt})$$

$$= \alpha_{YX}\alpha_{XY}\mathrm{cov}(Y_t, \varepsilon_{Xt}) - \alpha_{YX}\,\rho^2_{\varepsilon X}$$

$$\mathrm{cov}(Y_t, \varepsilon_{Xt}) = \frac{-\alpha_{YX}}{1-\alpha_{YX}\alpha_{XY}}\rho^2_{\varepsilon X} \quad (6)$$

Unless $\alpha_{YX} = 0$ is assumed, the estimation of the parameters in equation 5 using OLS is inconsistent. This implies that there is no effect of the repayment capacity on the debt stock. If a condition $\alpha_{YX} = 0$ is imposed, then the OLS estimates of the parameters of equation 5 will not be inconsistent. A repayment capacity shock $\varepsilon_{Xt} = 1$ will not affect Y_t while its effect on X_t will be equal to 1. Effect of a debt stock shock ε_{Yt} on Y_t will be 0. Effect of debt stock shock ε_{Yt} on Y_t will be 1 if $-\alpha_{XY}$ has an effect on X_t. As the OLS method is employed for estimation of the equations one by one, this approach of estimation is used in recursive VAR. One exception made in this paper is that Y_t is included among the regressors in equation 5 while X_t is excluded from the regressors in equation 4. Another more precise explanation of the use of OLS in estimating VAR model is the matrix form of the equations. Let the following VAR model be a structural model that cannot be estimated using OLS:

$$\begin{bmatrix} 1 & \alpha_{YX} \\ \alpha_{XY} & 1 \end{bmatrix}\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} \beta_{YY} & \beta_{YX} \\ \beta_{XY} & \beta_{XX} \end{bmatrix}\begin{bmatrix} Y_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{Yt} \\ \varepsilon_{Xt} \end{bmatrix} \quad (7)$$

The reduced form of equation 7 is:

$$\begin{bmatrix} Y_t \\ X_t \end{bmatrix} = \begin{bmatrix} 1 & \alpha_{YX} \\ \alpha_{XY} & 1 \end{bmatrix}^{-1}\begin{bmatrix} \beta_{YY} & \beta_{YX} \\ \beta_{XY} & \beta_{XX} \end{bmatrix}\begin{bmatrix} Y_{t-1} \\ X_{t-1} \end{bmatrix} + \begin{bmatrix} 1 & \alpha_{YX} \\ \alpha_{XY} & 1 \end{bmatrix}^{-1}\begin{bmatrix} \varepsilon_{Yt} \\ \varepsilon_{Xt} \end{bmatrix} \quad (8)$$

OLS can be used to estimate the reduced form of equation 7 in equation 8. This is because the structural parameters cannot be identified from the residuals of the two equations; hence, there is a correlation among the error terms of the equation 7 and equation 8 across the equations. Link between the structural parameters and the residuals of the reduced form equation 7 and 8 are given by:

$$r_{1t} = \frac{1}{1-\alpha_{YX}\alpha_{XY}}(\varepsilon_{Yt} - \alpha_{YX}\varepsilon_{Xt}) \tag{9}$$

$$r_{2t} = \frac{1}{1-\alpha_{YX}\alpha_{XY}}(\varepsilon_{Xt} - \alpha_{XY}\varepsilon_{Yt}) \tag{10}$$

If $\alpha_{YX} = 0$, then:

$$r_{1t} = \varepsilon_{Yt} \quad \ldots \tag{11}$$

$$r_{2t} = \varepsilon_{Xt} - \alpha_{XY}\varepsilon_{Yt} \quad \ldots \tag{12}$$

Following the above information, two major steps in the procedure are identified. The first step is the estimation of the reduced form equation through regressing Y on its lagged values and the lagged values of X recovering the structural shock ε_{Yt}. The second step follows from the realization that if the assumption $\alpha_{YX} = 0$ is made, the estimates of equation 5 using OLS are consistent. Hence, $X_t = -\alpha_{XY}Y_t + \beta_{XX}X_{t-1} + \beta_{XY}Y_{t-1} + \varepsilon_{Xt}$ is estimated and the residuals are calculated to recover ε_{Xt}. Structural parameters are easy to estimate in this way for the dynamic system developed in equation 4 and equation 5. There might be confusion that using reduced form to estimate equation 4 and excluding contemporaneous regressors to estimate equation 5, and so on for the actual 11 equations and 11 variables is the algorithm of the VAR jargon. The following two steps are involved instead:

(i) Using Eviews to estimate the 11 equations in reduced form.

(ii) Obtaining variance-covariance matrix of the residuals through computing Choleski decomposition. Choleski decomposition is defined to be an upper triangular matrix Γ for each symmetric, positive definite matrix Z such that:

$$Z = \Gamma'\Gamma \quad \ldots \tag{13}$$

Let $\alpha_{XY} = \phi$ and $\rho_{12} = \rho_z$. Then:

$$Z_t = \alpha^{-1}\beta z_{t-1} + \alpha^{-1}\varepsilon_t \quad \ldots \tag{14}$$

where $\alpha^{-1}\varepsilon_t = r_t$

$$\Sigma_r = \alpha^{-1}\Sigma_\varepsilon^{1/2}\Sigma_\varepsilon^{1/2}\alpha^{-1\,'} \tag{15}$$

$$\alpha^{-1} = \begin{bmatrix} 1 & 0 \\ -\phi & 1 \end{bmatrix} \quad \ldots \tag{16}$$

$$\begin{bmatrix} \rho_1^2 & \rho_Z \\ \rho_Z & \rho_2^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ -\phi & 1 \end{bmatrix}\begin{bmatrix} \rho_Y & 0 \\ 0 & \rho_X \end{bmatrix}\begin{bmatrix} \rho_Y & 0 \\ 0 & \rho_X \end{bmatrix}\begin{bmatrix} 1 & -\phi \\ 0 & 1 \end{bmatrix} \tag{17}$$

$$\begin{bmatrix} \rho_1^2 & \rho_Z \\ \rho_Z & \rho_2^2 \end{bmatrix} = \begin{bmatrix} \rho_Y & 0 \\ -\phi\rho_Y & \rho_X \end{bmatrix}\begin{bmatrix} \rho_Y & -\rho_Y\phi \\ 0 & \rho_X \end{bmatrix} \tag{18}$$

A system of three equations is depicted in equation 18 that can be solved for:

$$\rho_Y^2 = \rho_1^2 \ldots \tag{19}$$

$$\phi = -\frac{\rho_X}{\rho_Y^2} = -\frac{\rho_X}{\rho_1^2} \quad \ldots \tag{20}$$

$$\rho_X^2 = \rho_2^2 - \phi^2\rho_1^2 \quad \ldots \tag{21}$$

All the above defined procedures are done in the Eviews built in function providing only the consistent estimates of the 11 equations. Another notable expression is:

$$\mathrm{chol}(\Sigma_r) = \Sigma_\varepsilon^{1/2}\alpha^{-1\,'} \tag{22}$$

Hence, after the estimation of the VAR model containing 11 equations and 11 variables in reduced form, a matrix is obtained through the Choleski decomposition of Σ_r. The diagonal of the matrix contains the standard deviations of all the structural shocks. That is:

$$\Sigma_{\varepsilon}^{1/2} = \text{Dg}(\text{Dg}(\text{chol}(\Sigma_r))) \quad \ldots \tag{23}$$

Calculation of α and/or $\alpha^{-1}.\alpha^{-1}$ is then done as:

$$\alpha^{-1\prime} = \Sigma_{\varepsilon}^{-1/2}\ \text{chol}(\Sigma_r) \tag{24}$$
$$\alpha^{-1} = \text{chol}(\Sigma_r)'\ \Sigma_{\varepsilon}^{-1/2} \tag{25}$$

The contemporaneous relationships among the variables as estimated in the structural VAR model are sorted out using economic theory. For example, if economic theory suggests that $\alpha_{YX} = -0.5$, then only the contemporaneous effect of shocks do not need to be involved in the assumptions.

3.2 Impulse Response Function (IRF)

Impulse response functions (IRF) are often obtained in a VAR model. IRF captures the effect of one-unit increase or an increase equal to one standard deviation in the current values of the VAR errors on the current or future values of each of the variables included in the VAR model. Assumption made in obtaining IRF include that in subsequent periods, the effecting error returns to zero and all the other errors are equal to zero. IRF is typically obtained in structural and recursive VAR models as the process of estimating effect one error shock, keeping other error terms constant is appropriate only if the error terms are correlated across the equations. If α and ε are known, the procedure of obtaining IRF begins from:

$$Z_t = \alpha^{-1}\beta z_{t-1} + \alpha^{-1}\varepsilon_t \ldots \tag{26}$$

Where, $\alpha^{-1}\varepsilon_t = r_t$. Once, α^{-1} is known, the IRF's can be calculated to a unit shock of ε assuming that for a while, the system is in steady state. Consider that a two-variable VAR is obtained and the dynamics to a shock to the first variable are to be obtained. If a shock hits at time, t = 0, then:

$$\varepsilon_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \ \ldots \tag{27}$$

$$Z_0 = \begin{bmatrix} Y_0 \\ X_0 \end{bmatrix} = \alpha^{-1}\varepsilon_0 \ \ldots \tag{28}$$

For every m > 0,

$$Z_m = \alpha^{-1}\beta z_{m-1} \quad \ldots \tag{29}$$

Hence, the behavior of Z in response to shocks to the vector Γ over a time can be practically represented via IRF. The 11 equations of the VAR model in the current study are as follows:

$$EDSE_t = \alpha1 + \beta1_1\, EDSE_{t-1} + \beta1_2\, EDSE_{t-2} + \beta1_3\, EDSG_{t-1} + \beta1_4\, EDSG_{t-2} + \beta1_5\, IPDG_{t-1} + \beta1_6\, IPDG_{t-2} + \beta1_7\, IPDE_{t-1} + \beta1_8\, IPDE_{t-2} + \beta1_9\, TDSG_{t-1} + \beta1_{10}\, TDSG_{t-2} + \beta1_{11}\, TDSE_{t-1} + \beta1_{12}\, TDSE_{t-2} + \beta1_{13}\, NF_{t-1} + \beta1_{14}\, NF_{t-2} + \beta1_{15}\, EG_{t-1} + \beta1_{16}\, EG_{t-2} + \beta1_{17}\, GG_{t-1} + \beta1_{18}\, GG_{t-2} + \beta1_{19}\, GFCG_{t-1} + \beta1_{20}\, GFCG_{t-2} + \beta1_{21}\, FDI_{t-1} + \beta1_{21}\, FDI_{t-2} + \varepsilon1_t \ \ldots \tag{30}$$

$$EDSG_t = \alpha2 + \beta2_1\, EDSE_{t-1} + \beta2_2\, EDSE_{t-2} + \beta2_3\, EDSG_{t-1} + \beta2_4\, EDSG_{t-2} + \beta2_5\, IPDG_{t-1} + \beta2_6\, IPDG_{t-2} + \beta2_7\, IPDE_{t-1} + \beta2_8\, IPDE_{t-2} + \beta2_9\, TDSG_{t-1} + \beta2_{10}\, TDSG_{t-2} + \beta2_{11}\, TDSE_{t-1} + \beta2_{12}\, TDSE_{t-2} + \beta2_{13}\, NF_{t-1} + \beta2_{14}\, NF_{t-2} + \beta2_{15}\, EG_{t-1} + \beta2_{16}\, EG_{t-2} + \beta2_{17}\, GG_{t-1} + \beta2_{18}\, GG_{t-2} + \beta2_{19}\, GFCG_{t-1} + \beta2_{20}\, GFCG_{t-2} + \beta2_{21}\, FDI_{t-1} + \beta2_{21}\, FDI_{t-2} + \varepsilon2_t \ \ldots \tag{31}$$

$$IPDG_t = \alpha3 + \beta3_1\, EDSE_{t-1} + \beta3_2\, EDSE_{t-2} + \beta3_3\, EDSG_{t-1} + \beta3_4\, EDSG_{t-2} + \beta3_5\, IPDG_{t-1} + \beta3_6\, IPDG_{t-2} + \beta3_7\, IPDE_{t-1} + \beta3_8\, IPDE_{t-2} + \beta3_9\, TDSG_{t-1} + \beta3_{10}\, TDSG_{t-2} + \beta3_{11}\, TDSE_{t-1} + \beta3_{12}\, TDSE_{t-2} + \beta3_{13}\, NF_{t-1} + \beta3_{14}\, NF_{t-2} + \beta3_{15}\, EG_{t-1} + \beta3_{16}\, EG_{t-2} + \beta3_{17}\, GG_{t-1} + \beta3_{18}\, GG_{t-2} + \beta3_{19}\, GFCG_{t-1} + \beta3_{20}\, GFCG_{t-2} + \beta3_{21}\, FDI_{t-1} + \beta3_{21}\, FDI_{t-2} + \varepsilon3_t \ \ldots \tag{32}$$

$$IPDE_t = \alpha4 + \beta4_1\, EDSE_{t-1} + \beta4_2\, EDSE_{t-2} + \beta4_3\, EDSG_{t-1} + \beta4_4\, EDSG_{t-2} + \beta4_5\, IPDG_{t-1} + \beta4_6\, IPDG_{t-2} + \beta4_7\, IPDE_{t-1} + \beta4_8\, IPDE_{t-2} + \beta4_9\, TDSG_{t-1} + \beta4_{10}\, TDSG_{t-2} + \beta4_{11}\, TDSE_{t-1} + \beta4_{12}\, TDSE_{t-2} + \beta4_{13}\, NF_{t-1} + \beta4_{14}\, NF_{t-2} + \beta4_{15}\, EG_{t-1} + \beta4_{16}\, EG_{t-2} + \beta4_{17}\, GG_{t-1} + \beta4_{18}\, GG_{t-2} + \beta4_{19}\, GFCG_{t-1} + \beta4_{20}\, GFCG_{t-2} + \beta4_{21}\, FDI_{t-1} + \beta4_{21}\, FDI_{t-2} + \varepsilon4_t \ \ldots \tag{33}$$

$$TDSG_t = \alpha5 + \beta5_1\, EDSE_{t-1} + \beta5_2\, EDSE_{t-2} + \beta5_3\, EDSG_{t-1} + \beta5_4\, EDSG_{t-2} + \beta5_5\, IPDG_{t-1} + \beta5_6\, IPDG_{t-2} + \beta5_7\, IPDE_{t-1} + \beta5_8\, IPDE_{t-2} + \beta5_9\, TDSG_{t-1} + \beta5_{10}\, TDSG_{t-2} + \beta5_{11}\, TDSE_{t-1} + \beta5_{12}\, TDSE_{t-2} + \beta5_{13}\, NF_{t-1} + \beta5_{14}\, NF_{t-2} + \beta5_{15}\, EG_{t-1} +$$

$\beta5_{16}\,EG_{t-2} + \beta5_{17}\,GG_{t-1} + \beta5_{18}\,GG_{t-2} + \beta5_{19}\,GFCG_{t-1} + \beta5_{20}\,GFCG_{t-2} + \beta5_{21}\,FDI_{t-1} + \beta5_{21}\,FDI_{t-2} + \varepsilon5_t \ldots$ (34)

$TDSE_t = \alpha6 + \beta6_1\,EDSE_{t-1} + \beta6_2\,EDSE_{t-2} + \beta6_3\,EDSG_{t-1} + \beta6_4\,EDSG_{t-2} + \beta6_5\,IPDG_{t-1} + \beta6_6\,IPDG_{t-2} + \beta6_7\,IPDE_{t-1} + \beta6_8\,IPDE_{t-2} + \beta6_9\,TDSG_{t-1} + \beta6_{10}\,TDSG_{t-2} + \beta6_{11}\,TDSE_{t-1} + \beta6_{12}\,TDSE_{t-2} + \beta6_{13}\,NF_{t-1} + \beta6_{14}\,NF_{t-2} + \beta6_{15}\,EG_{t-1} + \beta6_{16}\,EG_{t-2} + \beta6_{17}\,GG_{t-1} + \beta6_{18}\,GG_{t-2} + \beta6_{19}\,GFCG_{t-1} + \beta6_{20}\,GFCG_{t-2} + \beta6_{21}\,FDI_{t-1} + \beta6_{21}\,FDI_{t-2} + \varepsilon6_t \ldots$ (35)

$NF_t = \alpha7 + \beta7_1\,EDSE_{t-1} + \beta7_2\,EDSE_{t-2} + \beta7_3\,EDSG_{t-1} + \beta7_4\,EDSG_{t-2} + \beta7_5\,IPDG_{t-1} + \beta7_6\,IPDG_{t-2} + \beta7_7\,IPDE_{t-1} + \beta7_8\,IPDE_{t-2} + \beta7_9\,TDSG_{t-1} + \beta7_{10}\,TDSG_{t-2} + \beta7_{11}\,TDSE_{t-1} + \beta7_{12}\,TDSE_{t-2} + \beta7_{13}\,NF_{t-1} + \beta7_{14}\,NF_{t-2} + \beta7_{15}\,EG_{t-1} + \beta7_{16}\,EG_{t-2} + \beta7_{17}\,GG_{t-1} + \beta7_{18}\,GG_{t-2} + \beta7_{19}\,GFCG_{t-1} + \beta7_{20}\,GFCG_{t-2} + \beta7_{21}\,FDI_{t-1} + \beta7_{21}\,FDI_{t-2} + \varepsilon7_t \ldots$ (36)

$EG_t = \alpha8 + \beta8_1\,EDSE_{t-1} + \beta8_2\,EDSE_{t-2} + \beta8_3\,EDSG_{t-1} + \beta8_4\,EDSG_{t-2} + \beta8_5\,IPDG_{t-1} + \beta8_6\,IPDG_{t-2} + \beta8_7\,IPDE_{t-1} + \beta8_8\,IPDE_{t-2} + \beta8_9\,TDSG_{t-1} + \beta8_{10}\,TDSG_{t-2} + \beta8_{11}\,TDSE_{t-1} + \beta8_{12}\,TDSE_{t-2} + \beta8_{13}\,NF_{t-1} + \beta8_{14}\,NF_{t-2} + \beta8_{15}\,EG_{t-1} + \beta8_{16}\,EG_{t-2} + \beta8_{17}\,GG_{t-1} + \beta8_{18}\,GG_{t-2} + \beta8_{19}\,GFCG_{t-1} + \beta8_{20}\,GFCG_{t-2} + \beta8_{21}\,FDI_{t-1} + \beta8_{21}\,FDI_{t-2} + \varepsilon8_t \ldots$ (37)

$GG_t = \alpha9 + \beta9_1\,EDSE_{t-1} + \beta9_2\,EDSE_{t-2} + \beta9_3\,EDSG_{t-1} + \beta9_4\,EDSG_{t-2} + \beta9_5\,IPDG_{t-1} + \beta9_6\,IPDG_{t-2} + \beta9_7\,IPDE_{t-1} + \beta9_8\,IPDE_{t-2} + \beta9_9\,TDSG_{t-1} + \beta9_{10}\,TDSG_{t-2} + \beta9_{11}\,TDSE_{t-1} + \beta9_{12}\,TDSE_{t-2} + \beta9_{13}\,NF_{t-1} + \beta9_{14}\,NF_{t-2} + \beta9_{15}\,EG_{t-1} + \beta9_{16}\,EG_{t-2} + \beta9_{17}\,GG_{t-1} + \beta9_{18}\,GG_{t-2} + \beta9_{19}\,GFCG_{t-1} + \beta9_{20}\,GFCG_{t-2} + \beta9_{21}\,FDI_{t-1} + \beta9_{21}\,FDI_{t-2} + \varepsilon9_t \ldots$ (38)

$GFCG_t = \alpha10 + \beta10_1\,EDSE_{t-1} + \beta10_2\,EDSE_{t-2} + \beta10_3\,EDSG_{t-1} + \beta10_4\,EDSG_{t-2} + \beta10_5\,IPDG_{t-1} + \beta10_6\,IPDG_{t-2} + \beta10_7\,IPDE_{t-1} + \beta10_8\,IPDE_{t-2} + \beta10_9\,TDSG_{t-1} + \beta10_{10}\,TDSG_{t-2} + \beta10_{11}\,TDSE_{t-1} + \beta10_{12}\,TDSE_{t-2} + \beta10_{13}\,NF_{t-1} + \beta10_{14}\,NF_{t-2} + \beta10_{15}\,EG_{t-1} + \beta10_{16}\,EG_{t-2} + \beta10_{17}\,GG_{t-1} + \beta10_{18}\,GG_{t-2} + \beta10_{19}\,GFCG_{t-1} + \beta10_{20}\,GFCG_{t-2} + \beta10_{21}\,FDI_{t-1} + \beta10_{21}\,FDI_{t-2} + \varepsilon10_t \quad \ldots$ (39)

$FDI_t = \alpha11 + \beta11_1\,EDSE_{t-1} + \beta11_2\,EDSE_{t-2} + \beta11_3\,EDSG_{t-1} + \beta11_4\,EDSG_{t-2} + \beta11_5\,IPDG_{t-1} + \beta11_6\,IPDG_{t-2} + \beta11_7\,IPDE_{t-1} + \beta11_8\,IPDE_{t-2} + \beta11_9\,TDSG_{t-1} + \beta11_{10}\,TDSG_{t-2} + \beta11_{11}\,TDSE_{t-1} + \beta11_{12}\,TDSE_{t-2} + \beta11_{13}\,NF_{t-1} + \beta11_{14}\,NF_{t-2} + \beta11_{15}\,EG_{t-1} + \beta11_{16}\,EG_{t-2} + \beta11_{17}\,GG_{t-1} + \beta11_{18}\,GG_{t-2} + \beta11_{19}\,GFCG_{t-1} + \beta11_{20}\,GFCG_{t-2} + \beta11_{21}\,FDI_{t-1} + \beta11_{21}\,FDI_{t-2} + \varepsilon11_t \quad \ldots$ (40)

4. Results and Discussions

This section presents the result of the VAR model consisting of 11 equations from equation 30 to equation 40. Moreover, plots of IRF are analyzed. In equation 30, coefficients of $EDSE_{t-1}$, $EDSE_{t-2}$, $IPDG_{t-2}$, $IPDE_{t-2}$, and $TDSE_{t-2}$ are significant. R-squared is 0.96 depicting that lagged values of the 11 variables explain 96% of the variation in EDSE. F-statistic is 21.89 showing that regression equation 30 is overall significant. In equation 31, coefficients of $EDSE_{t-1}$, $IPDG_{t-1}$, $IPDE_{t-2}$, $TDSE_{t-2}$, and NF_{t-2} are significant. R-squared is 0.93 showing that lagged values of the 11 variables explains 93% of the variation in EDSG. F-statistic is 11.52, which shows that over all equation 31 is significant. In equation 32, coefficients of $IPDG_{t-1}$, $IPDE_{t-1}$, $TDSG_{t-1}$, $TDSG_{t-2}$, GG_{t-1}, GG_{t-2}, and $GFCG_{t-1}$ are significant. R-squared is 0.86 depicting that lagged values of the 11 variables explain 86% of the variation in IPDG. F-statistic is 5.02 showing that regression equation 32 is overall significant. In equation 33, coefficients of $IPDG_{t-1}$, $IPDG_{t-2}$, $IPDE_{t-2}$, $TDSG_{t-1}$, $TDSE_{t-2}$, GG_{t-2}, and $GFCG_{t-2}$ are significant. R-squared is 0.94 showing that lagged values of the 11 variables explains 94% of the variation in IPDE. F-statistic is 14.5, which shows that over all equation 33 is significant. In equation 34, coefficients of $EDSE_{t-1}$, $IPDG_{t-1}$, $IPDG_{t-2}$, $IPDE_{t-2}$, $TDSG_{t-2}$, $TDSE_{t-2}$, NF_{t-2}, GG_{t-1}, and GG_{t-2} are significant. R-squared is 0.91 depicting that lagged values of the 11 variables explain 91% of the variation in TDSG. F-statistic is 8.9 showing that regression equation 34 is overall significant. In equation 35, coefficients of $EDSG_{t-1}$, $IPDG_{t-2}$, $IPDE_{t-1}$, $IPDE_{t-2}$, $TDSG_{t-2}$, $TDSE_{t-1}$, $TDSE_{t-2}$, NF_{t-1}, GG_{t-2}, and FDI_{t-2} are significant. R-squared is 0.94 showing that lagged values of the 11 variables explains 94% of the variation in TDSE. F-statistic is 13.64, which shows that over all equation 35 is significant. In equation 36, coefficients of $EDSE_{t-2}$, $EDSG_{t-2}$, $IPDE_{t-2}$, $TDSG_{t-1}$, $TDSE_{t-2}$, NF_{t-1}, EG_{t-1}, $GFCG_{t-2}$, FDI_{t-1}, and FDI_{t-2} are significant. R-squared is 0.91 depicting that lagged values of the 11 variables explain 91% of the variation in NF. F-statistic is 15.12 showing that regression equation 36 is overall significant. In equation 37, only coefficients of $IPDG_{t-2}$, $IPDE_{t-2}$, and EG_{t-2} are significant. R-squared is 0.59 showing that lagged values of the 11 variables explains only 59% of the variation in EG. F-statistic is 1.19, which shows that over all equation 37 is insignificant. In equation 38, only coefficients of GG_{t-2} FDI_{t-2} are significant. R-squared is 0.67 depicting that lagged values of the 11 variables explain only 67% of the variation in GG. F-statistic is 1.72 showing that regression equation 38 is overall insignificant. In equation 39, only coefficient of GG_{t-1} is significant. R-squared is 0.45 showing that lagged values of the 11 variables explains only

45% of the variation in GFCG. F-statistic is 0.68, which shows that over all equation 39 is insignificant. In equation 40, coefficients of $EDSE_{t-2}$ and $EDSG_{t-2}$ are significant. R-squared is 0.92 depicting that lagged values of the 11 variables explain 92% of the variation in FDI. F-statistic is 9.8 showing that regression equation 40 is overall significant. Appendix C summarizes the output of the VAR model obtained via Eviews. According to the results of VAR model, the variables included in this paper are suitable to predict the stock based indicators (EDSE and EDSG), flow based indicators (TDSE and TDSG), and the cost based indicators (IPDE and IPDG) of indebtedness. Moreover, domestic capacity of repayments of external debt (EG and GG) is unpredictable using this VAR model. However; the foreign resources to repay external debts (NF and FDI) are predictable via the variables in the VAR model. Hence the debt burden has no long run impact on the two major sources of repayment of external debt in Sudan, GDP and exports. The only resources of Sudan that are affected by the external debt are foreign resources. Hence, debt sustainability depends on the efficient use of the foreign resources, net foreign assets and foreign direct investments.

Analysis of shocks revailed significant estimates and given in the IRFs plots. Ratio of external debt to GDP is found to be significantly related with only one foreign capacity of repayment, net foreign assets, and no domestic capacity of repayment. Ratio of total debt servicing to GDP is found to be significantly affected by one foreign capacity of repayment, net foreign assets, and one domestic capacity of repayment, GDP growth. Ratio of total debt servicing to exports is found to be significantly affected by both of the foreign capacity of repayment, foreign direct investment and net foreign assets and one domestic capacity of repayment, GDP growth. Ratio of interest payments on external debt to exports is not significantly impacted by any foreign or domestic capacity of repayment. Ratio of interest payment on external debt to GDP is found to be significantly affected by two domestic capacities of repayment, GDP growth and gross fixed capital growth. the IRF plots of the above discussed significant responses, shows that the indicators of indebtedness response negatively to the positive shocks in the domestic capacity to repay. (appendix A-1).

Net foreign assets are found to be significantly affected by both of the stock based indicators of indebtedness, ratio of external debt to GDP and ratio of external debt to exports. From the flow based indicators of indebtedness, only one indicator, ratio of total debt service to GDP, significantly affect net foreign assets. One of the cost based indicators of indebtedness, ratio of interest payment on external debt to exports, significantly affects the net foreign assets. Net foreign assets responses positively to the shock in ratio of total debt service to GDP and negatively to the shock in the ratio of external debt to exports. Response of net foreign assets to ratio of external debt to GDP and ratio of interest payment on external debt to exports fluctuates around the line of zero response. for the above discussed significant responses(see appendix A-2). Only one domestic capacity, exports growth, is found to be significantly affected by the cost based indicators of indebtedness, ratio of interest payment on external debt to GDP and ratio of interest payment on external debt to exports. No other indicator of indebtedness found to affect any other domestic capacity of repayment. Only stock based indicators of indebtedness are found significantly affect the foreign direct investment, the foreign capacity of repayment. Foreign direct investments have positive response to the shock in ratio of external debt to GDP and negative response to the shock in ratio of external debt to exports. Response of exports growth to the cost based indicators of indebtedness fluctuates around the line of zero response, for the above discussed significant responses (see Appendix A-3).

Sustainable levels of stock based indicators of external debt in Sudan can only be achieved by setting policies for net foreign assets. However, flow based indicators of indebtedness can be made sustainable through improving the domestic capacity of repayment, specifically GDP. Cost based indicators of external debt in Sudan can be controlled to sustainable level if the gross fixed capital formation is also improved with the GDP. There is a bidirectional relationship between net foreign assets and total debt service to GDP ratio. Thus, any policy to make the flow based indicator of indebtedness must consider this nature of relationship. Cost based indicators of external indebtedness are most essential to keep sustainable as they significantly impact a major source of income of Sudan that is exports. Export growth significantly response to the shock in the interest payment on external debt; hence, sustainable interest payments are crucial.

5. Conclusion

This paper provides with an effective model to analyze the external debt sustainability of a developing country, taking the case of Sudan. External debt has a confusing role in the process of economic development of a country. On one hand it is an obligation; therefore always avoided. On the other hand, it is a supplement of the low domestic saving and hence required to finance the investments. Hence, the assessment and evaluations of the long run impact of external debt has always been an active area of research. Only recently, the question of dynamic association of the external indebtedness of a country and the country's growth has been questioned. Different methods and statistical tools are presented to assess in answering this question. One of such methods is vector autoregressive (VAR) model followed by a sensitivity analysis of the estimates using impulse response function (IRF). In VAR model, every variable can be considered as endogenous variables; hence, choice of variables requires close consideration. In this paper, the variables to be inserted in the VAR model are divided into broad categories; indicators of indebtedness and measures of repayment capacity. Indicators of indebtedness are further classified into three categories; stock based indicators, flow based indicators, and cost based indicators. The measures of repayment capacity are further classified as domestic capacity of repayment and foreign capacity of repayment. A total of 11 variables are introduced to be used in the VAR mode. And hence, 11 equations are formed. Model specification in this paper is done carefully, starting from the very initial steps of the VAR procedure using a 2-variable 2-equation model.

Time series data is inserted in the VAR model for the period 1970-2012. The data is collected for Sudan from the website of the World Bank, which provides World Development Indicators (WDI). Eviews is used to estimate the model. The estimates are further used to calculate IRF for the significant relationships only. IRFs plots are provided in this paper. The results showed that all the three indicators of indebtedness; the stock based indicators, the flow based indicators, and the cost based indicators, are predictable using the measures of foreign and domestic capacity to repay the external debt. In turn, the indicators of indebtedness can predict only foreign direct investment in Sudan. No other measures of foreign and domestic capacity to repay external debt are predictable by the indicators of indebtedness. IRF plots showed that mostly the response of all three indicators of indebtedness is negative to the shocks in the capacity to repay external debt. The indicators of indebtedness respond more to the shocks in the domestic capacities of repayment than to the shocks in the foreign capacity of repayments. Effective policies to enhance the domestic capacities to repay external debt are recommended on the basis of this result. As net foreign assets are also found to be significantly effected in turn by the indicators of indebtedness, it is realized that the policies to control indebtedness to a sustainable level must consider its effects on the foreign capacity of repayments. Cost based indicators of indebtedness significantly affect the exports growth of Sudan. Hence, from the three indicators of indebtedness, interest payment on external debt is the most deteriorating factor of unstable external debt which negatively affects the most important source of income in the indebted country that is exports.

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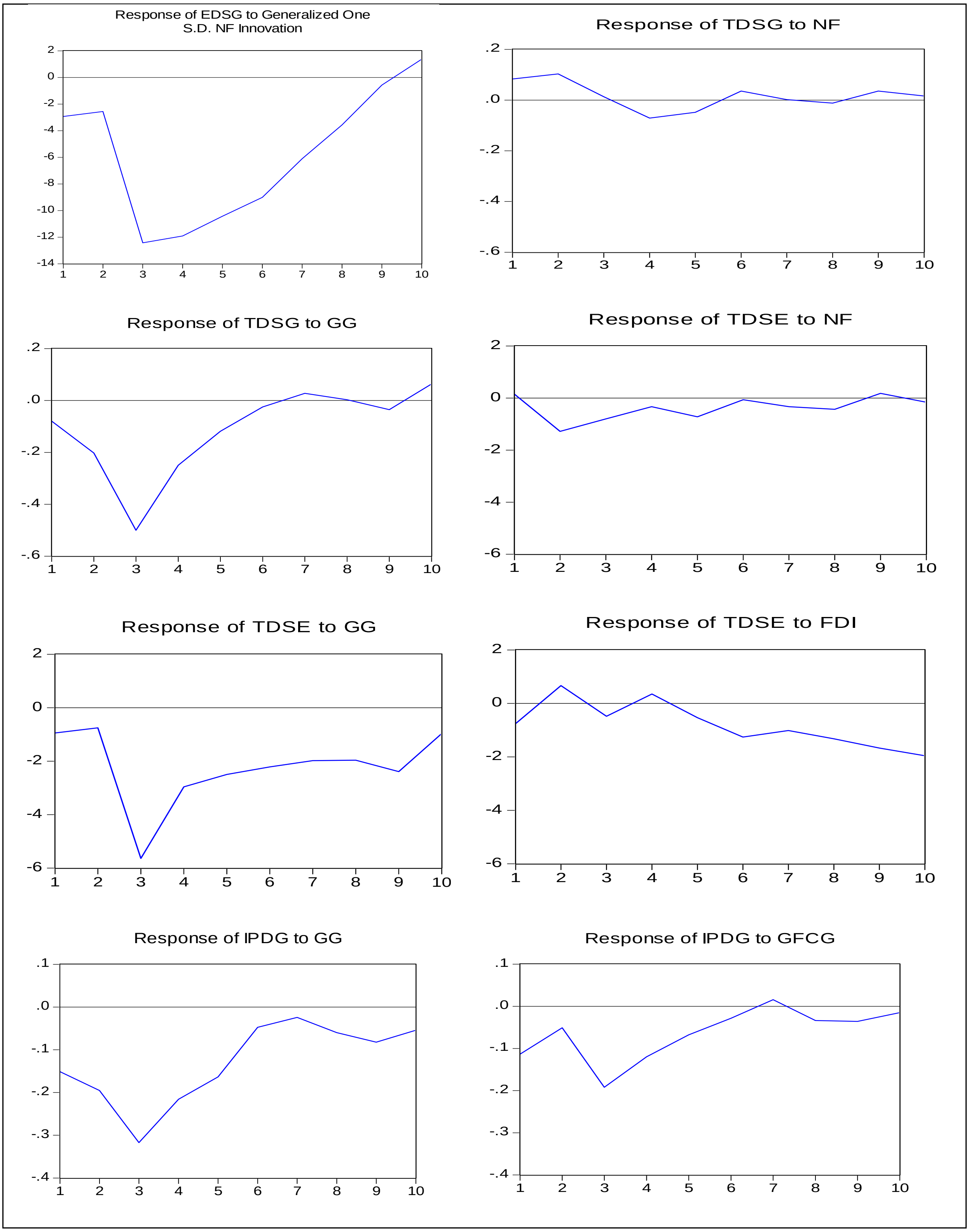
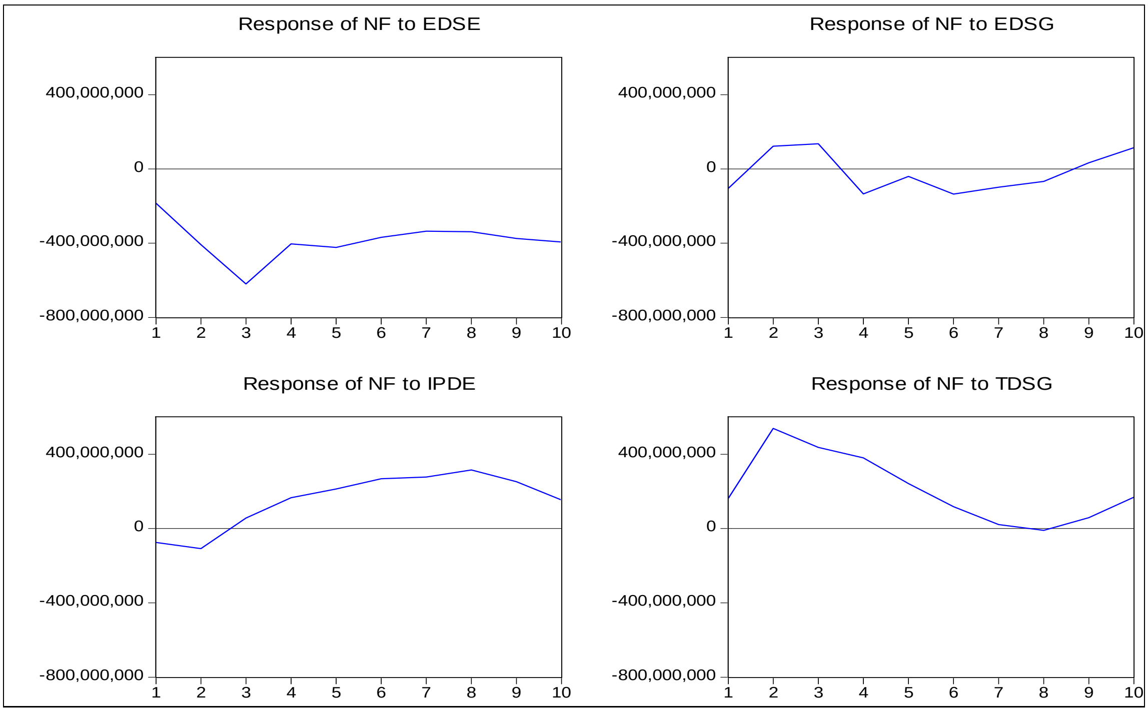
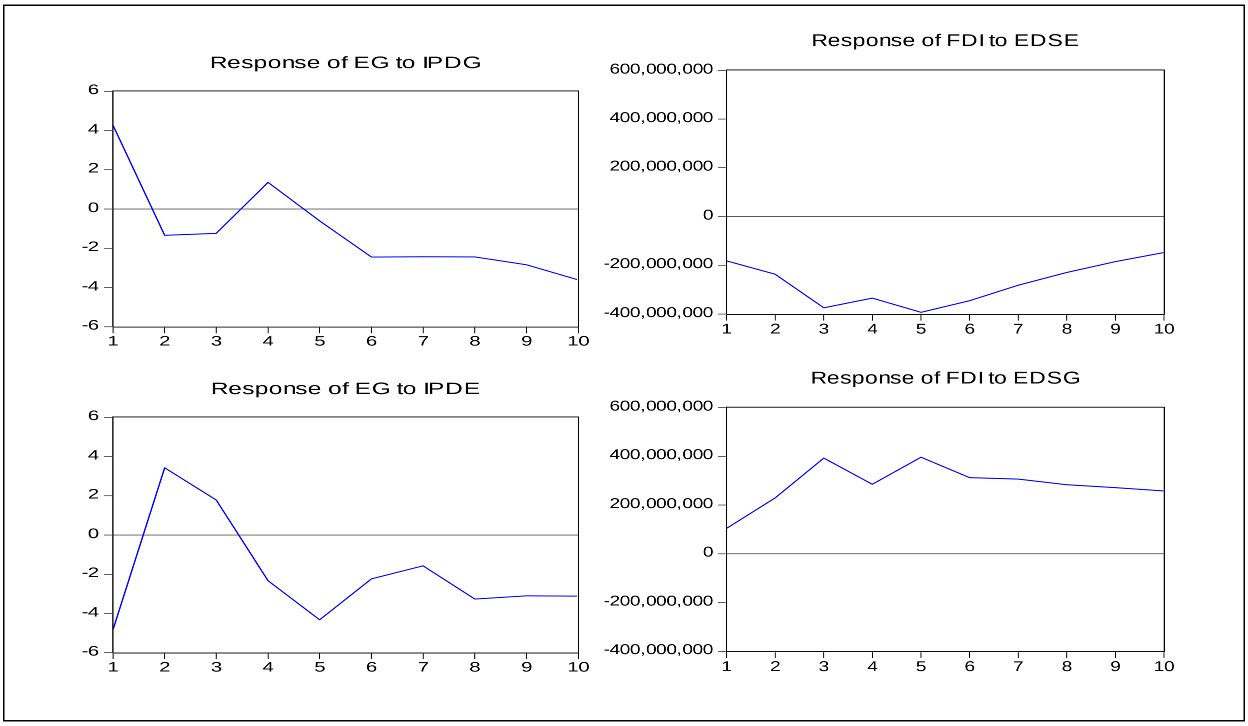
Appendix A-1: IRF Plots for Response of Indebtedness to Repayment Capacity



Appendix A-2:IRF Plots for Response of Net Foreign Assets to Indebtedness



Appendix A-3: IRF Plots for Response of Repayment Capacities to Indebtedness



Appendix B: IRF Tables

Table B-1: IRF for Response of NF to EDSE, EDSG, IPDE, and TDSG

Period	EDSE	EDSG	IPDE	TDSG
1	-1.85E+08	-1.05E+08	-74989774	1.63E+08
2	-4.08E+08	1.23E+08	-1.08E+08	5.39E+08
3	-6.19E+08	1.36E+08	56128676	4.37E+08
4	-4.04E+08	-1.34E+08	1.66E+08	3.81E+08
5	-4.23E+08	-40342046	2.13E+08	2.42E+08
6	-3.68E+08	-1.36E+08	2.69E+08	1.18E+08
7	-3.36E+08	-98433332	2.78E+08	21302867
8	-3.39E+08	-67180235	3.16E+08	-9756689.
9	-3.74E+08	32780422	2.52E+08	58587592
10	-3.93E+08	1.15E+08	1.54E+08	1.69E+08

Generalized Impulse

Table B-2:IRF for Response of TDSG to NF and GG

Period	NF	GG
1	0.083277	-0.079764
2	0.103375	-0.202489
3	0.013443	-0.500471
4	-0.070947	-0.249628
5	-0.048390	-0.118819
6	0.035467	-0.025022
7	0.001832	0.027531
8	-0.012068	0.002622
9	0.035689	-0.035274
10	0.016050	0.063654

Generalized Impulse

Table B-3: IRF for Response of TDSE to NF, GG, and FDI

Period	NF	GG	FDI
1	0.144063	-0.948047	-0.752164
2	-1.283625	-0.752295	0.663544
3	-0.803243	-5.642585	-0.481834
4	-0.331062	-2.960284	0.347686
5	-0.723205	-2.496046	-0.536458
6	-0.066639	-2.218120	-1.260972
7	-0.335928	-1.983889	-1.017934
8	-0.434399	-1.967438	-1.325639
9	0.178901	-2.390315	-1.671776
10	-0.163402	-0.968146	-1.961168

Generalized Impulse

Table B-4: IRF for Response of IPDG to GG and GFCG

Period	GG	GFCG
1	-0.151278	-0.113552
2	-0.195141	-0.051087
3	-0.317014	-0.192228
4	-0.215847	-0.119868
5	-0.163327	-0.067853
6	-0.047399	-0.028438
7	-0.024296	0.015544
8	-0.059975	-0.033911
9	-0.082047	-0.036004
10	-0.054313	-0.015101

Generalized Impulse

Table B-5:IRF for Response of FDI to EDSE and EDSG

Period	EDSE	EDSG
1	-1.82E+08	1.04E+08
2	-2.37E+08	2.30E+08
3	-3.75E+08	3.93E+08
4	-3.35E+08	2.85E+08
5	-3.93E+08	3.96E+08
6	-3.45E+08	3.12E+08
7	-2.82E+08	3.07E+08
8	-2.30E+08	2.83E+08
9	-1.85E+08	2.71E+08
10	-1.48E+08	2.58E+08
Generalized Impulse		

Table B-6:IRF for Response of EG to IPDE and IPDG

Period	IPDE	IPDG
1	-4.816459	4.261872
2	3.425221	-1.344313
3	1.785196	-1.241352
4	-2.328804	1.359812
5	-4.325722	-0.610222
6	-2.235729	-2.447994
7	-1.573983	-2.432179
8	-3.267538	-2.438304
9	-3.102953	-2.839058
10	-3.118011	-3.612517
Generalized Impulse		

Table B-7: IRF for Response of EDSG to NF

Period	
1	-2.933088
2	-2.559798
3	-12.42201
4	-11.90654
5	-10.42397
6	-9.010264
7	-6.102706
8	-3.562700
9	-0.572359
10	1.373697
Generalized Impulse	

Appendix C: Estimation of VAR Model

	EDSE	EDSG	IPDG	IPDE	TDSG	TDSE	NF	EG	GG	GFCG	FDI
EDSE(-1)	1.056670*	0.040760*	-4.87E-05	0.000228	-0.00041***	-0.002660	314276.0	-0.006380	0.000233	0.002293	-67767.47
	(0.21550)	(0.01331)	(0.00019)	(0.00128)	(0.00024)	(0.00204)	(474296.)	(0.01419)	(0.00267)	(0.01570)	(494409.)
	[4.90330]	[3.06265]	[-0.25721]	[0.17822]	[-1.68932]	[-1.30182]	[0.66262]	[-0.44948]	[0.08736]	[0.14609]	[-0.13707]
EDSE(-2)	-0.4757**	-0.009456	0.000186	0.000320	0.000354	0.000638	-1379046*.	0.007543	0.000937	0.000180	-966262.1***
	(0.22044)	(0.01361)	(0.00019)	(0.00131)	(0.00025)	(0.00209)	(485164.)	(0.01452)	(0.00273)	(0.01606)	(505737.)
	[-2.15804]	[-0.69463]	[0.95952]	[0.24478]	[1.42666]	[0.30549]	[-2.84243]	[0.51947]	[0.34357]	[0.01120]	[-1.91060]
EDSG(-1)	2.290466	0.137556	-0.003324	-0.031364	-0.005061	-0.0707***	6762332.	-0.011026	-0.016638	-0.010763	2539585.
	(3.86159)	(0.23848)	(0.00339)	(0.02288)	(0.00434)	(0.03661)	(8498934)	(0.25435)	(0.04779)	(0.28126)	(8859329)
	[0.59314]	[0.57681]	[-0.98016]	[-1.37051]	[-1.16555]	[-1.93206]	[0.79567]	[-0.04335]	[-0.34814]	[-0.03827]	[0.28666]
EDSG(-2)	-4.399345	-0.336369	0.000406	0.017500	-0.000787	0.034315	13386454***	0.014368	0.031739	-0.070304	13518323***
	(3.46932)	(0.21425)	(0.00305)	(0.02056)	(0.00390)	(0.03289)	(7635599)	(0.22851)	(0.04294)	(0.25269)	(7959384)
	[-1.26807]	[-1.56996]	[0.13313]	[0.85116]	[-0.20186]	[1.04336]	[1.75316]	[0.06287]	[0.73922]	[-0.27823]	[1.69841]
IPDG(-1)	313.1070	60.21163***	1.911709*	6.754640**	1.628288*	-2.515399	-1.19E+09	5.853567	-2.257136	62.57066	58130028
	(573.243)	(35.4015)	(0.50342)	(3.39718)	(0.64457)	(5.43428)	(1.3E+09)	(37.7575)	(7.09442)	(41.7518)	(1.3E+09)
	[0.54620]	[1.70082]	[3.79744]	[1.98831]	[2.52617]	[-0.46288]	[-0.94646]	[0.15503]	[-0.31816]	[1.49863]	[0.04420]
IPDG(-2)	-1040***	-24.75649	-0.182941	5.864633***	1.121057***	16.35717*	-1.60E+09	71.59720***	-4.825779	-2.590208	-6.79E+08
	(589.333)	(36.3952)	(0.51755)	(3.49253)	(0.66266)	(5.58681)	(1.3E+09)	(38.8173)	(7.29354)	(42.9236)	(1.4E+09)
	[-1.76449]	[-0.68021]	[-0.35348]	[1.67919]	[1.69176]	[2.92782]	[-1.23058]	[1.84447]	[-0.66165]	[-0.06034]	[-0.50206]
IPDE(-1)	32.01167	-2.262018	-0.126890*	0.067206	-0.082127	2.105018*	1.62E+08	-1.017541	1.017824	-2.014312	52716860
	(63.1559)	(3.90029)	(0.05546)	(0.37428)	(0.07101)	(0.59871)	(1.4E+08)	(4.15985)	(0.78161)	(4.59992)	(1.4E+08)
	[0.50687]	[-0.57996]	[-2.28782]	[0.17956]	[-1.15649]	[3.51592]	[1.16830]	[-0.24461]	[1.30221]	[-0.43790]	[0.36383]
IPDE(-2)	219.3322*	7.221339**	-0.058492	-0.926206*	-0.233121*	-2.321273*	2.11E+08***	-8.312801**	-0.715766	-1.295137	54516129
	(55.8095)	(3.44661)	(0.04901)	(0.33074)	(0.06275)	(0.52907)	(1.2E+08)	(3.67598)	(0.69069)	(4.06485)	(1.3E+08)
	[3.93001]	[2.09520]	[-1.19343]	[-2.80040]	[-3.71488]	[-4.38747]	[1.71582]	[-2.26139]	[-1.03630]	[-0.31862]	[0.42578]
TDSG(-1)	-186.5081	-18.95530	-0.54489**	-3.595561**	-0.376062	-3.324137	1.01E+09***	-12.48302	-0.162171	-18.54237	-2.35E+08
	(277.954)	(17.1655)	(0.24410)	(1.64722)	(0.31254)	(2.63497)	(6.1E+08)	(18.3078)	(3.43994)	(20.2446)	(6.4E+08)
	[-0.67100]	[-1.10427]	[-2.23226]	[-2.18281]	[-1.20326]	[-1.26155]	[1.65415]	[-0.68184]	[-0.04714]	[-0.91592]	[-0.36902]
TDSG(-2)	137.2569	2.612896	0.002895	-1.456363	-0.466113**	-3.58143**	2.84E+08	-17.51029	2.606192	0.428720	-93026420
	(196.494)	(12.1348)	(0.17256)	(1.16447)	(0.22094)	(1.86275)	(4.3E+08)	(12.9424)	(2.43180)	(14.3115)	(4.5E+08)
	[0.69853]	[0.21532]	[0.01678]	[-1.25066]	[-2.10966]	[-1.92266]	[0.65587]	[-1.35294]	[1.07171]	[0.02996]	[-0.20636]
TDSE(-1)	-43.09904	-1.567581	0.059637**	0.190027	0.032678	-0.5222***	-1.02E+08	1.065946	0.066241	0.790385	-26354550
	(30.7863)	(1.90125)	(0.02704)	(0.18245)	(0.03462)	(0.29185)	(6.8E+07)	(2.02778)	(0.38101)	(2.24229)	(7.1E+07)
	[-1.39994]	[-0.82450]	[2.20580]	[1.04155]	[0.94400]	[-1.78957]	[-1.50164]	[0.52567]	[0.17386]	[0.35249]	[-0.37313]
TDSE(-2)	-101.107*	-4.009099*	0.047776**	0.653775*	0.108881*	0.942242*	-51887450	2.479884	-0.159016	-0.744782	-24692831
	(24.8718)	(1.53599)	(0.02184)	(0.14740)	(0.02797)	(0.23578)	(5.5E+07)	(1.63821)	(0.30781)	(1.81152)	(5.7E+07)
	[-4.06512]	[-2.61010]	[2.18730]	[4.43550]	[3.89330]	[3.99625]	[-0.94789]	[1.51377]	[-0.51660]	[-0.41114]	[-0.43274]
NF(-1)	1.22E-08	4.92E-09	6.34E-11	-2.98E-10	1.33E-10	-1.3E-10***	1.094788*	-6.33E-10	4.28E-10	-2.89E-10	0.126779
	(8.6E-08)	(5.3E-09)	(7.6E-11)	(5.1E-10)	(9.7E-11)	(8.2E-10)	(0.19002)	(5.7E-09)	(1.1E-09)	(6.3E-09)	(0.19808)
	[0.14077]	[0.92320]	[0.83611]	[-0.58327]	[1.36805]	[-1.63533]	[5.76134]	[-0.11123]	[0.40090]	[-0.04597]	[0.64004]
NF(-2)	-3.92E-08	-1.38E-08*	-2.43E-11	3.76E-10	-1.77E-10***	2.75E-10	-0.154876	-6.29E-09	-7.22E-10	-3.13E-09	0.107583
	(8.7E-08)	(5.4E-09)	(7.7E-11)	(5.2E-10)	(9.8E-11)	(8.3E-10)	(0.19233)	(5.8E-09)	(1.1E-09)	(6.4E-09)	(0.20048)
	[-0.44821]	[-2.56155]	[-0.31639]	[0.72559]	[-1.79868]	[0.33230]	[-0.80527]	[-1.09270]	[-0.66746]	[-0.49226]	[0.53661]
EG(-1)	-0.190809	0.125732	0.003479	0.022138	0.003847	0.004937	25393527*	-0.158093	0.003307	-0.137267	13882447
	(3.96194)	(0.24468)	(0.00348)	(0.02348)	(0.00445)	(0.03756)	(8719798)	(0.26096)	(0.04903)	(0.28856)	(9089558)
	[-0.04816]	[0.51387]	[1.00000]	[0.94285]	[0.86346]	[0.13144]	[2.91217]	[-0.60582]	[0.06745]	[-0.47569]	[1.52730]
EG(-2)	2.902134	-0.013827	0.001810	0.019673	-0.006072	-0.020693	-8379088.	-0.530060**	-0.047813	-0.141263	-1911732.
	(3.95389)	(0.24418)	(0.00347)	(0.02343)	(0.00445)	(0.03748)	(8702088)	(0.26043)	(0.04893)	(0.28798)	(9071098)
	[0.73399]	[-0.05663]	[0.52116]	[0.83958]	[-1.36583]	[-0.55207]	[-0.96288]	[-2.03534]	[-0.97712]	[-0.49053]	[-0.21075]
GG(-1)	5.844489	0.352099	-0.03666**	-0.065790	-0.023196	0.157629	36023519	0.693610	0.116491	2.4768***	44489119
	(19.6376)	(1.21275)	(0.01725)	(0.11638)	(0.02208)	(0.18616)	(4.3E+07)	(1.29346)	(0.24303)	(1.43029)	(4.5E+07)
	[0.29762]	[0.29033]	[-2.12554]	[-0.56532]	[-1.05050]	[0.84673]	[0.83349]	[0.53624]	[0.47932]	[1.73167]	[0.98748]
GG(-2)	-17.24666	-1.016562	-0.03097**	-0.327160*	-0.058488*	-0.871464*	74796373**	-0.487869	-0.38524**	-0.313175	28516595

	(18.0366)	(1.11388)	(0.01584)	(0.10689)	(0.02028)	(0.17099)	(4.0E+07)	(1.18801)	(0.22322)	(1.31369)	(4.1E+07)
	[-0.95620]	[-0.91263]	[-1.95546]	[-3.06074]	[-2.88392]	[-5.09672]	[1.88420]	[-0.41066]	[-1.72583]	[-0.23839]	[0.68914]
GFCG(-1)	3.866376	0.204108	0.009079**	0.021193	0.006518	0.000535	-12971079	-0.322686	0.065374	-0.190544	-698446.1
	(4.86085)	(0.30019)	(0.00427)	(0.02881)	(0.00547)	(0.04608)	(1.1E+07)	(0.32017)	(0.06016)	(0.35404)	(1.1E+07)
	[0.79541]	[0.67993]	[2.12695]	[0.73571]	[1.19246]	[0.01161]	[-1.21245]	[-1.00787]	[1.08671]	[-0.53821]	[-0.06263]
GFCG(-2)	0.749720	0.199553	-0.000518	-0.03610***	0.000941	-0.024613	-16143080**	0.041027	-0.034572	-0.137490	802131.4
	(3.59604)	(0.22208)	(0.00316)	(0.02131)	(0.00404)	(0.03409)	(7914487)	(0.23686)	(0.04450)	(0.26191)	(8250099)
	[0.20849]	[0.89857]	[-0.16397]	[-1.69388]	[0.23278]	[-0.72200]	[-2.03969]	[0.17321]	[-0.77681]	[-0.52494]	[0.09723]
FDI(-1)	-6.51E-08	-9.36E-10	-9.53E-12	3.71E-10	-8.01E-11	9.93E-10	-0.842111*	1.09E-08	2.68E-09**	5.60E-09	0.326547
	(1.0E-07)	(6.5E-09)	(9.2E-11)	(6.2E-10)	(1.2E-10)	(9.9E-10)	(0.23014)	(6.9E-09)	(1.3E-09)	(7.6E-09)	(0.23989)
	[-0.62232]	[-0.14489]	[-0.10378]	[0.59874]	[-0.68123]	[1.00200]	[-3.65919]	[1.58053]	[2.07329]	[0.73509]	[1.36121]
FDI(-2)	-1.28E-07	-5.43E-09	3.82E-11	-2.10E-10	5.71E-11	-2.45E-09*	0.716865*	-6.33E-09	-1.84E-09	-5.44E-09	0.345706
	(1.0E-07)	(6.2E-09)	(8.8E-11)	(5.9E-10)	(1.1E-10)	(9.5E-10)	(0.22074)	(6.6E-09)	(1.2E-09)	(7.3E-09)	(0.23010)
	[-1.28047]	[-0.87613]	[0.43350]	[-0.35326]	[0.50659]	[-2.57544]	[3.24757]	[-0.95823]	[-1.47882]	[-0.74535]	[1.50242]
C	1814.489*	115.3306*	0.231026	1.288358	1.809094*	19.81522*	-1.05E+09	5.714927	1.003658	16.62889	1.01E+09
	(573.126)	(35.3943)	(0.50332)	(3.39648)	(0.64444)	(5.43317)	(1.3E+09)	(37.7498)	(7.09297)	(41.7432)	(1.3E+09)
	[3.16595]	[3.25845]	[0.45901]	[0.37932]	[2.80725]	[3.64708]	[-0.83319]	[0.15139]	[0.14150]	[0.39836]	[0.77088]
R-squared	0.963973	0.933701	0.860627	0.946691	0.915925	0.943439	0.948672	0.594147	0.678712	0.456064	0.923507
Adj. R-squared	0.919941	0.852668	0.690282	0.881536	0.813166	0.874310	0.885937	0.098105	0.286026	-0.208746	0.830015
Sum sq. resids	2118316.	8078.991	1.633706	74.39589	2.678240	190.3695	1.03E+19	9190.078	324.4490	11237.32	1.11E+19
S.E. equation	343.0514	21.18568	0.301266	2.033004	0.385734	3.252089	7.55E+08	22.59557	4.245580	24.98590	7.87E+08
F-statistic	21.89235	11.52253	5.052268	14.52976	8.913377	13.64741	15.12197	1.197776	1.728385	0.686007	9.877926