



THE STRUCTURAL RELATIONSHIP BETWEEN FISCAL DEFICIT AND CURRENT ACCOUNT DEFICIT IN INDIA: SVAR ESTIMATION OF THE TWIN DEFICIT HYPOTHESIS

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Abstract: This paper tests the validity of the twin deficit hypothesis, the causal relationship between fiscal deficit (FD) and current account balance (CAB), in India for the period 1994-2016 by estimating a structural model that includes the interest rate and exchange rate as an interlinking variable. The SVAR estimates show a negative effect implying that a positive shock given to FD worsens the CAB. The current account deficit, while not directly determined by fiscal deficit, is significantly influenced by RIR and REER. The IRF indicates that a positive shock to FD leads to an increase in the domestic interest rate which appreciates the real exchange rate of the domestic currency making the exports costlier and imports cheaper and thereby widening the current account deficit. The SVAR, IRF and Granger causality analyses show that fiscal deficit affects the current account balance in India through the interlinking variables RIR and REER for the time period 1994 (quarter-I) to 2016 (quarter-IV). This result validates the relevance of the twin deficit hypothesis in the Indian economy and is consistent with the Keynesian proposition in the Indian economy during the study period.

Keywords: Fiscal deficit, current account balance, interest rate, exchange rate, SVAR estimation

INTRODUCTION

Most of the developing countries have fiscal or deficit as well as current account deficits. Fiscal deficit refers to the budget deficit wherein tax revenues are less than the government expenditure. The current account deficit refers to the trade deficit where imports exceed exports. The simultaneous occurrence of the two deficits has been referred to as the twin deficit hypothesis and the causal relationship between the two deficits has been controversial. Many studies have attempted to test the validity of both the views on current account and

fiscal deficit in different origins and contexts using different methodologies. Some studies find that a higher fiscal deficit leads to a higher current account deficit while other studies find the opposite and observe no significant relationship between the two. Thus, the empirical evidence on the causality and validity of the twin deficit hypothesis has been inconclusive.

Most Asian countries experience twin deficits. But, in Saudi Arabia and Kuwait, there is reverse causality from the current account balance to the fiscal deficit (Alkswani, 2000; Merza, Alawin and Bashayreh, 2012). This is because both the countries are oil-based economies and the current account balance is more sensitive to the fluctuations in oil prices than to the changes in fiscal balance. However, in Turkey the validity of the twin deficit hypothesis is different. The differential validity of the twin deficit hypothesis in western Asia is attributed to the difference in the income levels in these countries. While Kuwait and Saudi Arabia belong to the high-income economy, Turkey is a middle-income country. The former countries are highly oil-based economies which yield them higher income (making the current account more sensitive to the income) than in the latter country and hence, creating an income gap between these countries which leads to varying results of the twin deficit hypothesis. In African countries like Egypt, South Africa and Ghana, there is a twin divergence between the fiscal balance and the current account balance implying that a fiscal deficit would lead to improvement of the current account deficit. However, among most African countries, the twin deficit hypothesis is found to be valid only in Nigeria (Onafowora and Owoye, 2006). The validity of the twin deficit hypothesis in 10 European countries shows on one hand absence of any relationship between fiscal deficit and current account for Austria, Finland, Germany, Greece, Netherlands and Portugal and on the other hand valid twin deficit hypothesis for France, Ireland, Italy and Spain (Deltoro, 2015). Thus, the validity of the twin deficit hypothesis for different countries depends on the economic conditions of the country.

India is one of the many countries with both current account deficits and fiscal deficits. India has been experiencing twin deficits since the 1980s. The average fiscal deficit of the central government has remained at 5.8% from 1980 to 2010. It is argued that the main reason behind the financial crisis of 1991 has been the inability to finance the high current account deficit via capital inflows leading to the BOP crisis. In fact, the financial crisis in the mid-1980s led to the BOP crisis in the next decade. In the first half of the 1980s, the fiscal deficit has been around 6 to 7.5% and it increased to 9% in the next half. The fiscal deficit is driven more by the revenue deficit. By the 1990s, the fiscal deficit and current account deficit have risen to 9.4% and 3.5% respectively. With an aim to control the fiscal deficit, the fiscal responsibility and budget management act (FRBM) was introduced in 2003. The FRBM Act warrants a medium-term target for balancing current revenues and expenditures and restricts the overall limits to the fiscal deficit at 3% of GDP to be achieved by a phased deficit reduction roadmap by 2008. However, with the implementation of massive social security schemes under the national rural employment guarantee programme (MGNREGA) and the sixth pay commission, and without any reduction in subsidies, the high government expenditures improved the domestic demand of the economy and a contraction of Indian exports.

During the financial crisis in 1991, the current account deficit of India has been above 3%. The structural reforms undertaken subsequently have reduced the current account deficit and in fact, there has been a trade surplus between 2001-02 and 2003-04. However, from 2004-05 onwards, the current account experienced a deficit of high magnitude and the trade deficit has increased to 4.2% in 2011-12. Thus, with the recovery of the economy, the current account deficit also started to widen (Mitra and Khan, 2014). The biggest contributors to the trade deficit of India are the oil and gold imports, followed by factor income paid abroad and government grants made to the foreigners. The current account deficit is about 0.7% of India’s GDP in 2016-17 (IMF, BOP Statistics Yearbook).

Figure 1 shows the trends in fiscal deficit (FD) and current account balance (CAB) of the Indian economy as a percentage of real GDP from 1994-95 to 2016-17. It can be observed that both FD and CAB are fluctuating over the years. India has been experiencing a fiscal deficit in all the years except in the second and third quarters of 2007-08. This is due to the rise in tax revenues from excise and customs duties of the central government. Though the fiscal deficit was high in the 1980s and in the early 1990s, it had dropped down in the later years, especially in the post FRBM act period. The FD is seen to be fluctuating between 0-4% which is due to the government’s effort to reduce the deficit by 0.5% and bring it down to 3% as per the FRBM act. The components of CAB include imports, exports, net transfers and net factor income. The current account balance is negative for most of the years indicating that there has been a current account deficit. The negative balance in the current account from 1994 to 2001 can be attributed to the rising imports and falling exports caused by currency appreciation. Between 2002-03 and 2004-05, there has been a surplus in the current account balance due to a high surplus from transfers and net income (GOI, Economic

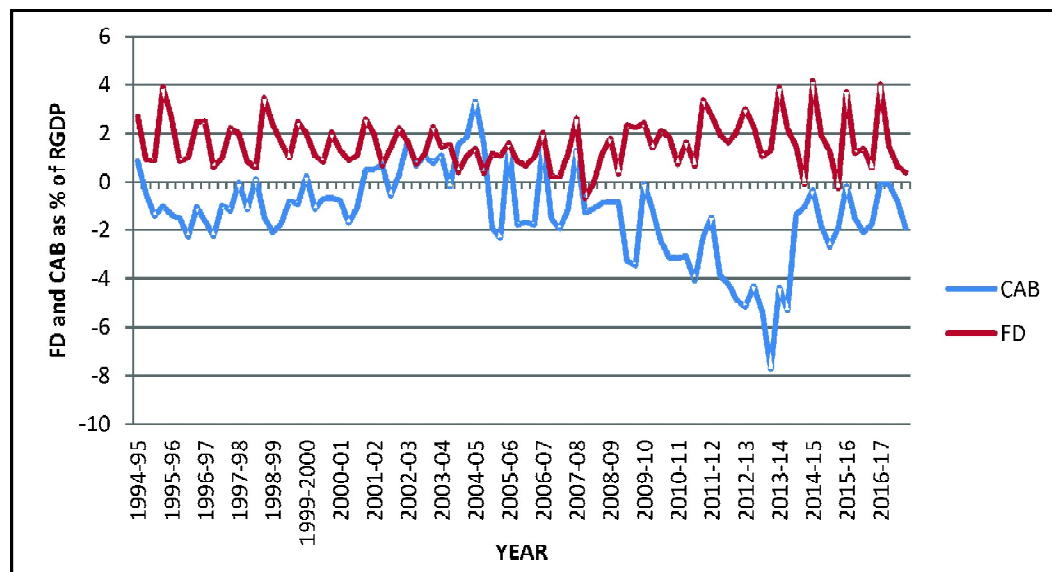


Figure 1: Trends in Fiscal Deficit and Current Account Balance in India

Survey, 2005). However, the current account experienced a deficit of more than 4% in 2011 due to a sharp rise in oil prices and a fall in the growth of the economy. With continuous growth in gold and electronic imports and a fall in pharma exports, the deficit in CAB further expanded to around 8% by 2014. Though the deficit in CAB reduced to around 2% by 2016, it is seen that there is a persistent deficit in CAB since 2009-10.

From Figure 1, it can also be observed that when the fiscal deficit is on a rise, the current account balance is running into a deficit indicating the possibility of a causal relationship between FD and CAB. And both FD and CAB have been fluctuating over the years. However, there is no similarity in the trends of FD and CAB in India. Therefore, it is necessary to examine the nature of the relationship between fiscal deficit and current account deficit and verify if fiscal deficit fuels the deficit in the external account of India. The previous attempts to test the validity of the twin deficit hypothesis in India considered only these two variables, the fiscal deficit and current account balance, and ignored other relevant variables like interest rate and the exchange rate which could act as interlinking variables between FD and CAB.

Therefore, the main objective of this paper is to analyse the nature of the relationship between fiscal deficit and current account balance in India including the interlinking variables interest rate and exchange rate. The causal relationship between FD and CAB is examined for the time period beginning from quarter I of 1994 to quarter IV of 2016 applying the Structural Vector Autoregressive (SVAR) model for the time series data obtained from the Handbook of Statistics on Indian Economy of the RBI and the International Financial Statistics of the IMF.

REVIEW OF LITERATURE

The theoretical background of the twin deficit hypothesis that explores the relationship between current account balance and fiscal deficit is derived from the Keynesian proposition and the Ricardian equivalence hypothesis. The Keynesian proposition argues for the existence of a positive relationship between fiscal deficit and current account deficit and proposes that fiscal deficit leads to a current account deficit. In the Mundell-Fleming framework, in an open economy, the government's expansionary fiscal policy leads to a fiscal deficit which induces the domestic rate of interest to rise above the global rate of interest causing capital inflows into the domestic economy. Hence, the exchange rate gets appreciated leading to a trade deficit and current account deficit. Therefore, the Keynesian proposition states that a fiscal surplus by contraction of government expenditure will improve the current account balance.

In contrast to the Keynesian approach, the Ricardian equivalence hypothesis denies any relationship between the fiscal deficit and the current account deficit instead it proposes the 'twin divergence hypothesis'. Using the rational expectations framework, it argues that rational individuals know that the reduction in taxes, which leads to fiscal deficit, is temporary and hence they will increase their savings anticipating higher taxes in the future.

The impact of such changes in fiscal deficit is adjusted in the national savings and therefore the fiscal deficit has no effect on the current account deficit.

The relationship between these two variables can be put in the national income accounting identity as given by,

$$Y = C + I + G + (X - M) \quad (1)$$

where Y is national income, C is private consumption expenditure, I is investment, G is government expenditure on final goods and services, X is exports of goods and services, and M is imports of goods and services. Also, the individual disposes of income (Y) is either consumption (C), saving (S), or taxes (T). Therefore,

$$Y = C + S + T \quad (2)$$

Combining equations (1) and (2) yields,

$$C + S + T = C + I + G + (X - M) \quad (3)$$

$$(X - M) = (S - I) + (T - G) \quad (4)$$

The equation (4) is the basis for the relationship between fiscal deficit and current account balance which states that the current account balance equals the sum of excess private savings over investment and fiscal deficit. If the difference between private savings and investment is assumed to be stable over time, as the Keynesian proposition holds, the fluctuations in the public sector balance which is FD will be fully translated to the current account (CAB) and vice versa. Therefore, the twin deficit hypothesis will hold. In the second case, the Ricardian equivalence hypothesis states that the change in fiscal deficit is fully offset by the change in savings.

There is extensive theoretical and empirical literature that has examined the relationship between current account deficits and fiscal deficits and other macroeconomic variables. An early paper by Bernheim (1988) investigates the relationship between fiscal deficits and trade deficits for the US and several of its major trading partners (Canada, UK, West Germany, Mexico and Japan) for the period 1960-1984. The growth of real GDP is also included to control for the effects of the business cycle. The results show that the fiscal deficit does significantly affect the trade deficit, suggesting the validity of the twin deficit hypothesis for the US. The twin deficit relationship also holds true for all the other nations in the study except for Japan.

Kim and Roubini (2008) examine the impact of fiscal policy on the current account and real exchange rate of the US for the period 1973-2004 by considering a variable system containing budget deficit, current account deficit and real exchange rate employing Vector Autoregressive (VAR) method that allows dynamic interactions among the variables. The empirical results suggest twin divergence rather than twin deficits in the US data as the fiscal accounts worsen the current account improves and vice versa. Further, an expansionary fiscal policy shock (or a fiscal deficit shock) improves the current account and depreciates

the real exchange rate. The private saving rises and the investment falls contributing to the current account improvement while the nominal exchange rate depreciation is mainly responsible for the real exchange rate appreciation. They explain the twin divergence of fiscal deficit and current account balance by the prevalence of output shocks and cyclical fluctuations of output.

Normandin (1999) gauge the twin deficit hypothesis for the Canadian and US economies for the period 1950 to 1992 by examining the responses of the external deficit to changes in the fiscal deficit. The empirical results show that the responses are positively affected by the degree of persistence of the fiscal deficit, as well as by the birth rate, and the great persistence of the fiscal deficits yields numerically large and statistically positive responses.

Merza, Alawin and Bashayreh (2012) examine the twin deficit hypothesis for Kuwait for the period 1993-2010 using quarterly data and applying time-series tests and the VAR estimation method. The causality analysis shows that there is unidirectional causality that runs from current account balance to fiscal balance in the short run. However, in the long run, there is a significant negative relationship between the two deficits. Thus, the twin deficits hypothesis was rejected in the case of Kuwait. A similar study by Onafowora and Owoye (2006) observe a statistically significant short-run and long-run bidirectional relationship between the two deficits in Nigeria during the period 1970-2008. However, Mukhtar, Zakaria and Ahmed (2007) and Saeed and Khan (2012), investigate the twin deficit hypothesis in Pakistan using Granger-causality tests and claim the presence of twin deficits in Pakistan.

Lau and Baharumshah (2006) analyse the twin deficits hypothesis of SEACEN countries, including India, using a panel VAR framework covering the period 1957-1993. The results support the presence of unidirectional reverse causality from current account deficit to fiscal deficit with inflation, interest rate and exchange rate playing the role of interlinking variables.

Basu and Datta (2005) investigate the nature of the statistical relationship between fiscal and trade deficits in India both in levels as well as in percentage terms using quarterly data for the period 1985-2003. From the empirical results, there seems no long-run relationship exists between the two deficits either at their levels or at percentages and thus, no evidence in favour of the twin deficit phenomenon in India. The study by Mitra and Khan (2014) on the twin deficits hypothesis in India for the period 1994-95 to 2013-14 shows that the lagged values of CAB jointly predict the present value of FB statistically significantly and vice versa, Therefore, they conclude that there exists a bi-directional causality among the variables and the causality is positive. The impulse response function results further supported the prevalence of bidirectional causality between current account balance and fiscal balance and the causality is positive, supporting the twin deficit hypothesis in India. Suresh and Gautam (2015) consider the endogenously determined structural breaks in both unit root and cointegration tests to test the relevance of the twin deficit hypothesis in India for the period 1973-1974 to 2013-2014. While there is no evidence of a cointegrating

relationship i.e. no long term relationship between fiscal deficit and current account deficit, the Granger causality test indicates the presence of bi-directional causality between the FD and CAB. Therefore, they conclude that the twin deficit hypothesis is invalid in India.

As this brief review of empirical studies on the validity of the twin deficit hypothesis in various economic shows the twin deficit hypothesis turned out to be inconclusive for different countries and for different estimation techniques. Especially, the evidence in India is mixed and warrants further examination with improved estimation methods. Hence, this paper attempts to analyse the relevance of the twin deficit hypothesis on the relationship between fiscal deficit and current account deficit in India with interlinking variables interest rate and exchange rate, applying the structural vector autoregressive (SVAR) estimation method for the period first quarter of 1994 to the fourth quarter of 2016.

DATA AND METHODOLOGY

In the empirical analysis of the relationship between budget deficit and trade deficit in India, this paper uses quarterly data for the time period from 1994-I to 2016-IV. The variables considered are fiscal deficit (FD), current account balance (CAB), real effective exchange rate (REER) and real interest rate (RIR). Fiscal deficit is measured as the excess of government expenditure over revenue receipts and non-debt capital receipts. The current account balance is a measure of trade balance, the sum of exports and imports of goods and services, net factor income and net transfers that have taken place in a year. The real effective exchange rate is the weighted average of Indian currency in relation to an index of currencies of 36 countries. The real interest rate is the lending interest rate. The FD and CAB are expressed as a percentage of real gross domestic product (RGDP) where the RGDP is adjusted for cyclical fluctuations using the Hodrick-Prescott filter and REER and RIR are obtained after adjusting for inflation using the wholesale price index (WPI). Data for FD, CAB and REER have been obtained from the Reserve Bank of India Handbook of Statistics on Indian Economy and that of RIR has been obtained from the IMF International Financial Statistics. For the period quarter-I of 1994 to quarter-IV of 2016, there are 92 observations on FD, CAB, REER and RIR.

Before examining the relevance of the twin deficit hypothesis in India, the data is subjected to various time series diagnostics. The first test is the stationarity test and the Augmented Dickey-Fuller (ADF) test has been applied to the regression equation,

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \sum_{i=1}^m \alpha_i \Delta Y_{t-i} + \varepsilon_t \quad (5)$$

where Y_t is a variable at time t , $\hat{\alpha}_t$ is the disturbance term that is generated from a white noise process. The ADF test is to test for the null hypothesis that the series has a unit root ($\delta = 0$) meaning that the series is non-stationary against the alternative hypothesis of the series being stationary. If a unit root (non-stationarity) exists, then δ would not be statistically different from zero. If the p-value of the coefficient of Y_{t-1} is less than 0.05 at 5% level of significance, the null hypothesis is rejected indicating that the series is stationary.

If two-time series data are non-stationary, there is a possibility that the two variables may be cointegrated. In other words, the two variables may have a long term or equilibrium relationship between them and there may exist a linear combination of the two variables such that the error term is stationary. The existence of cointegration between the variables is tested on the null hypothesis H_0 : no cointegration ($r = 0$) against H_1 : presence of cointegration ($r > 0$) by the eigen value and trace statistics defined as,

$$\text{Trace statistic: Trace} = -T \sum \log(1 - \lambda_t^l) \quad t=r+1, \dots, p \quad (6)$$

$$\text{Maximum eigen value statistic: } \lambda_{max}(r, r + 1) = -T \log(1 - \lambda_{t+1}^l) \quad (7)$$

where $\lambda_{r+1}^l, \dots, \lambda_p^l$ are $(p-r)$ number of estimated eigen values. When the absolute value of the computed trace statistic and the computed eigen value statistic are greater than their respective critical values, then the null hypothesis is rejected and there may exist at least one cointegrating relation between the variables. Then, the cointegration test is to test the hypothesis, H_0 : presence of one cointegrating relation ($r=1$) against H_1 : presence of more than one cointegrating relation among the variables ($r>1$). Based on the value of the computed trace statistic and the eigen value, null hypothesis is either accepted or rejected.

The existence of corelationship between variables does not necessarily imply causation or the direction of influence. The Granger-causality test allows determining the short-run or forecasting direction of the relations between the variables. In the two-variable relations model, the Granger causality test postulates that y and z are affected by their own lags and the lags of the other variable,

$$y_t = \sum_{i=1}^n \alpha_i z_{t-i} + \sum_{j=1}^n \beta_j y_{t-j} + u_{1t} \quad (8)$$

$$z_t = \sum_{i=1}^n \gamma_i z_{t-i} + \sum_{j=1}^n \delta_j y_{t-j} + u_{2t} \quad (9)$$

There are two null hypotheses in the case of a two-variable system, H_0 : one variable does not granger cause the other against the alternative hypothesis (H_a): the variable granger causes the other. The coefficients α_i , β_j , γ_i and δ_j are jointly tested for their significance in order to determine the direction of causality.

Structural Vector Auto-Regressive (SVAR) Method

The Vector Auto-regression (VAR) model is used to estimate the relationship between a group of variables where there is no a priori distinction of variables as endogenous and exogenous variables. Instead, the VAR model treats all variables on an equal footing and symmetrically by including lags of each of the dependent variables in the model. The information criteria like Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC) are used to choose the appropriate lag length for the VAR model. A two-variable SVAR is given by,

$$y_t = b_{10} - b_{12}z_t + \gamma_{11}y_{t-1} + \gamma_{12}z_{t-1} + \varepsilon_{yt} \quad (10)$$

$$z_t = b_{20} - b_{21}y_t + \gamma_{21}y_{t-1} + \gamma_{22}z_{t-1} + \varepsilon_{zt} \tag{11}$$

where y_t and z_t are the current endogenous variables and y_{t-1} and z_{t-1} are the lags of y_t and z_t respectively and are predetermined. Assuming that y_t and z_t are stationary, ε_{y_t} and ε_{z_t} are white noise disturbances and are uncorrelated, equations (10) and (11) represent first-order SVAR with a lag length of one. Both y_t and z_t affect each other and the coefficients are: $-b_{12}$ is the contemporaneous effect of a unit change of z_t on y_t and γ_{11} and γ_{12} are the effect of a unit change in y_{t-1} and z_{t-1} respectively on y_t . Similarly, $-b_{21}$ is the contemporaneous effect of a unit change of y_t on z_t and γ_{21} and γ_{22} are the effect of a unit change in y_{t-1} and z_{t-1} respectively on z_t .

The matrix form of the S VAR equations can be written as,

$$\begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix} \begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{z_t} \end{bmatrix} \tag{12}$$

Or
$$\mathbf{B}\mathbf{x}_t = \mathbf{z}_0 + \mathbf{z}_1\mathbf{x}_{t-1} + \boldsymbol{\varepsilon}_t \tag{13}$$

where
$$\mathbf{B} = \begin{bmatrix} 1 & b_{12} \\ b_{21} & 1 \end{bmatrix}, \quad \mathbf{x}_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix}, \quad \mathbf{z}_0 = \begin{bmatrix} b_{10} \\ b_{20} \end{bmatrix},$$

$$\mathbf{z}_1 = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix}, \quad \mathbf{x}_{t-1} = \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix}, \quad \boldsymbol{\varepsilon}_t = \begin{bmatrix} \varepsilon_{y_t} \\ \varepsilon_{z_t} \end{bmatrix} \tag{14}$$

Pre-multiplying equation (13) by \mathbf{B}^{-1} ,

$$\mathbf{B}^{-1}\mathbf{B}\mathbf{x}_t = \mathbf{B}^{-1}\mathbf{z}_0 + \mathbf{B}^{-1}\mathbf{z}_1\mathbf{x}_{t-1} + \mathbf{B}^{-1}\boldsymbol{\varepsilon}_t \tag{15}$$

$$\mathbf{x}_t = \mathbf{A}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \mathbf{e}_t \tag{16}$$

where
$$\mathbf{A}_0 = \mathbf{B}^{-1}\mathbf{z}_0, \quad \mathbf{A}_1 = \mathbf{B}^{-1}\mathbf{z}_1, \quad \mathbf{e}_t = \mathbf{B}^{-1}\boldsymbol{\varepsilon}_t \tag{17}$$

and a_{i0} is element i of the vector \mathbf{A}_0 , a_{ij} is an element in row i and column j of matrix \mathbf{A}_1 and e_{it} is the element i of the vector \mathbf{e}_t . The equations in standard SVAR form are,

$$y_t = a_{10} + a_{11}y_{t-1} + a_{12}z_{t-1} + e_{1t} \tag{18}$$

$$z_t = a_{20} + a_{21}y_{t-1} + a_{22}z_{t-1} + e_{2t} \tag{19}$$

The resulting SVAR model in matrix notation, with p lag, is,

$$\mathbf{y}_t = \boldsymbol{\alpha}_0 + \mathbf{1}\mathbf{y}_{t-1} + \dots + \mathbf{p}\mathbf{y}_{t-p} + \mathbf{v}_t \tag{20}$$

where \mathbf{y}_t and its lagged values are vectors of endogenous variables \mathbf{v}_t is a vector of non-auto-correlated disturbances, and s are matrices of coefficients to be estimated.

The SVAR associated Impulse Response Function (IRF) defines the response of the

dependent variable in the VAR model to shocks in the error terms, that is, the IRF detects the impact of a one-time shock in one of the innovations (the impulse) on current and future values of the endogenous variables (the responses). The general form for the IRF is,

$$y_t = \alpha + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \dots + \theta_i \varepsilon_{t-i} \quad (21)$$

where y_t is a vector of the dependent variables, α is a vector of the constants, ε_t is a vector of innovations for all variables that have been included in the SVAR model, and θ_i is a vector of parameters that measure the reaction of the dependent variable to innovations in all variables included in the SVAR model.

EMPIRICAL ANALYSIS

The descriptive statistics of the variables used in the empirical relationship between fiscal deficit and current account balance along with their measures are presented in Table 1. The average fiscal deficit is 1.55% of RGDP and the mean current account balance is -1.29% of RGDP, indicating a deficit in CAB on an average. While the average REER is 90.001, the mean of RIR is 9.11%. The standard deviation of the variables shows the spread of the values, the fiscal deficit has the lowest standard deviation of 0.99 and the real effective exchange rate has the highest standard deviation of 6.72.

Table 1: Descriptive Statistics of Variables used in the Twin Deficit Hypothesis Analysis

<i>Variable</i>	<i>Description</i>	<i>Mean</i>
FD	Fiscal deficit (percent of RGDP)	1.5589 (0.997)
CAB	Current account balance (percent of RGDP)	-1.2931 (1.838)
REER	Real effective exchange rate	90.001 (6.721)
RIR	Real interest rate	9.1139 (2.778)

Note: Standard deviations are in parentheses.

In the first step of econometric analysis, the variables are tested for the presence of unit root at levels as well as at first difference using the Augmented Dickey-Fuller (ADF) unit root test. The null hypothesis states the presence of unit root that is, the series is non-stationary against the alternative hypothesis that the series is stationary. From Table 2 which shows the ADF unit root test, it can be observed that FD, RIR, REER and CAB are non-stationary at levels as their probability values exceed 0.05 leading to the acceptance of the null hypothesis that the series are non-stationary. However, they become stationary after taking the first difference and therefore are integrated into order 1, that is, the variables are I(1).

The Cointegration test is used to test the presence of a long term relationship between variables which are integrated of order 1. The null hypothesis is that there is no cointegration against the alternative hypothesis of cointegration between the variables. The result of the Johansen cointegration test presented in Table 3 shows that the p-values are high at the 5%

Table 2: Augmented Dickey Fuller (ADF) Unit Root Test

Variable	Description	At levels		At first difference	
		<i>t</i> -statistics	<i>p</i> -value	<i>t</i> -statistics	<i>p</i> -value
FD	Fiscal deficit	-2.3978	0.1453	-21.678	0.0001*
RIR	Real interest rate	-4.1758	0.2875	-9.459	0.0000*
REER	Real effective exchange rate	-1.9038	0.3293	-9.719	0.0000*
CAB	Current account balance	-2.5613	0.3744	-10.751	0.0000*

Note: * Rejection of null hypothesis of the presence of unit root at 5% significance level.

level of significance and the 0.05 critical values are greater than both the trace statistic and eigen value statistic indicating that there are no cointegrating equations between FD, RIR, REER and CAB. Therefore, the vector autoregression can be applied to examine the relationship among the variables in the model.

Table 3: Johansen Cointegration Test

Hypothesised no. of Cointegrating equations	Trace statistic	0.05 critical value	Probability	Maximum eigen statistic	0.05 critical value	probability
None	38.90	40.17	0.06	29.18	34.162	0.08
At most 1	9.72	24.27	0.87	4.976	17.80	0.96
At most 2	4.75	12.32	0.60	4.588	11.22	0.54
At most 3	0.16	4.13	0.74	0.158	4.13	0.74

Table 4 presents the optimal lag length in the VAR model selected using VAR lag order selection criteria. The optimal lag length is 4 as indicated by LR, FPE, AIC and HQIC criteria. This suggests that each variable is lagged by 4 periods and the equation for each endogenous variable is regressed on 4 lags of itself and other endogenous variables in the system.

Table 4: Lag Length Selection for VAR Estimation

Lag	Log L	LR	FPE	AIC	SIC	HQIC
0	-766.7995	NA	1097.583	18.3523	18.4681	18.3989
1	-646.3550	226.5503	91.3456	15.8656	16.4443	16.0982
2	-607.5589	69.2787	53.2301	15.3228	16.3646*	15.7416
3	-594.4610	22.1417	57.4232	15.3919	16.8967	15.9968
4	-554.9175	63.0813*	33.1991*	14.8313*	16.7991	15.6224*
5	-545.8359	13.6222	39.9603	14.9960	17.4269	15.9732
6	-528.7335	24.0248	40.1502	14.9698	17.8636	16.1331
7	-509.2533	25.5098	38.6207	14.8869	18.2438	16.2364
8	-491.2327	21.8821	39.0913	14.8388	18.6587	16.3744

Note: * Lag order selected by the criterion. LR: sequentially modified LR test statistic, FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQIC: Hannan-Quinn information criterion.

The structural VAR (SVAR) model accounting for the four variables along with their four lags are,

$$\begin{aligned} FD_t = & c_{10} - b_{12}RIR_t - b_{13}REER_t - b_{14}CAB_t + \beta_{11}FD_{t-1} + \beta_{12}RIR_{t-1} \\ & + \beta_{13}REER_{t-1} + \beta_{14}CAB_{t-1} + \gamma_{11}FD_{t-2} + \gamma_{12}RIR_{t-2} + \gamma_{13}REER_{t-2} \\ & + \gamma_{14}CAB_{t-2} + \alpha_{11}FD_{t-3} + \alpha_{12}RIR_{t-3} + \alpha_{13}REER_{t-3} + \alpha_{14}CAB_{t-3} \\ & + \delta_{11}FD_{t-4} + \delta_{12}RIR_{t-4} + \delta_{13}REER_{t-4} + \delta_{14}CAB_{t-4} + \varepsilon_{FD_t} \end{aligned}$$

$$\begin{aligned} RIR_t = & c_{20} - b_{21}FD_t - b_{23}REER_t - b_{24}CAB_t + \beta_{21}FD_{t-1} + \beta_{22}RIR_{t-1} \\ & + \beta_{23}REER_{t-1} + \beta_{24}CAB_{t-1} + \gamma_{21}FD_{t-2} + \gamma_{22}RIR_{t-2} + \gamma_{23}REER_{t-2} \\ & + \gamma_{24}CAB_{t-2} + \alpha_{21}FD_{t-3} + \alpha_{22}RIR_{t-3} + \alpha_{23}REER_{t-3} + \alpha_{24}CAB_{t-3} \\ & + \delta_{21}FD_{t-4} + \delta_{22}RIR_{t-4} + \delta_{23}REER_{t-4} + \delta_{24}CAB_{t-4} + \varepsilon_{RIR_t} \end{aligned}$$

$$\begin{aligned} REER_t = & c_{30} - b_{31}FD_t - b_{32}RIR_t - b_{34}CAB_t + \beta_{31}FD_{t-1} + \beta_{32}RIR_{t-1} \\ & + \beta_{33}REER_{t-1} + \beta_{34}CAB_{t-1} + \gamma_{31}FD_{t-2} + \gamma_{32}RIR_{t-2} + \gamma_{33}REER_{t-2} \\ & + \gamma_{34}CAB_{t-2} + \alpha_{31}FD_{t-3} + \alpha_{32}RIR_{t-3} + \alpha_{33}REER_{t-3} + \alpha_{34}CAB_{t-3} \\ & + \delta_{31}FD_{t-4} + \delta_{32}RIR_{t-4} + \delta_{33}REER_{t-4} + \delta_{34}CAB_{t-4} + \varepsilon_{REER_t} \end{aligned}$$

$$\begin{aligned} CAB_t = & c_{40} - b_{41}FD_t - b_{42}RIR_t - b_{43}REER_t + \beta_{41}FD_{t-1} + \beta_{42}RIR_{t-1} \\ & + \beta_{43}REER_{t-1} + \beta_{44}CAB_{t-1} + \gamma_{41}FD_{t-2} + \gamma_{42}RIR_{t-2} + \gamma_{43}REER_{t-2} \\ & + \gamma_{44}CAB_{t-2} + \alpha_{41}FD_{t-3} + \alpha_{42}RIR_{t-3} + \alpha_{43}REER_{t-3} + \alpha_{44}CAB_{t-3} \\ & + \delta_{41}FD_{t-4} + \delta_{42}RIR_{t-4} + \delta_{43}REER_{t-4} + \delta_{44}CAB_{t-4} + \varepsilon_{CAB_t} \end{aligned}$$

In matrix form,

$$\begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} \\ b_{21} & 1 & b_{23} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \begin{bmatrix} FD_t \\ RIR_t \\ REER_t \\ CAB_t \end{bmatrix} = \begin{bmatrix} c_{10} \\ c_{20} \\ c_{30} \\ c_{40} \end{bmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{bmatrix} \begin{bmatrix} FD_{t-1} \\ RIR_{t-1} \\ REER_{t-1} \\ CAB_{t-1} \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \gamma_{24} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} & \gamma_{34} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & \gamma_{44} \end{bmatrix} \begin{bmatrix} FD_{t-2} \\ RIR_{t-2} \\ REER_{t-2} \\ CAB_{t-2} \end{bmatrix} + \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} \end{bmatrix} \begin{bmatrix} FD_{t-3} \\ RIR_{t-3} \\ REER_{t-3} \\ CAB_{t-3} \end{bmatrix} + \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14} \\ \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24} \\ \delta_{31} & \delta_{32} & \delta_{33} & \delta_{34} \\ \delta_{41} & \delta_{42} & \delta_{43} & \delta_{44} \end{bmatrix} \begin{bmatrix} FD_{t-4} \\ RIR_{t-4} \\ REER_{t-4} \\ CAB_{t-4} \end{bmatrix} + \begin{bmatrix} \varepsilon_{FD_t} \\ \varepsilon_{RIR_t} \\ \varepsilon_{REER_t} \\ \varepsilon_{CAB_t} \end{bmatrix} \quad 2$$

where the ordering of the variables is: fiscal deficit, real interest rate, real effective exchange rate and current account balance. That is,

$$BX_t = z_0 + z_1X_{t-1} + z_2X_{t-2} + z_3X_{t-3} + z_4X_{t-4} + \varepsilon_t \quad (22)$$

where,

$$\mathbf{B} = \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} \\ b_{21} & 1 & b_{23} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \mathbf{X}_t = \begin{bmatrix} FD_t \\ RIR_t \\ REER_t \\ CAB_t \end{bmatrix} \mathbf{z}_0 = \begin{bmatrix} c_{10} \\ c_{20} \\ c_{30} \\ c_{40} \end{bmatrix} \mathbf{z}_1 = \begin{bmatrix} \beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} \\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} \\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} \\ \beta_{41} & \beta_{42} & \beta_{43} & \beta_{44} \end{bmatrix} \\
\mathbf{z}_2 = \begin{bmatrix} \gamma_{11} & \gamma_{12} & \gamma_{13} & \gamma_{14} \\ \gamma_{21} & \gamma_{22} & \gamma_{23} & \gamma_{24} \\ \gamma_{31} & \gamma_{32} & \gamma_{33} & \gamma_{34} \\ \gamma_{41} & \gamma_{42} & \gamma_{43} & \gamma_{44} \end{bmatrix} \mathbf{z}_3 = \begin{bmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{24} \\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{34} \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{44} \end{bmatrix} \\
\mathbf{z}_4 = \begin{bmatrix} \delta_{11} & \delta_{12} & \delta_{13} & \delta_{14} \\ \delta_{21} & \delta_{22} & \delta_{23} & \delta_{24} \\ \delta_{31} & \delta_{32} & \delta_{33} & \delta_{34} \\ \delta_{41} & \delta_{42} & \delta_{43} & \delta_{44} \end{bmatrix} \boldsymbol{\varepsilon}_t = \begin{bmatrix} \varepsilon_{FD_t} \\ \varepsilon_{RIR_t} \\ \varepsilon_{REER_t} \\ \varepsilon_{CAB_t} \end{bmatrix}$$

The VAR in standard form is given by,

$$\mathbf{X}_t = \mathbf{A}_0 + \mathbf{A}_1 \mathbf{X}_{t-1} + \mathbf{A}_2 \mathbf{X}_{t-2} + \mathbf{A}_3 \mathbf{X}_{t-3} + \mathbf{A}_4 \mathbf{X}_{t-4} + \mathbf{e}_t \quad (23)$$

where

$$\mathbf{A}_0 = \mathbf{B}^{-1} \mathbf{z}_0, \mathbf{A}_1 = \mathbf{B}^{-1} \mathbf{z}_1, \mathbf{A}_2 = \mathbf{B}^{-1} \mathbf{z}_2, \mathbf{A}_3 = \mathbf{B}^{-1} \mathbf{z}_3, \mathbf{A}_4 = \mathbf{B}^{-1} \mathbf{z}_4, \mathbf{e}_t = \mathbf{B}^{-1} \boldsymbol{\varepsilon}_t \quad (24)$$

The standard form of the equations of VAR which are to be estimated is,

$$\begin{aligned}
FD_t &= c_{10} + \omega_{11} FD_{t-1} + \omega_{12} RIR_{t-1} + \omega_{13} REER_{t-1} + \omega_{14} CAB_{t-1} + \varphi_{11} FD_{t-2} \\
&\quad + \varphi_{12} RIR_{t-2} + \varphi_{13} REER_{t-2} + \varphi_{14} CAB_{t-2} + \theta_{11} FD_{t-3} + \theta_{12} RIR_{t-3} \\
&\quad + \theta_{13} REER_{t-3} + \theta_{14} CAB_{t-3} + \rho_{11} FD_{t-4} + \rho_{12} RIR_{t-4} + \rho_{13} REER_{t-4} \\
&\quad + \rho_{14} CAB_{t-4} + e_{1t} \\
RIR_t &= c_{20} + \omega_{21} FD_{t-1} + \omega_{22} RIR_{t-1} + \omega_{23} REER_{t-1} + \omega_{24} CAB_{t-1} + \varphi_{21} FD_{t-2} \\
&\quad + \varphi_{22} RIR_{t-2} + \varphi_{23} REER_{t-2} + \varphi_{24} CAB_{t-2} + \theta_{21} FD_{t-3} + \theta_{22} RIR_{t-3} \\
&\quad + \theta_{23} REER_{t-3} + \theta_{24} CAB_{t-3} + \rho_{21} FD_{t-4} + \rho_{22} RIR_{t-4} + \rho_{23} REER_{t-4} \\
&\quad + \rho_{24} CAB_{t-4} + e_{2t} \\
REER_t &= c_{30} + \omega_{31} FD_{t-1} + \omega_{32} RIR_{t-1} + \omega_{33} REER_{t-1} + \omega_{34} CAB_{t-1} + \varphi_{31} FD_{t-2} \\
&\quad + \varphi_{32} RIR_{t-2} + \varphi_{33} REER_{t-2} + \varphi_{34} CAB_{t-2} + \theta_{31} FD_{t-3} + \theta_{32} RIR_{t-3} \\
&\quad + \theta_{33} REER_{t-3} + \theta_{34} CAB_{t-3} + \rho_{31} FD_{t-4} + \rho_{32} RIR_{t-4} + \rho_{33} REER_{t-4} \\
&\quad + \rho_{34} CAB_{t-4} + e_{3t} \\
CAB_t &= c_{40} + \omega_{41} FD_{t-1} + \omega_{42} RIR_{t-1} + \omega_{43} REER_{t-1} + \omega_{44} CAB_{t-1} + \varphi_{41} FD_{t-2} \\
&\quad + \varphi_{42} RIR_{t-2} + \varphi_{43} REER_{t-2} + \varphi_{44} CAB_{t-2} + \theta_{41} FD_{t-3} + \theta_{42} RIR_{t-3} \\
&\quad + \theta_{43} REER_{t-3} + \theta_{44} CAB_{t-3} + \rho_{41} FD_{t-4} + \rho_{42} RIR_{t-4} + \rho_{43} REER_{t-4} \\
&\quad + \rho_{44} CAB_{t-4} + e_{4t}
\end{aligned}$$

In these equations, ω 's are the coefficients of the variables lagged by one year, φ ' are the coefficients of the variables lagged by two years, θ 's are the coefficients of the variables lagged by three years and ρ 's are the coefficients of the variables lagged by four years. The VAR estimates of the coefficients of the equations are presented in Table 5.

Table 5: VAR Estimates of the Parameters of FD, RIR, REER and CAB

<i>Parameter</i>	<i>FD</i>	<i>RIR</i>	<i>REER</i>	<i>CAB</i>
ω_{j1}	-0.1701***(1.84)	-0.0586(0.22)	0.8662***(1.87)	-0.3743**(1.98)
ϕ_{j1}	-0.2681*(2.88)	0.0007(0.00)	0.7459(1.61)	-0.3387***(1.78)
θ_{j1}	-0.1952**(2.33)	-0.1543(0.63)	-0.0595(0.14)	-0.1513(0.88)
ρ_{j1}	0.5312*(6.43)	0.1008(0.42)	1.1229*(2.73)	0.0307(0.18)
ω_{j2}	-0.0683(1.52)	0.434*(3.30)	0.2811(1.25)	0.0014(0.02)
ϕ_{j2}	0.0498(1.05)	0.2848**(2.05)	-0.3348(1.41)	-0.1185(1.22)
θ_{j2}	0.0831***(1.78)	0.0592(0.43)	-0.3214(1.38)	-0.0039(0.04)
ρ_{j2}	0.0277(0.67)	0.0560(0.46)	-0.0649(0.31)	0.2361*(2.77)
ω_{j3}	0.0141(0.57)	-0.2774*(3.79)	0.7917*(6.37)	0.0070(0.14)
ϕ_{j3}	-0.0132(0.36)	0.3209*(2.98)	0.2454(1.34)	-0.0231(0.31)
θ_{j3}	-0.0376(0.97)	-0.0211(0.18)	-0.1694(0.87)	-0.0047(0.06)
ρ_{j3}	0.0734*(2.60)	-0.0385(0.47)	-0.1104(0.78)	0.0285(0.49)
ω_{j4}	-0.1303**(2.43)	-0.0445(0.28)	0.1545(0.58)	0.5330*(4.85)
ϕ_{j4}	-0.0386(0.61)	0.1165(0.62)	0.2047(0.67)	0.0108(0.08)
θ_{j4}	-0.0356(0.57)	-0.1639(0.87)	-0.0842(0.26)	-0.1117(0.85)
ρ_{j4}	0.0551(1.00)	-0.0072(0.04)	-0.2163(0.79)	0.2517**(2.24)
c_{j0}	-2.6191***(1.94)	2.9340(0.74)	21.7918*(3.23)	-0.8564(0.31)
R-square	0.8709	0.8503	0.9345	0.9220
Adjusted R-square	0.7967	0.7715	0.8972	0.8368
S.E. of regression	0.6195	1.8138	3.0893	1.2683
Sum squared residual	27.2551	233.5922	677.6511	114.2260
Log likelihood	-73.2944	-167.8212	-214.6836	-136.3437
F-statistic	9.0479	8.2529	22.3761	7.3022
Prob. (F-statistic)	0.0000	0.0000	0.0000	0.0000
Mean of dependent variable	1.5347	8.9860	89.9105	-1.3280
Std.dev. of dependent variable	0.9757	2.7710	6.8604	1.8637
AIC	2.0521	4.2004	5.2655	3.4850
SIC	2.5307	4.6790	5.7441	3.9636
HQIC	2.2449	4.3932	5.4583	3.6778
Durbin-Watson statistic	1.9323	2.0402	2.0536	2.0154

Note: Absolute t-values in parentheses. j denotes variables FD, RIR, REER and CAB. Time lags are denoted as 1,2,3,4, and constant is denoted as c_{j0} . *, **, *** Significant at 1, 5, 10% levels.

The results of the VAR estimates show that fiscal deficit is significantly influenced by its own lags. The first and third lags of real interest rate and the fourth lag of real effective exchange rate have a significant impact on FD at 5% level of significance. However, only the first lag of CAB is affecting FD and the other lags do not have any significant effect on FD. The first and third lag of FD is significantly affecting RIR at 5% level of significance. The first two lags of RIR, CAB and REER have a statistically significant impact on RIR

and CAB does not have any significant impact on RIR at 5% level of significance. While only the first and fourth lags of FD significantly affect the real effective exchange rate, the first 3 lags of RIR have a significant impact on REER. Except for the third lag, all the other lags of REER are affecting REER significantly and CAB has no impact on REER. While RIR has no impact on CAB at 5% level of significance, the first two lags of FD and the first, second and fourth lags of REER are significantly impacting CAB. Also, CAB is significantly affected by its own lags in the first, second and fourth years.

Though the coefficients of the variables in the VAR model are estimated, it is important for the sequences of the variables to be stationary which holds true only if the stability condition of VAR is satisfied. Also, it is important to examine the stability of the model as it will indicate if the impact of the shocks in one variable on the other will die out or explode over the period. The stability condition of VAR requires that the characteristic roots of the polynomial lie outside the unit circle. From Figure 2 it is observed that the inverse roots of the AR characteristic polynomial lie inside the unit circle. Hence, the VAR model is stable and the sequences of FD, RIR, REER and CAB have a finite and time-invariant mean and variance.

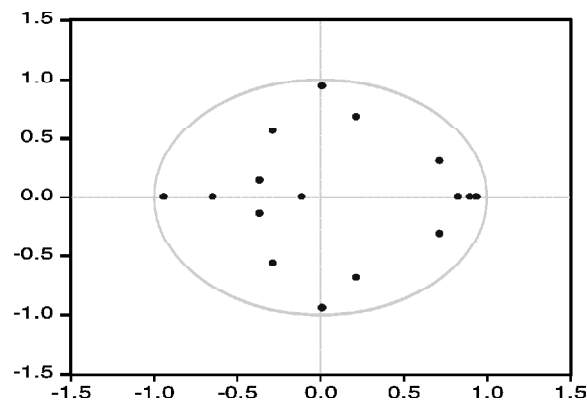


Figure 2: Stability of VAR Model

Further, the residuals obtained by estimating the equations in a VAR model are required to be tested for autocorrelation and heteroscedasticity as these may affect the efficiency of the estimated coefficients. The coefficients are efficient if the residuals are homoscedastic and serially uncorrelated. The variances of the residuals are tested for heteroscedasticity using White’s heteroscedasticity under VAR residual heteroscedasticity test. The null hypothesis is that there is no heteroscedasticity against the alternative hypothesis of heteroscedasticity of the residuals. The residual test is presented in Table 6. The estimated results show that the residuals are homoscedastic. The null hypothesis of no heteroscedasticity is accepted at 5% level of significance as the p-value is 0.2 which is higher than 0.05. Also, the individual probabilities are greater than 0.05 leading to the

acceptance of the null hypothesis and thereby supporting the homoscedasticity of the residuals. The residuals obtained from VAR are tested for serial correlation.

Table 6: VAR Residual Heteroscedasticity Test

<i>Chi-square</i> 439.7370		<i>df</i> 320	<i>Probability</i> 0.2000		
<i>Residual</i>	<i>R-square</i>	<i>F(32,55)</i>	<i>Probability</i>	<i>Chi-sq(32)</i>	<i>Probability</i>
res1*res1	0.3595	0.9648	0.5339	31.6396	0.4847
res2*res2	0.6314	2.9445	0.2002	55.5656	0.2060
res3*res3	0.4361	1.3295	0.1740	38.3826	0.2026
res4*res4	0.5678	2.2584	0.2039	49.9709	0.1224
res2*res1	0.5341	1.9708	0.1133	47.0069	0.1423
res3*res1	0.4298	1.2956	0.1963	37.8238	0.2206
res3*res2	0.6772	3.6061	0.3000	59.5959	0.1022
res4*res1	0.5043	1.7486	0.2338	44.3788	0.1715
res4*res2	0.6117	2.7082	0.1006	53.8345	0.2092
res4*res3	0.4190	1.2396	0.2380	36.8745	0.2536

Note: * Significant at 5% level.

Table 7 presents the results of the VAR residual serial correlation LM test. At all the four lags, the p-values exceed 0.05 at 5% significance level leading to the acceptance of the null hypothesis that the residuals are serially uncorrelated. Thus, the residuals are serially uncorrelated and homoscedastic and therefore the estimates of the VAR model are efficient. Therefore, the estimates of the Structural VAR (SVAR) coefficients can be obtained by placing appropriate restrictions.

Table 7: VAR Residual Serial Correlation LM Test

<i>Lags</i>	<i>LM-statistics</i>	<i>Probability</i>
1	12.47449	0.7107
2	22.84126	0.1180
3	14.60267	0.5539
4	11.66858	0.7665

Note: * Significant at 5% level.

The estimated coefficients of the VAR method report only the effects of the lags of other endogenous variables in the system for each of the endogenous variables. However, the current period effects of one variable on the other endogenous variables are not obtained in the VAR model. This necessitates the estimation of SVAR coefficients as they estimate current period impact also. The coefficients of the structural VAR model can be estimated

by placing restrictions based on the theory of the twin deficit hypothesis. The matrix of structural coefficients is given by,

$$\mathbf{B} = \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} \\ b_{21} & 1 & b_{23} & b_{24} \\ b_{31} & b_{32} & 1 & b_{34} \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \tag{25}$$

In the matrix **B**, the b_{ij} is an element where *i* indicate the response variable and *j* includes the other endogenous variables in the system. The ordering of the variables is: fiscal deficit, real interest rate, real effective exchange rate and current account balance.

According to the twin deficit hypothesis, a deficit in fiscal balance leads to a deficit in the current account balance. According to the Mundell-Fleming model, this impact takes place through the RIR and REER. An increase in FD increases the domestic interest rate which leads to the appreciation of REER. This further leads to a deficit in the CAB. Therefore, these can be imposed as restrictions and the restricted matrix **B** is given as,

$$\mathbf{B} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 \\ b_{41} & b_{42} & b_{43} & 1 \end{bmatrix} \tag{26}$$

With these restrictions, the estimated SVAR coefficients of matrix **B** are presented in Table 8.

Table 8: SVAR Estimates of the Twin Deficit Hypothesis

Parameter	Coefficient	Std. error	z-statistics	Probability
b_{21}	0.9818	0.10660	9.2108	0.0000*
b_{31}	-0.3958	0.14939	-2.6499	0.0080*
b_{32}	0.71603	0.10660	-6.7170	0.0000*
b_{41}	-0.10004	0.15524	-0.6444	0.0193*
b_{42}	0.06459	0.13111	0.4926	0.0223*
b_{43}	-0.8674	0.10660	-0.0813	0.0351*

Note: * Significant at 5% level.

All the SVAR coefficients are significant at 5% level of significance. On average, the RIR increases by 9.8% for a 1% increase in the fiscal deficit (b_{21}). The rise in RIR by 1% leads to a 7.1% appreciation in the real exchange rate (indicated by b_{32}). While fiscal deficit directly affects CAB such that, a percentage change in FD leads to a 1% rise in the current account deficit (b_{41}), the REER appreciation (due to a rise in RIR caused by an increase in FD) by a unit increases the current account deficit by 8.6% (b_{43}).

The VAR results are augmented by the impulse response function (IRF) and the forecast error variance decomposition (FEVD). The IRF shows the persistence of the impact of a unit shock in one variable on the other variables in the system and FEVD shows the variation in the errors of a variable due to its own shocks and the shocks to other variables. The IRFs generate the effects of shocks to the \hat{a} 's on the entire time paths of the variables contained in the VAR system. In Figure 3, the IRFs are shown for a period of 8 quarters.

In Figure 3, the diagonal graphs show the response of a variable to its own shock by one standard deviation. The off-diagonal graphs show the response of a variable to shock

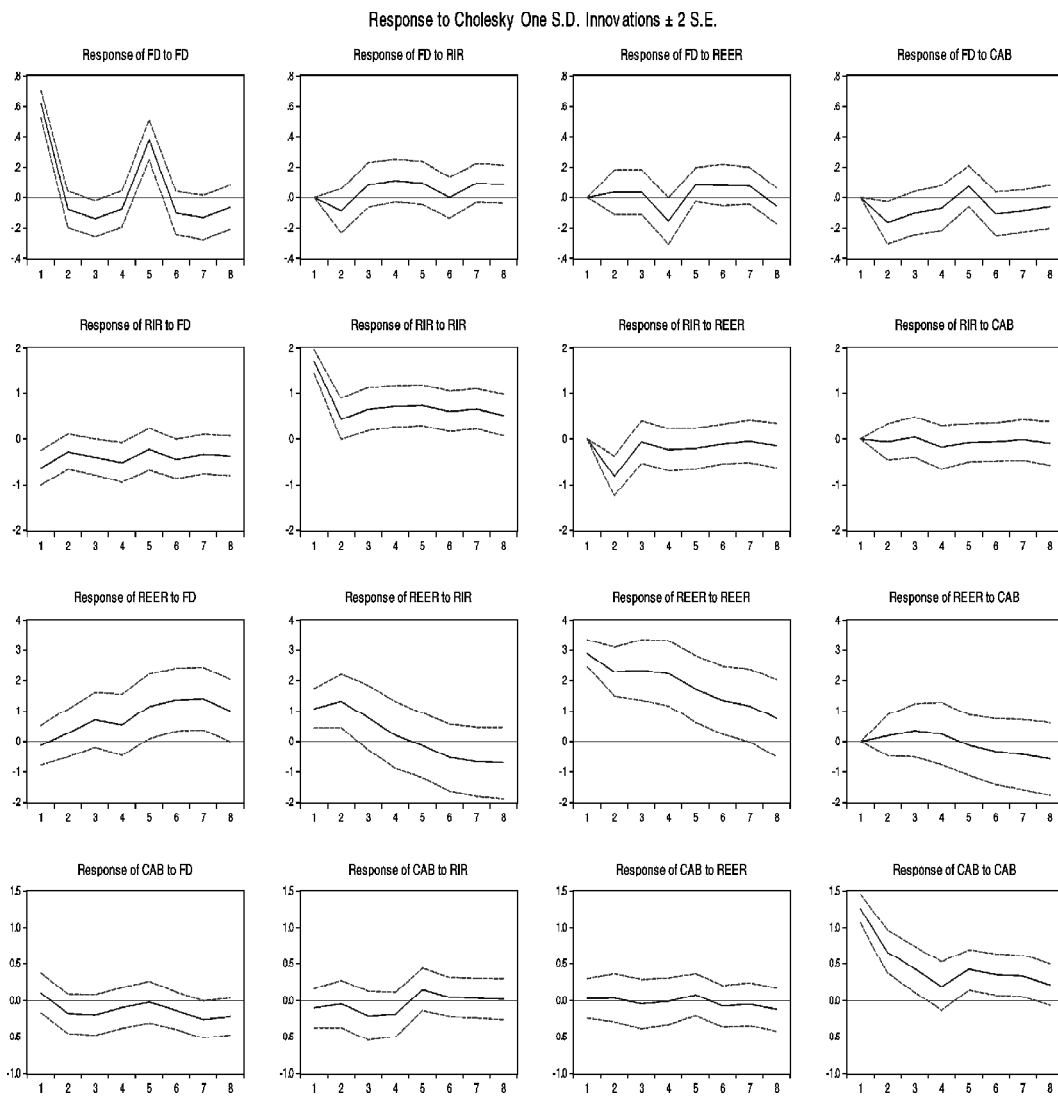


Figure 3: Impulse Response Functions

in other variables in the system by one standard deviation. The shortfalls in collections of indirect taxes due to sluggish growth in industrial production and imports are captured by the shocks to FD. A shock to fiscal deficit leads to a decline in fiscal deficit till the second quarter. However, it increases from the third quarter to the fifth quarter and starts declining thereafter. While both RIR and CAB decline initially and then become stable in response to their own shocks, a shock to REER leads to a continuous decline in itself till the 8th quarter. RIR follows a cyclical pattern in response to shocks in FD and does not respond to shocks in the current account balance. Also, REER is on an increasing trend over the 8 quarters to shocks in FD and is decreasing to shocks in RIR. However, when there are shocks in the real effective exchange rate, the current account balance is on the zero line till the 5th quarter indicating that there is no response. It increases slightly and then starts falling from the sixth quarter and becomes negative over time.

Table 9 presents the variance decomposition of the fiscal deficit over 10 quarters. In the first quarter, 100% of the variation in FD is due to its own shocks. Over the period that is in the 5th quarter, the variation in FD due to its own shocks reduces to 83.2% and 7% variation is explained by shocks to CAB. In the tenth quarter, around 9% of fluctuations in FD are caused by shocks to CAB and 14% variation is caused by shocks to RIR and REER each contributing to around 7% fluctuation in FD. About 88% of the variation in RIR is due to its own shocks and the remaining 12% is divided between FD and CAB in the first quarter. However, in the tenth quarter, REER causes 8.5% fluctuations in RIR and variations in RIR due to shocks in FD, itself and CAB are 14%, 72% and 5% respectively. Around 82% and 17% of the fluctuations in REER are due to its own shocks and shocks in RIR respectively and FD and CAB do not lead to any significant variation in the first quarter. By the tenth quarter, variation in REER due to shocks in FD and CAB has increased to 12% and 1.5% respectively. The fluctuation in REER caused by its own shocks has declined to 64% over the quarters. Almost 100% of the variation in CAB is due to its own shocks in the first quarter. This has fallen to 87% in the 10th quarter. The contribution of shocks to RIR and REER to fluctuations in CAB has risen from zero percent in the first quarter to 3.6% and 1.05% respectively in the tenth quarter and shocks in FD cause 8% fluctuations in CAB in the same period.

Table 9: Variance Decomposition of FD, RIR, REER and CAB

<i>Variable</i>	<i>Period</i>	<i>Std. error</i>	<i>FD</i>	<i>RIR</i>	<i>REER</i>	<i>CAB</i>
FD	1	0.6227	100.000	0.0000	0.0000	0.0000
	2	0.6536	92.2224	1.9848	0.1687	5.6236
	3	0.6830	88.8220	3.3227	0.2785	7.5766
	4	0.7150	82.1644	5.0738	4.6026	8.1589
	5	0.8198	83.1557	5.2072	4.6395	6.9974
	6	0.8357	81.6871	5.0109	5.1667	8.1350

contd. table 9

<i>Variable</i>	<i>Period</i>	<i>Std. error</i>	<i>FD</i>	<i>RIR</i>	<i>REER</i>	<i>CAB</i>
RIR	7	0.8602	79.5823	6.1689	5.4297	8.8189
	8	0.8721	78.0423	6.9346	5.5528	9.4701
	9	0.9357	78.1198	7.2084	6.0237	8.6479
	10	0.9415	77.4515	7.1264	6.3525	9.0695
	1	2.9528	11.3956	88.062	0.0000	0.5419
	2	3.8514	11.1910	76.4192	11.5922	0.7968
	3	4.4488	13.3140	75.4010	10.5505	0.7343
	4	4.7750	15.5907	73.2240	9.2715	1.9137
	5	4.9384	14.6048	74.3641	8.4951	2.5358
	6	5.0471	15.3466	73.1345	8.3060	3.2127
REER	7	5.1218	14.8603	73.4098	8.3248	3.4049
	8	5.1394	14.7733	73.0725	8.1443	4.0097
	9	5.1592	14.5193	72.7702	8.4691	4.2413
	10	5.1709	14.3411	72.2590	8.4874	4.9123
	1	1.2766	0.4196	17.0986	82.4569	0.0247
	2	1.4581	0.7069	27.6507	71.3961	0.2460
	3	1.5508	2.5194	27.1576	69.3481	0.9747
	4	1.5787	2.7511	25.0967	70.7284	1.4235
	5	1.6474	5.8296	23.7998	68.8713	1.4991
	6	1.6980	9.1591	22.8203	66.5727	1.4477
CAB	7	1.7541	11.5071	22.3010	64.7857	1.4058
	8	1.7862	11.7631	22.2591	64.4996	1.4777
	9	1.8061	12.1132	22.1000	64.2852	1.5013
	10	1.8218	12.2462	22.0003	64.2075	1.5459
	1	1.8114	0.6152	0.0000	0.0000	99.3842
	2	1.9875	2.0065	0.0159	0.0020	97.9751
	3	2.1043	3.4474	1.2098	0.1760	95.1667
	4	2.2571	3.7886	2.3658	0.1880	93.6574
	5	2.3585	3.5091	3.5638	0.2560	92.6709
	6	2.4445	4.0398	3.5856	0.5597	91.8145
7	2.5208	6.2406	3.4742	0.6148	89.6702	
8	2.5646	7.6754	3.3752	0.9745	87.9747	
9	2.5953	7.5365	3.5885	1.0352	87.8396	
10	2.6148	7.9946	3.6354	1.0585	87.3113	

Table 10 presents the results of the Granger causality test at lag length 4. The null hypothesis under the test is that the variable under consideration does not Granger cause the other variable against the alternative hypothesis that the variable Granger cause the other variable. The FD Granger causes all the other variables RIR, REER and CAB. The null hypothesis that FD does not Granger cause RIR, REER and CAB are rejected as the p-

values are less than 0.05 at 5% level of significance. The real interest rate (RIR) also causes REER and CAB through its impact on capital inflows. Also, the null hypothesis that REER does not Granger cause CAB is rejected at 5% level. This result is obvious as the change in exchange rate affects the imports and exports which is one of the principal components of CAB. However, the CAB does not Granger cause any of the variables in the system as the p-values indicate. Therefore, from the SVAR, IRF and Granger causality analyses, it can be inferred that the fiscal deficit affects the current account balance in India through the interlinking variables RIR and REER for the time period 1994 (quarter-I) to 2016 (quarter-IV) validating the relevance of twin deficit hypothesis in the Indian economy.

Table 10: Pairwise Granger Causality Test of Twin Hypothesis

<i>Null hypothesis</i>	<i>F-Statistics</i>	<i>Probability</i>
REER does not Granger cause FD	1.35427	0.2575
FD does not Granger cause REER	2.42824	0.0447
RIR does not Granger cause FD	1.47310	0.2184
FD does not Granger cause RIR	1.01460	0.0451
CAB does not Granger cause FD	0.47526	0.7538
FD does not Granger cause CAB	4.24717	0.0037
RIR does not Granger cause REER	1.29642	0.0188
REER does not Granger cause RIR	4.92751	0.1014
CAB does not Granger cause REER	2.55451	0.1454
REER does not Granger cause CAB	1.71920	0.0442
CAB does not Granger cause RIR	3.24180	0.2163
RIR does not Granger cause CAB	1.94639	0.0111
Sample: 1994Q1 2016Q4	Lags 4	No. of obs.: 88

CONCLUSION

The causal relationship between fiscal deficit (FD) and current account balance (CAB) has been referred to as the twin deficit hypothesis and both the theoretical explanations and the empirical evidence have been controversial. This paper examines the relevance of the twin deficit hypothesis in India for the period 1994 to 2016 by including the interlinking variable interest rate (RIR) and exchange rate (REER). Treating these variables as endogenous, the Structural Vector Autoregressive (SVAR) model has been estimated. The empirical results of this paper lend support to the existence of a causal relationship between budget deficit and trade deficit in India during 1994 to 2016. The SVAR coefficients show a negative impact implying that a positive shock given to FD worsens the CAB. The current account deficit, while not directly determined by fiscal deficit, is significantly influenced by RIR and REER. The IRF indicates that a positive shock to FD leads to an increase in the domestic interest rate. This appreciates the real exchange rate of the domestic currency which makes the exports costlier and imports cheaper and thereby widening the current account deficit.

The expansionary fiscal policy of the Indian government leads to a rise in government expenditure inducing the fiscal balance to run in deficit. This rise in government expenditure leads to an increase in RIR inducing the exchange rate of the economy (rupees) to appreciate. With the appreciation of the rupee, the import of foreign goods and services rises such that the trade balance runs into deficit. This trade deficit leads to a current account deficit in the Indian economy. Hence, there is unidirectional causality from fiscal deficit to current account deficit. Therefore, policy changes in the internal sector of the economy affect the external sector in India. Thus, the results of this paper are consistent with the Keynesian proposition and validate the twin deficit hypothesis in the Indian economy during the period 1994 to 2016.

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