Verification of Causality through VAR and Intervention Analysis: Econometric Modeling on Budget Deficit and Trade Deficit in Nepal

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Direction of causality between budget deficit and trade deficit, which is popularly known as Twin Deficit Hypothesis (TDH), has been tested in this paper covering the period 1964-2004. Stationarity, co-integration, and error correction tests have been performed as fundamental groundwork on real-term datasets. Datasets are found to be stationary at first difference. Long-run relationship (co-integration) among model variables is found at first difference. Long-run stability has been supported since short-run dynamics indicated converging pattern. Residual tests and conventional Granger Causality tests suggested trade deficit has been Granger Caused by the budget deficit. This initial gesticulation has further been reinforced by the vector autoregressive (VAR) modeling and intervention analysis (impulse response function and variance decomposition) also as it has reconfirmed unidirectional causality from budget deficit to trade deficit indicating need of a policy revisit regarding efficient public expenditure management, export-led growth and strategic capital formation with the help of revised fiscal, monetary and financial policies in the present globalization context.

I. INTRODUCTION

Budget Deficit and Trade Deficit in Nepal

Trade deficit has never shown positive sign indicating absence of trade surplus over the past forty-one years. Budget deficit has also registered positive balances only in selected years such as in 1965, 1968, 1969, and 1970. The graphical representation in Figure 1 suggests that both the trade deficit (TD_t) and budget deficit (BD_t) balances (in real terms) in Nepal for 1964-2004 are in an increasing trend with frequent upswings and downswings during these periods. These movements of the TD_t and BD_t in the defined periods are the motivations to examine the twin deficit hypothesis (TDH) which has been

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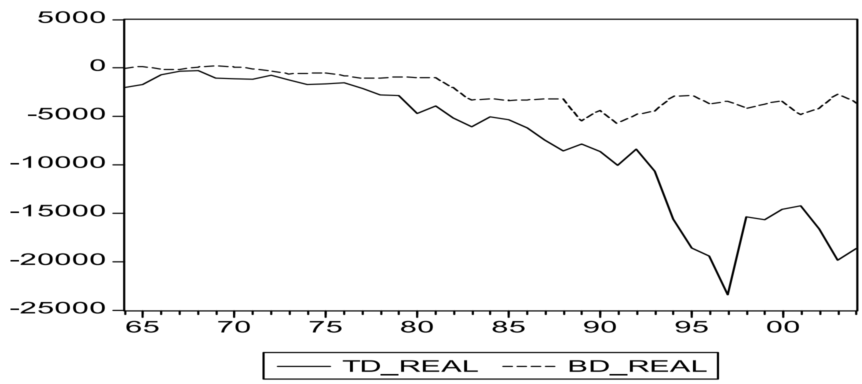
widely tested for the other countries, but not yet in the Nepalese context by applying contemporary time series econometric tools. Superimposed time plots of the TD_t and BD_t have been presented in Figure 1 below.

FIGURE 1 : Time Plots of Real Trade Deficits and Budget Deficits (1964-2004)



Objectives and Hypothesis

The twin deficits would demonstrate multiple linkages to the macroeconomic variables and they may produce substantial effects on the economy. In fact, they have a blending feature of national and international relation reflected through their oscillations forcing the economy forward (or backward) accordingly. Considering their importance in the economy, the following are the specific objectives of this study:

(i) To explore the causal relationship between trade deficit and budget deficit in Nepal through Granger Causality test method.

(ii) To reconfirm the causality through VAR modeling and intervention analysis (impulse response function and variance decomposition).

With these objectives, this paper is primarily concerned with verifying the causal relationship between budget deficits and trade deficits postulating the following hypotheses:

(i) The budget deficit causes the trade deficit in Nepal i.e. twin deficit hypothesis (Null Hypothesis), against

(ii) The budget deficit does not cause the trade deficit in Nepal (Alternative Hypothesis).

Literature Synthesis

This section discusses the causal relationship between budget deficit (domestic) and trade deficit (external). More specifically, the hypothesis indicates that government deficit would force trade deficit to move either way depending upon the direction of its change. How the budget deficit implicates the trade deficit is inherent to the interactions among different concerned macroeconomic variables depending upon the market movements and policy measures taken by the country. There are basically four types of possible transmission mechanism:

(i) The first one is the Mundel Fleming perspective. Any increase in budget deficit would cause an upswing of interest rate with a net result of capital inflow and current account deficit. However, it is determined with the situation of capital account convertibility, openness of the economy, and response of the economic agents. In Nepal, this transmission channel would be less effective since capital account is regulated and the economy is not fully opened.

(ii) The second transmission mechanism pertains to the Keynesian absorption theory. This proposition tells that any increase in budget deficit would result in increase in trade deficit through high volume of import. This mechanism is called 'domestic absorption'. This is a second choice of the economy to accommodate rising aggregate demand created through the liberal government expenditure. In Nepal, this diffusion conduit would be more operative because of the prevalence of structural rigidity in production, open border with China and India, high degree of marginal propensity to consume (MPC), high volume of consumption and capital expenditure.

(iii) The third one is the combined effect. With a simple intuition from point (i) and (ii), combined effect would be observed through capital inflow and domestic absorption. However, it would be difficult to segregate the exact and accurate measurement of such joint effect.

(iv) The last one is the opposite effect on trade deficit by the budget deficit. In contrast to other views, this view has been proposed as Ricardian Equivalence Hypothesis (REH). This proposition conveys that any change in government tax does not affect real interest rates, volume of investments and current account deficit. It is because of rational expectation of the taxpayers, who assume that present tax cut is a future burden and government would extract it ultimately in the future so that they start saving at present for meeting the future burden. Such behavior would nullify the net effect so that the twin deficit hypothesis would not appear.

By aforesaid propositions, four possibilities of relationships can be visualized, which are usually found in empirical investigations. These include the following:

(i) Budget deficit has positive relationship with and significant effect on trade deficit (Keynesian proposition).

(ii) Even though not very well defined theoretically, there exists a possibility of trade deficit that causes the budget deficit. This is sometimes seen in petroleum exporting economies. [Reverse proposition of (i)].

(iii) By natural deduction from (i) and (ii), both of them may be mutually dependent or bi-directional relation may hold. (Feed-back effect).

(iv) By the same token, no relation may prevail between the trade and budget deficits. (Ricardian Equivalence Hypothesis).

Based on the above possibilities, relevant research studies are reviewed. The empirical findings are summarized in Annex 2.

II. CAUSALITY TEST

Causality Defined

Causation is normally understood as a direction of change in one variable due to the change in another variable in an appropriately defined econometric model. While, Fisher believed that 'causation runs from price inflation to unemployment', Phillips believed that 'causation runs from unemployment to wage inflation'. The disagreement of propositions between Fisher (1926) and Phillips (1958) related to the appropriate direction of causation between inflation and unemployment which has led the foundation for causality testing historically.[1] The Fisher-Phillips dichotomy suggests only two types of causation; however, direction of causation would have broadly five theoretical possibilities as presented below. Let Y_t be the trade deficit (TD_t) and X_t be the budget deficit (BD_t) under bi-variate postulates; the possible directions of casualty would be:

(a) $Yt \Rightarrow Xt$ (b) $Xt \Rightarrow Yt$ (c) $Yt \not\Rightarrow Xt$ (d) $Xt \not\Rightarrow Yt$ and, (e) $Xt \Leftrightarrow Yt$

The symbol $\Rightarrow$ implies one-way causation; $\not\Rightarrow$ implies no causation and $\Leftrightarrow$ implies mutual causations.

Vector Autoregression (VAR) Modeling

While testing the long-run dynamic relationship between the variables concerned, any *priori* assumption of endogeneity and exogeneity of variables concerned may not always be made. In such situation, a vector autoregressive model (VAR) can be a best solution. This model treats all variables systematically without making reference to the issue of dependence or independence. A VAR model additionally offers a scope for intervention analysis through the study of impulse response functions for the endogenous variables in the model. Moreover, a VAR model allows the analysis of 'variance decompositions' for these variables and further helps to understand the interrelationships among the variables concerned. Hence, a VAR model for the twin deficit relationship is used in the study.

Impulse Response Function

Any shocks to any variable (presumably i-th variable) not only directly affect the respective variable (i-th variable) only, but also it would be transmitted to all of the endogenous variables in the model through dynamic (lag) structure of VAR. An impulse response function (IRS) tries to find out the effect of one time shock to one of the innovations on current and future values of the endogenous variables. Due to this feature, impulse response function in VAR System is widely used in describing the dynamic behaviors of variables in the system related to shocks in the residual of the time series under study.

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[1] The disagreement of propositions between Fisher and Phillips are discussed in Paterson (2000), pp. 536-537

Variance Decomposition

Specifically, the IRS discovers the effects of a shock to one and thereby transmitted to other endogenous variables in the VAR System. However, it cannot tell the magnitude of shocks in the system. To overcome this problem, variance decomposition mechanism is applied to separate out the variation in an endogenous variable into the constituent shocks to the VAR system. So, the variance decomposition is applied in the model to find out the information about relative importance of every random innovation in question of its effects to the variables concerned in the VAR system.

Data

This study is related to the relationship between budget deficit and trade deficit in Nepal for the period 1964-2004. The time series of trade deficit (TD_t) and budget deficit (BD_t) of Nepal have been taken from the different issues of the *International Financial Statistics* (IFS). The real data of budget deficits and trade deficits have been utilized. The nominal and real (1985=100) figures of the TD_t and BD_t are presented in Annex 1. Nominal time series datasets are normally influenced by the same price index/deflator affecting their movements. In real practice too, nominal data are seldom modeled for deriving the conclusions.

Methodology and Preliminary Tests

The background tests have been conducted on concerned variables before jumping into the core study intended in this paper. For any time series data that are used in econometric analyses, the preliminary econometric test step is to verify the stationarity of each individual series. Non-stationary data would contain unit roots. The main objective of unit root test is to determine the degree of integration of each individual time series data. The results derived from the regression models would produce 'spurious results' if the data was employed without checking their stationarity properties. The nature of stationarity or non-stationarity of the datasets is examined with the help of (a) graphics: time plots of the data (b) battery of tests: (ADF unit-root tests and Philip-Perron unit-root tests), and (c) correlograms. Data are found to be stationary at first difference. The nature of long-run relationship of the model variables through both the Engle-Granger and Johansen Maximum Likelihood co-integration test results suggest that the budget deficit and trade deficit are co-integrated at first order. Short-run dynamics through vector error correction (VEC) analysis indicated that the short-run dynamics appeared in converging pattern suggesting prevalence of long-run stability. With this background, the following methodology has been followed for causality verification and further reinforcing it through intervention analysis (if there is any causality).

Granger Causality Test Method and Estimable Models

The model for *Granger Causality Test* is based on the following Equations 1 and 2 which are developed in line with Maddala (2002, pp 379):

$$TD_t = \sum_{i=1}^{m} \alpha_{1i} BD_{t-i} + \sum_{i=1}^{n} \beta_{1i} TD_{t-i} + \eta_t \quad (1)$$

$$BD_t = \sum_{i=1}^{p} \alpha_{2i} TD_{t-i} + \sum_{i=1}^{r} \beta_{2i} BD_{t-i} + \varepsilon_t \quad (2)$$

where, BD_t and TD_t represent the budget deficit (real) and trade deficit (real) respectively.

Pursuing the model developed for Granger Causality Test above, the testable 'causality equations' have been developed below:

$$\Delta TD_t = \alpha_1 + \beta_1 \Delta TD_{t-1} + \gamma_1 \Delta BD_{t-1} + \gamma_2 \Delta BD_{t-2} + \gamma_3 \Delta BD_{t-3} + u_t \quad (3)$$

$$\Delta BD_t = \alpha_2 + \beta_2 \Delta BD_{t-1} + \theta_1 \Delta TD_{t-1} + \theta_2 \Delta TD_{t-2} + \theta_3 \Delta TD_{t-3} + w_t \quad (4)$$

The VAR Method and Estimable Model

The vector autoregression (VAR) model for trade deficit (TD_t) and budget deficit (BD_t) for the economy of Nepal consists of the equations as:

$$\Delta TD_t = \alpha_1 + \sum_{i=1}^{m} \beta_{1i} \Delta TD_{t-i} + \sum_{i=1}^{n} \gamma_{1i} \Delta BD_{t-i} + u_{1t} \quad (5)$$

$$\Delta BD_t = \alpha_2 + \sum_{i=1}^{p} \beta_{2i} \Delta BD_{t-i} + \sum_{i=1}^{r} \gamma_{2i} \Delta TD_{t-i} + u_{2t} \quad (6)$$

where,

α_s	=	intercepts
u_{1t} and u_{2t}	=	stochastic error terms (alternatively called as impulses or innovations or shocks in VAR modeling)
$\sum_{i=1}^{m} \beta_{1i} \Delta TD_{t-i}$ and $\sum_{i=1}^{r} \gamma_{2i} \Delta TD_{t-i}$	=	all summation values of lagged variables of trade deficit (TD_t) in the model
$\sum_{i=1}^{n} \gamma_{1i} \Delta BD_{t-i}$ and $\sum_{i=1}^{p} \beta_{2i} \Delta BD_{t-i}$	=	all Summation values of lagged variables of budget deficit (BD_t) in the model

Furthermore, the VAR model consists of Equations 5 and 6 which requires that (i) ΔTD_t and ΔBD_t be stationary and (ii) u_{1t} & u_{2t} be white noise terms such that: $u_{1t} \sim iid\ N(0, \sigma^2 u_1)$, and $u_{1t} \sim iid\ N(0, \sigma^2 u_2)$

The estimable VAR model, therefore, consists of the following equations:

$$\Delta Y_t = \alpha_1 + \beta_{11}\Delta Y_{t-1} + \beta_{12}\Delta Y_{t-2} + \beta_{13}\Delta Y_{t-3} + \beta_{14}\Delta Y_{t-4} + \beta_{15}\Delta Y_{t-5} + \beta_{16}\Delta Y_{t-6} + \gamma_{11}\Delta X_{t-1} + \gamma_{12}\Delta X_{t-2} + \gamma_{13}\Delta X_{t-3} + \gamma_{14}\Delta X_{t-4} + \gamma_{15}\Delta X_{t-5} + \gamma_{16}\Delta X_{t-6} + u_{1t} \quad (7)$$

$$\Delta X_t = \alpha_2 + \beta_{21}\Delta X_{t-1} + \beta_{22}\Delta X_{t-2} + \beta_{23}\Delta X_{t-3}\beta_{24}\Delta X_{t-4} + \beta_{25}\Delta X_{t-5} + \beta_{26}\Delta X_{t-6} + \gamma_{21}\Delta Y_{t-1} + \gamma_{22}\Delta Y_{t-2} + \gamma_{23}\Delta Y_{t-3} + \gamma_{24}\Delta Y_{t-4} + \gamma_{25}\Delta Y_{t-5} + \gamma_{26}\Delta Y_{t-6} + u_{2t} \quad (8)$$

where,

ΔY_t is the first difference of real trade deficit (TD_t) and ΔX_t is the first difference of real budget deficit (BD_t).

Stability Conditions for the VAR Model

Equation 7 can be expressed as the following:

$$\Delta Y_t - \beta_{11}\Delta Y_{t-1} - \beta_{12}\Delta Y_{t-2} - \beta_{13}\Delta Y_{t-3} - \beta_{14}\Delta Y_{t-4} - \beta_{15}\Delta Y_{t-5} - \beta_{16}\Delta Y_{t-6} = \alpha_1 + \gamma_{11}\Delta X_{t-1} + \gamma_{12}\Delta X_{t-2} + \gamma_{13}\Delta X_{t-3} + \gamma_{14}\Delta X_{t-4} + \gamma_{15}\Delta X_{t-5} + \gamma_{16}\Delta X_{t-6} + u_{1t}$$

or, $$\Delta Y_t - \beta_{11}L\Delta Y_t - \beta_{12}L^2\Delta Y_t - \beta_{13}L^3\Delta Y_t - \beta_{14}L^4\Delta Y_t - \beta_{15}L^5\Delta Y_t - \beta_{16}L^6\Delta Y_t = \alpha_1 + \gamma_{11}\Delta X_{t-1} + \gamma_{12}\Delta X_{t-2} + \gamma_{13}\Delta X_{t-3} + \gamma_{14}\Delta X_{t-4} + \gamma_{15}\Delta X_{t-5} + \gamma_{16}\Delta X_{t-6} + u_{1t}$$

or, $$(1 - \beta_{11}L - \beta_{12}L^2 - \beta_{13}L^3 - \beta_{14}L^4 - \beta_{15}L^5 - \beta_{16}L^6)\Delta Y_t = \alpha_1 + \gamma_{11}L\Delta X_{t-1} + \gamma_{12}L^2\Delta X_{t-2} + \gamma_{13}L^3\Delta X_{t-3} + \gamma_{14}L^4\Delta X_{t-4} + \gamma_{15}L^5\Delta X_{t-5} + \gamma_{16}L^6\Delta X_{t-6} + u_{1t}$$

or, $$A(L)\Delta Y_t = \alpha_1 + (\gamma_{11}L + \gamma_{12}L^2 + \gamma_{13}L^3 + \gamma_{14}L^4 + \gamma_{15}L^5 + \gamma_{16}L^6)\Delta X_t + u_{1t}$$

or, $$A(L)\Delta Y_t = \alpha_1 + \gamma(L)\Delta X_t + u_{1t}$$

$$\Delta Y_t = [A(L)]^{-1}[\alpha_1 + \gamma(L)\Delta X_t + u_{1t}] \tag{9}$$

where,

$$\gamma_1(L) = (\gamma_{11}L + \gamma_{12}L^2 + \gamma_{13}L^3 + \gamma_{14}L^4 + \gamma_{15}L^5 + \gamma_{16}L^6)$$

Stability of Equation 9 requires that the roots of the characteristic polynomial A(L) be less than one.

By the similar simplification process, Equation 8 can also be written as:

$$\Delta X_t = [B(L)]^{-1}[\alpha_2 + \gamma_2(L)\Delta Y_t + u_{2t}] \tag{10}$$

where,

$B(L) = (1 - \beta_{21}L - \beta_{22}L^2 - \beta_{23}L^3 - \beta_{24}L^4 - \beta_{25}L^5 - \beta_{26}L^6)$, and

$\gamma_2(L) = (\gamma_{21}L + \gamma_{22}L^2 + \gamma_{23}L^3 + \gamma_{24}L^4 + \gamma_{25}L^5 + \gamma_{26}L^6)$

Stability of Equation 10 requires that the roots of the characteristic polynomials B(L) be less than unity.

It, therefore, follows that the estimated VAR model, consisting of equations (9) and (10) will be stable if (i) the roots of the characteristic polynomials A(L) are less than unity, and (ii) the roots of the characteristic polynomials B(L) are less than unity

Impulse Response Function and Variance Decomposition

Innovations are normally correlated and may be viewed as having common properties that cannot be associated only to a specific variable. In order to explain the impulses, a transformation *P* is widely applied to the innovations so that they become uncorrelated.

$$\upsilon_t = P ™_t \sim (O, D) \tag{11}$$

where D = diagonal co-variance matrix (Equation 11 is discussed in E-views 4.1 Users Guide, 2001)

Specifically, impulse response function discovers the effects of a shock to one and thereby transmitted to other endogenous variables in the VAR System. However, it cannot tell us the magnitude of shocks in the system. To overcome this problem, variance decomposition mechanism is applied to separate out the variation in an endogenous variable into the constituent shocks to the VAR system. So, variance decomposition is applied in the models to find out the information about relative importance of every random innovation and question of its effects on the variables concerned in the VAR system developed in this study.

III. CAUSALITY ANALYSIS

Granger Causality Test

Test results from the estimation of the Equations 3 and 4 are presented in Tables 1 and 2.

TABLE 1 : Results of Equation (3)

Dependent Variable: DTD_REAL		Sample (adjusted): 1968-2004		
Included observations: 37 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-827.7407	376.4408	-2.198860	0.0352
DTD_REAL(-1)	-0.213085	0.184320	-1.156059	0.2562
DBD_REAL(-1)	-0.429874	0.498753	-0.861897	0.3952
DBD_REAL(-2)	-0.662719	0.526301	-1.259200	0.2171
DBD_REAL(-3)	-0.904591	0.512940	-1.763542	0.0874
R-squared	0.117538			
Adjusted R-squared	0.007231	F-statistic		1.065550
Durbin-Watson stat	1.906190	Prob(F-statistic)		0.389600

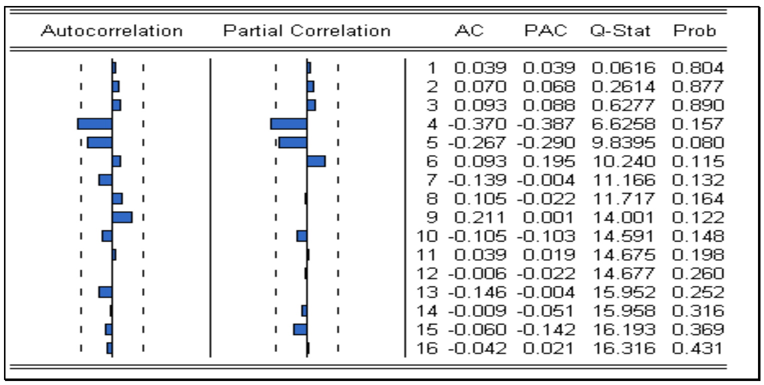
TABLE 2 : Results of Equation (4)

Dependent Variable: DBD_REAL		Sample (adjusted): 1968-2004		
Included observations: 37 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-82.78322	135.9543	-0.608905	0.5469
DBD_REAL(-1)	-0.263712	0.183926	-1.433799	0.1613
DTD_REAL(-1)	0.007264	0.067752	0.107218	0.9153
DTD_REAL(-2)	0.080552	0.064637	1.246207	0.2217
DTD_REAL(-3)	-0.023496	0.066998	-0.350706	0.7281
R-squared	0.119479			
Adjusted R-squared	0.009413	F-statistic		1.085525
Durbin-Watson stat	1.970702	Prob(F-statistic)		0.380171

Correlogram of the Residuals

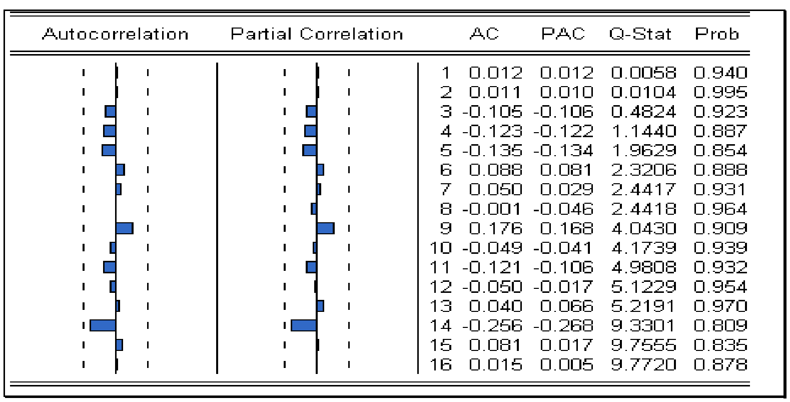
Correlograms of the residuals (RES_1 and RES_2) have been obtained for both Equations 3 and 4 designed for Granger Causality test. The autocorrelation (AC) and partial autocorrelation (PAC) plots of the respective models are presented in Figures 2 and 3 respectively.

FIGURE 2: Correlogram of Residual ($\hat{u}_t$) of Equation (3)



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.039	0.039	0.0616	0.804
		2	0.070	0.068	0.2614	0.877
		3	0.093	0.088	0.6277	0.890
		4	-0.370	-0.387	6.6258	0.157
		5	-0.267	-0.290	9.8395	0.080
		6	0.093	0.195	10.240	0.115
		7	-0.139	-0.004	11.166	0.132
		8	0.105	-0.022	11.717	0.164
		9	0.211	0.001	14.001	0.122
		10	-0.105	-0.103	14.591	0.148
		11	0.039	0.019	14.675	0.198
		12	-0.006	-0.022	14.677	0.260
		13	-0.146	-0.004	15.952	0.252
		14	-0.009	-0.051	15.958	0.316
		15	-0.060	-0.142	16.193	0.369
		16	-0.042	0.021	16.316	0.431

FIGURE- 3 : Correlogram of Residual ($\hat{w}_t$) of Equation (4)



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.012	0.012	0.0058	0.940
		2	0.011	0.010	0.0104	0.995
		3	-0.105	-0.106	0.4824	0.923
		4	-0.123	-0.122	1.1440	0.887
		5	-0.135	-0.134	1.9629	0.854
		6	0.088	0.081	2.3206	0.888
		7	0.050	0.029	2.4417	0.931
		8	-0.001	-0.046	2.4418	0.964
		9	0.176	0.168	4.0430	0.909
		10	-0.049	-0.041	4.1739	0.939
		11	-0.121	-0.106	4.9808	0.932
		12	-0.050	-0.017	5.1229	0.954
		13	0.040	0.066	5.2191	0.970
		14	-0.256	-0.268	9.3301	0.809
		15	0.081	0.017	9.7555	0.835
		16	0.015	0.005	9.7720	0.878

Findings of Test Results and Correlogram of the $\hat{u}_t$ and $\hat{w}_t$

Tables 1 and 2 and the correlograms (Figures 2 and 3) indicate the following. Firstly, the residual datasets for $\hat{u}_t$ and $\hat{w}_t$ display no significant spike in the corresponding ACF at the first lag. Secondly, the corresponding $PACF_s$ are free from any significant spike at the first lag for the residuals $\hat{u}_t$ and $\hat{w}_t$. These confirm to the stationarity of datasets for

$\hat{u}_t$ and $\hat{w}_t$ of Equations 3 and 4. Thirdly, in case of Equation 3, $\hat{\gamma}_1$ and $\hat{\gamma}_2$ and $\hat{\beta}_1$ are insignificant though the coefficient of ΔBD_{t-3} (i.e. value of $\hat{\gamma}_3$) is significant at 10% level of significance. It indicates that BD_t Granger causes TD_t. Finally, in case of Equation 4, $\hat{\beta}_2$, $\hat{\theta}_1$, $\hat{\theta}_2$, $\hat{\theta}_3$ are insignificant. These indicate that TD_t does not Granger cause BD_t.

Conventional Granger Causality Tests

Conventional Granger Causality test explains more about the causal relationships between trade deficit and budget deficit. Test results are reported in Table 3 below:

TABLE 3: Results of Conventional Granger Causality Tests

Null Hypothesis	Observations	lags	F-statistics	Probability
TD_t does not Granger Cause BD_t	40	1	2.12568	0.15329
BD_t does not Granger Cause TD_t			3.75896*	0.06018
TD_t does not Granger Cause BD_t	39	2	0.44748	0.64294
BD_t does not Granger Cause TD_t			2.35569	0.11012
TD_t does not Granger Cause BD_t	38	3	0.80406	0.50119
BD_t does not Granger Cause TD_t			2.20002	0.10791
TD_t does not Granger Cause BD_t	37	4	0.64129	0.63751
BD_t does not Granger Cause TD_t			4.88646***	0.00408
TD_t does not Granger Cause BD_t	36	5	0.35137	0.87647
BD_t does not Granger Cause TD_t			3.77817**	0.01099

*, **, *** indicates statistical significance at the 10%, 5% and 1% level respectively.

Conventional Granger Causality test above has derived: (a) the F-statistics and its corresponding value of probability suggest that the 'TD does not Granger Cause BD' hypothesis has been accepted in all lag values (up to 5 lags) for the real trade deficit (TD_t) and real budget deficit (BD_t) indicating real trade deficit does not Granger cause real budget deficit and, (b) F-statistics have been found significant at first, fourth and fifth lag values at the 10%, 1% and 5% level of significance respectively of real budget deficit indicating unidirectional causality from budget to trade deficit.

IV. VAR ANALYSIS

Selection of Lag Length

Appropriate lag-length can be selected through the 'Selection Criteria' like AIC, SIC, HQIC etc. Table 4 exhibits the statistics corresponding to different criteria across different lags.

TABLE 4: VAR Lag Order Selection Criteria

Endogenous variables: DTD_REAL DBD_REAL
Exogenous variables: C
Included observations: 33

Lag	LR	FPE	AIC	SIC	HQ
0	NA	2.81E+12*	34.34127	34.43196*	34.37178*
1	3.775914	3.16E+12	34.45783	34.72992	34.54938
2	2.219377	3.74E+12	34.62099	35.07447	34.77357
3	3.995056	4.12E+12	34.70976	35.34464	34.92337
4	3.748915	4.56E+12	34.79597	35.61225	35.07063
5	9.885715	3.80E+12	34.58905	35.58672	34.92473
6	9.918660*	3.06E+12	34.33554*	35.51461	34.73226
7	2.355808	3.61E+12	34.44709	35.80755	34.90484

* indicates lag order selected by the criterion

It is observed from Table 4 that (a) LR and AIC statistics for lag 6 are significant at 5% level, and (b) FPE, HQ and SIC statistics for lag 0 lag is significant at 5% level. Therefore 6 (six) lags are chosen for each endogenous variable in their autoregressive and distributed lag structures in the estimable VAR model.

Results of Estimation of the VAR Model

The results of estimation of the VAR model consisting of Equations 7 and 8 are given by Tables 5 and 6 below.

TABLE 5: Results of the Estimations of VAR Equation 7

Dependent Variable	Explanatory Variables	Coefficients	Standard errors	't' statistics
ΔTD_t	Constant	-521.777	445.089	-1.172
	ΔTD_{t-1}	-0.437	0.187	-2.329*
	ΔTD_{t-2}	0.043	0.179	0.240
	ΔTD_{t-3}	0.226	0.159	1.417
	ΔTD_{t-4}	-0.222	0.159	-1.393
	ΔTD_{t-5}	-0.343	0.166	-2.055*
	ΔTD_{t-6}	0.249	0.181	1.377
	ΔBD_{t-1}	-0.451	0.409	-1.102
	ΔBD_{t-2}	-0.434	0.477	-0.909
	ΔBD_{t-3}	-0.201	0.480	-0.418
	ΔBD_{t-4}	0.539	0.504	1.070
	ΔBD_{t-5}	1.199	0.524	2.285*
	ΔBD_{t-6}	1.549	0.517	2.995*

* indicate that the co-efficients are significant at 1% level.

TABLE 6: The Results of the Estimations of VAR Equation 8

Dependent variable	Explanatory Variables	Coefficients	Standard errors	't' statistics
	Constant	-164.193	247.284	-0.663
	ΔTD_{t-1}	-0.002	0.104	-0.016
	ΔTD_{t-2}	0.007	0.099	0.072
	ΔTD_{t-3}	-0.073	0.088	-0.833
	ΔTD_{t-4}	0.032	0.088	0.365
	ΔTD_{t-5}	0.107	0.092	1.159
ΔBD_t	ΔTD_{t-6}	-0.050	0.100	-0.502
	ΔBD_{t-1}	-0.266	0.227	-1.172
	ΔBD_{t-2}	0.034	0.265	0.129
	ΔBD_{t-3}	-0.185	0.267	-0.692
	ΔBD_{t-4}	-0.308	0.280	-1.100
	ΔBD_{t-5}	-0.092	0.291	-0.318
	ΔBD_{t-6}	0.144	0.287	0.501

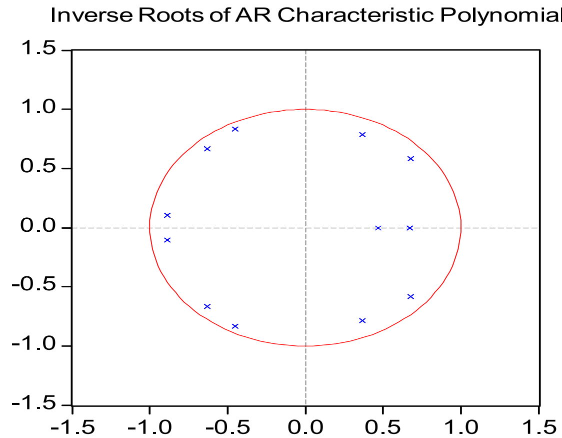
Stability of the Estimated VAR Model

The roots of the estimated Characteristic Polynomials A(L) and B(L) are given in Table 7 and Figure 4.

TABLE 7: VAR Stability Condition Roots of the Characteristic Polynomial A(L) and B(L)

Root	Modulus
-0.450493 - 0.832885i	0.946911
-0.450493 + 0.832885i	0.946911
-0.629951 - 0.668002i	0.918186
-0.629951 + 0.668002i	0.918186
0.676737 - 0.584385i	0.894136
0.676737 + 0.584385i	0.894136
-0.887032 - 0.105545i	0.893289
-0.887032 + 0.105545i	0.893289
0.367548 - 0.783496i	0.865423
0.367548 + 0.783496i	0.865423
0.670899	0.670899
0.471633	0.471633

FIGURE 4 : VAR Stability Condition



It is observed from Table 7 and Figure 4 that (a) values of the roots are less than unity (b) modulus values are also less than unity; and (c) the inverse roots of the AR Characteristic Polynomials lie within the Unit Circle (Figure 4). All these observations testify for the stability of the VAR model and thus, all these findings confirm that the estimated VAR model is stable.

Normality of the VAR Residuals ($\hat{u}_{1t}$ *and* $\hat{u}_{2t}$)

Table 8 presents the results of the VAR residual normality tests.

TABLE 8: Results of the VAR Residual Normality Tests

VAR Residual Normality Tests
H0: residuals are multivariate normal
Included observations: 34

Component	Skewness	Chi-sq	df	Prob.
1	0.343032	0.666802	1	0.4142
2	-0.404313	0.926323	1	0.3358
Joint		1.593124	2	0.4509
Component	*Kurtosis*	Chi-sq	df	Prob.
1	1.451911	3.395155	1	0.0654
2	1.256838	4.304701	1	0.0380
Joint		7.699856	2	0.0213
Component	*Jarque-Bera*	df	Prob.	
1	4.061957	2	0.1312	
2	5.231024	2	0.0731	
Joint	9.292980	4	0.0542	

It is observed from Table 8 that the JB statistic for $\hat{u}_{1t}$ = 9.292980, indicating the null hypothesis (that $\hat{u}_{1t}$ and $\hat{u}_{2t}$ are multivariate normal) is accepted at 5% level which justifies for the normality of $\hat{u}_{1t}$ and $\hat{u}_{2t}$, the residuals in Equations 7 and 8 respectively.

Serial Independence for the VAR Residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$)

The residuals of the estimated VAR equations (7) and (8) are $\hat{u}_{1t}$ & $\hat{u}_{2t}$ respectively and ACF and PACF plots of these VAR residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$) are presented in Figure 5 and 6.

FIGURE 5 : Correlogram for $\hat{u}_{1t}$

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.137	0.137	0.6946	0.405
		2	-0.243	-0.266	2.9479	0.229
		3	-0.048	0.033	3.0394	0.386
		4	0.044	-0.019	3.1200	0.538
		5	-0.053	-0.069	3.2367	0.664
		6	-0.190	-0.176	4.8183	0.567
		7	-0.096	-0.076	5.2396	0.631
		8	-0.177	-0.279	6.7076	0.568
		9	0.079	0.111	7.0135	0.636
		10	0.165	0.010	8.3947	0.590
		11	0.028	0.019	8.4369	0.674
		12	0.159	0.203	9.8365	0.630
		13	0.080	-0.012	10.206	0.677
		14	-0.077	-0.090	10.567	0.720
		15	-0.242	-0.219	14.344	0.500
		16	0.020	0.047	14.370	0.571

FIGURE 6 : Correlogram for $\hat{u}_{2t}$

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.026	-0.026	0.0248	0.875
		2	0.011	0.011	0.0296	0.985
		3	0.077	0.078	0.2652	0.966
		4	0.042	0.046	0.3376	0.987
		5	0.020	0.021	0.3545	0.996
		6	0.024	0.018	0.3796	0.999
		7	0.109	0.104	0.9155	0.996
		8	-0.030	-0.029	0.9570	0.999
		9	0.073	0.065	1.2173	0.999
		10	-0.097	-0.114	1.7014	0.998
		11	-0.186	-0.205	3.5376	0.982
		12	-0.031	-0.061	3.5910	0.990
		13	-0.035	-0.033	3.6612	0.994
		14	-0.142	-0.129	4.8952	0.987
		15	0.024	0.046	4.9313	0.993
		16	-0.038	-0.029	5.0293	0.996

It has been observed from the correlograms that (a) the corresponding ACFs are marked by the absence of any dying out pattern of spikes and (b) the corresponding PACFs are also free from any single significant spike at any lag. These observations testify the fact that $\hat{u}_{1t}$ and $\hat{u}_{2t}$ are free from autocorrelations of any order.

VAR Residual Portmanteau Test Results

The VAR Residual Portmanteau test for autocorrelations is done for further confirmation of serial independence for residuals. Tests results are presented in the Table 9.

TABLE 9: VAR Residual Portmanteau Test Results

VAR Residual Portmanteau Tests for Autocorrelations
H0: no residual autocorrelations up to lag h
Included observations: 34

Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	df
1	1.201573	NA*	1.237984	NA*	NA*
2	5.022571	NA*	5.297795	NA*	NA*
3	6.845539	NA*	7.297179	NA*	NA*
4	7.205460	NA*	7.705089	NA*	NA*
5	8.190853	NA*	8.860378	NA*	NA*
6	12.40652	NA*	13.97940	NA*	NA*
7	14.28686	0.0064	16.34724	0.0026	4
8	21.70890	0.0055	26.05298	0.0010	8
9	23.52710	0.0236	28.52573	0.0046	12
10	25.72585	0.0580	31.64063	0.0111	16
11	27.49644	0.1219	34.25802	0.0244	20
12	31.20052	0.1481	39.98252	0.0215	24

*The test is valid only for lags larger than the VAR lag order.
df is degrees of freedom for (approximate) chi-square distribution

The adjusted Q-Statistics for the corresponding Chi-Square values, given the degrees of freedom, in Table 9 show that (a) the hypothesis of serial correlations have been rejected for up to the 8^{th} lag at 1% level, (b) the hypothesis of serial correlations have been rejected for the 9^{th} lag at 5% level, and (c) the hypothesis of serial correlation has been rejected at 10% level for the 10^{th} lag. Consequently, Portmanteau test testifies for the serial independence of the VAR residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$).

VAR Residual Serial Correlation LM Test Results

The VAR residual serial correlation LM test is also conducted for further confirmation of serial independence of residuals. The results of the VAR residual serial correlation LM tests have been presented in the Table 10.

TABLE 10: VAR Residual LM Test Results

VAR Residual Serial Correlation LM Tests
H0: no serial correlation at lag order h
Included observations: 34

Lags	LM-Stat	Prob	Lags	LM-Stat	Prob
1	1.837243	0.7657	7	2.570008	0.6321
2	8.320099	0.0805	8	10.70807	0.0300
3	3.155266	0.5322	9	3.087800	0.5432
4	1.621287	0.8050	10	4.123171	0.3896
5	2.103152	0.7168	11	7.758058	0.1009
6	9.951638	0.0413	12	7.505920	0.1114

Probs from chi-square with 4 df.

It is observed from Table10 that the marginal significance at LM statistics for autocorrelation at any lag h (h = 1, ...,11) is not large enough to reject the null hypothesis of 'no serial correlation.'

Homoscadasticity of the VAR Residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$)

Time plots of the VAR residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$) are illustrated in Figures 7 and 8 below.

FIGURE 7: Time Plot of VAR Residuals ($\hat{u}_{1t}$)

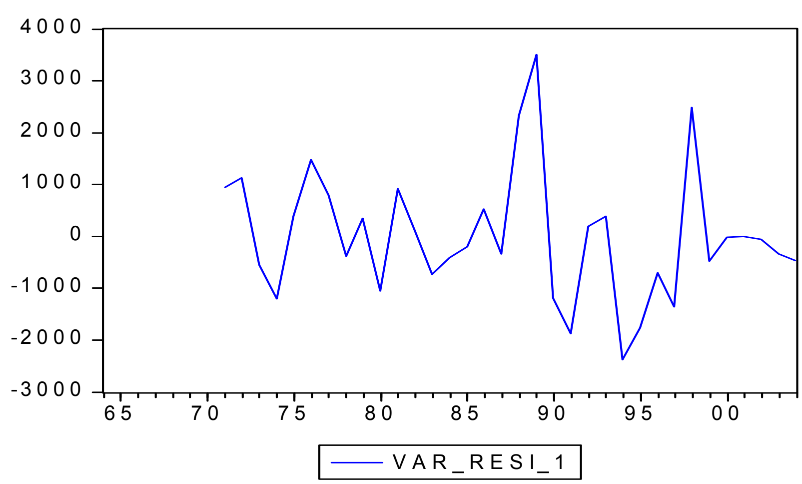
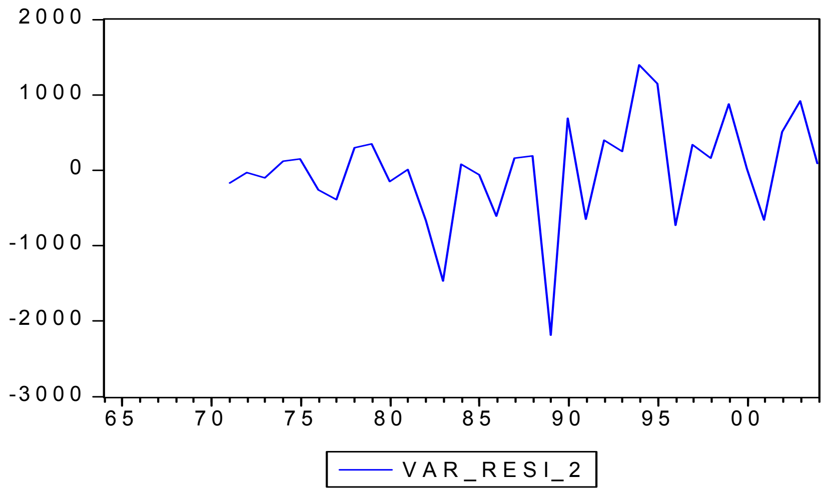


FIGURE 8: Time Plot of VAR Residuals ($\hat{u}_{2t}$)



Figures 7 and 8 show that (a) there exists no cluster in the time plot of $\hat{u}_{1t}$ and (b) the time plot of $\hat{u}_{2t}$ is also marked by the absence of any cluster. These observations testify for the 'homoscadasticity' of the residuals concerned.

Findings from Estimation of the VAR and Economic Interpretations

It is observed from Table 5 for the estimated Equation 7 that (a) $\sum_{i=1}^{6} \beta_{1i} < 1$ and $\sum_{i=1}^{6} \gamma_{1i} < 1$, which indicate that the auto-regressive and distributed lag structures in equation (7) are consistent; (b) $\hat{\gamma}_{15}$ and $\hat{\gamma}_{16}$ are significant at 1% level (c) $\hat{\gamma}_{15} > 1$ and $\hat{\gamma}_{16} > 0$ and (d) $\hat{\beta}_{11} < 0$ and $\hat{\beta}_{11}$ is significant at 1% level.

The economic significance of these findings are as follows: (a) $\hat{\gamma}_{15}$ *and* $\hat{\gamma}_{16}$ being significant indicate that BD_t significantly affected TD_t, even in the presence of TD_{t-I} *(i = 1, ……,6)* in the vector of regressors indicating that BD_t, the budget deficit Granger Caused trade deficit in the economy of Nepal over the period of study; (b) $\hat{\gamma}_{15}$ *and* $\hat{\gamma}_{16}$ being significant also indicate that variations in budget deficit did not lead to an immediate trade deficit and trade deficit, on the other hand, was affected by the variations in four and five period back deficits in the budgetary provision; (c) $\hat{\gamma}_{15} > 1$ and $\hat{\gamma}_{16} > 0$ indicate that variations in 4-period and 5-period back budget deficits led to more than proportionate variation in trade deficit in the economy of Nepal; and (d) $\hat{\beta}_{11} < 0$ indicates that trade deficit at any period reduces the volume of trade deficit in the next period. Thus, trade deficit at any period is negatively related to trade deficit in the previous period.

It is observed from Table - 6 for the estimated Equation 8 that (a) $\sum_{i=1}^{6} \beta_{2i} < 1$ and $\sum_{i=1}^{6} \gamma_{2i} < 1$, which indicate that the auto-regressive and distributed lag structures in Equation 8 are consistent (b) $\hat{\beta}_{2i}$ (i = 1, …, 6) are not significant even at 10% level and (c) $\hat{\gamma}_{2i}$ (i = 1, …, 6) is also not significant even at 10% level.

The economic significances of these findings are as follows: (a) $\hat{\gamma}_{2i}$ (i = 1, … …, 6) being insignificant (even at 10% level), in the presence of BD_t *(i = 1, ……,6)* in the vector of regressors for BD_t implies that trade deficit failed to Granger Cause the budget deficit in the economy of Nepal over the period of study and (b) $\hat{\beta}_{2i}$ (i = 1, … …, 6) being insignificant (even at 10% level) indicate that budget deficit at any period is not related significantly to budget deficits which occurred at any previous periods.

V. IMPULSE RESPONSE FUNCTION

Impulse Response Functions for Trade Deficit (TD_t)

The relevant impulse response functions of the estimated VAR model consisting of Equations 7 and 8 are presented in Figures 9 and 10. Corresponding numerical values of such responses, given Cholesky one S. D. innovations are also presented in Table 11. In Figures 9 and 10, the solid lines and their respective broken lines represent ΔTD real and ΔBD real respectively.

FIGURE 9: Response of DTD REAL to Cholesky One S.D. DTD REAL

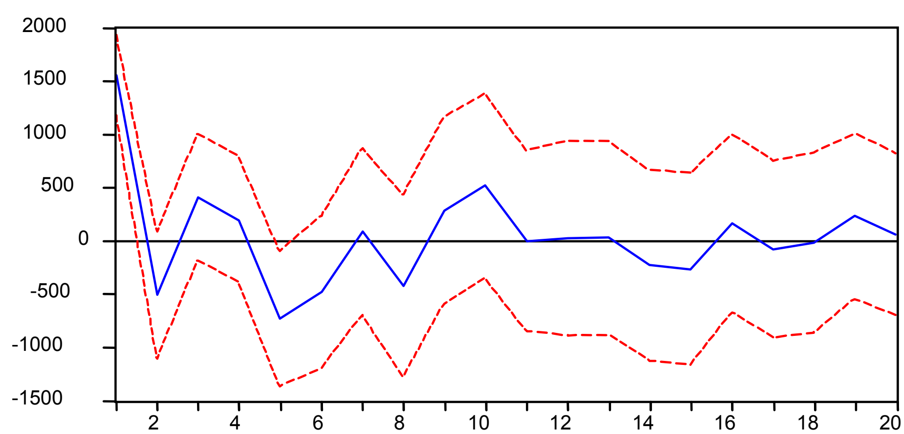


FIGURE 10: Response of DTD_REAL to Cholesky One S.D. DBD_REAL Innovation

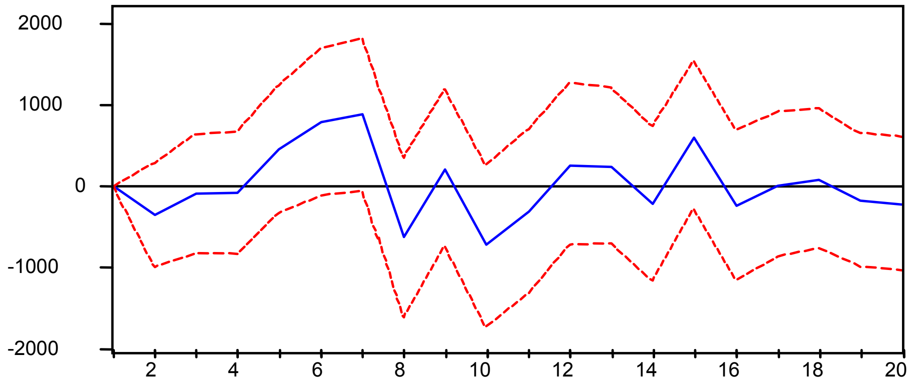


TABLE 11: Response of TD_t to Cholesky (d.f. adjusted) One SD Innovations

Response of DTD_REAL					
Periods	DTD_REAL	DBD_REAL	Periods	DTD_REAL	DBD_REAL
1	1557.167	0.000000	11	1.239855	-312.1763
	(188.834)	(0.00000)		(424.938)	(507.279)
2	-507.9100	-350.2065	12	25.32605	257.5842
	(296.979)	(320.420)		(457.898)	(507.352)
3	410.5063	-90.34934	13	32.08946	235.6596
	(295.832)	(366.411)		(455.811)	(488.073)
4	197.2944	-78.99740	14	-227.1050	-217.7563
	(295.795)	(375.904)		(449.192)	(479.307)
5	-727.5489	454.7184	15	-263.9144	597.2423
	(319.047)	(390.817)		(448.056)	(470.711)
6	-475.1972	790.2957	16	164.7680	-237.2051
	(356.259)	(449.452)		(417.465)	(465.638)
7	89.09157	885.9334	17	-80.05393	11.77264
	(391.944)	(468.999)		(415.719)	(451.793)
8	-418.2148	-624.7834	18	-18.11183	80.18549
	(427.511)	(487.505)		(422.391)	(439.567)
9	288.2315	205.0797	19	233.9000	-177.5751
	(438.803)	(490.805)		(389.352)	(417.833)
10	521.0436	-721.7626	20	61.08477	-222.9215
	(434.039)	(491.779)		(381.525)	(415.617)
Cholesky Ordering: DTD_REAL DBD_REAL					
Standard Errors: Analytic					

Findings from the Impulse Response Functions for Trade Deficit

It is observed from Figure 9 and Table 11 that the shocks transmitted through the channel of trade deficit: (a) responded immediately by rising above the long-run base at t = 1 (b) fell below the long-run base at t = 2, (c) exhibited sharp ups and down until t = 11,

(d) touched the base at t = 11 and remained so until t = 13 periods, and (e) exhibited damped oscillations around the base for $15 \leq t_2 < \propto$.

Similarly, Figure 9 and Table 11 show that the shocks, transmitted through the channel of budget deficit as trade deficit: (a) exhibited delayed response by falling below the base level t = 2, (b) registered a rise at t = 3, and continued such trend until t = 6 periods, (c) exhibited non-convergent oscillations around the base level for $7 \leq t \leq 20$ and (d) did not collapse on the base line for $t > 20$.

The overall findings on the nature of trade deficit responses are the following:

(i) The shocks, transmitted through the channel of trade deficit: (a) were short lived, (b) failed to change the long-run equilibrium base of trade deficit and (c) produced very damped oscillations in trade deficit around the long-run base.

(ii) The shocks, transmitted through the channel of budget deficit: (a) were not short-lived, (b) began to account for the significant part of the short-run variations in trade deficit for $6 \leq t \leq 8$ and (c) accounted for most of the short-run variations in trade deficit for $t > 20$.

Impulse Response Functions for Budget Deficit (BD_t)

The impulse response functions of budget deficit corresponding to Equation 8, for the VAR system and in response to impulses transmitted through the channels of budget deficit and trade deficits are presented in Figures 11 and 12 where the solid lines and their respective dotted lines represent ΔBD real and ΔTD real respectively.

The corresponding numerical values of these responses are shown in Table 12.

TABLE 12 : Response of BD_t to Cholesky (d.f. adjusted) One SD Innovations

Response of DBD_REAL					
Periods	DTD_REAL	DBD_REAL	Periods	DTD_REAL	DBD_REAL
1	-382.7484	775.8650	11	91.35727	102.5818
	(140.923)	(94.0875)		(138.218)	(173.554)
2	99.37480	-206.9425	12	-27.05567	-25.72795
	(162.310)	(178.225)		(143.983)	(183.453)
3	-27.52784	82.55465	13	-61.52379	-32.83696
	(155.159)	(197.148)		(140.494)	(170.885)
4	-37.97940	-175.1343	14	130.5823	49.05744
	(155.775)	(195.976)		(146.773)	(158.163)
5	199.4511	-125.8178	15	-28.54667	-148.2221
	(156.585)	(206.863)		(138.362)	(165.576)
6	78.74385	-1.975006	16	-18.17717	32.18566
	(155.263)	(212.699)		(116.236)	(163.306)
7	-202.0420	101.3539	17	32.63024	76.48848
	(158.419)	(204.220)		(119.350)	(131.414)
8	174.7026	-11.36037	18	-26.81906	-48.30445
	(153.207)	(193.924)		(125.206)	(128.888)
9	-116.6539	33.67000	19	-47.87831	47.49769
	(162.208)	(184.261)		(111.806)	(133.847)
10	-87.44434	-32.99330	20	26.70577	49.95589
	(144.390)	(180.239)		(109.381)	(127.405)

Cholesky Ordering: DTD_REAL DBD_REAL
Standard Errors: Analytic

FIGURE 11: Response of DBD_REAL to Cholesky one S.D. DBD_REAL Innovation

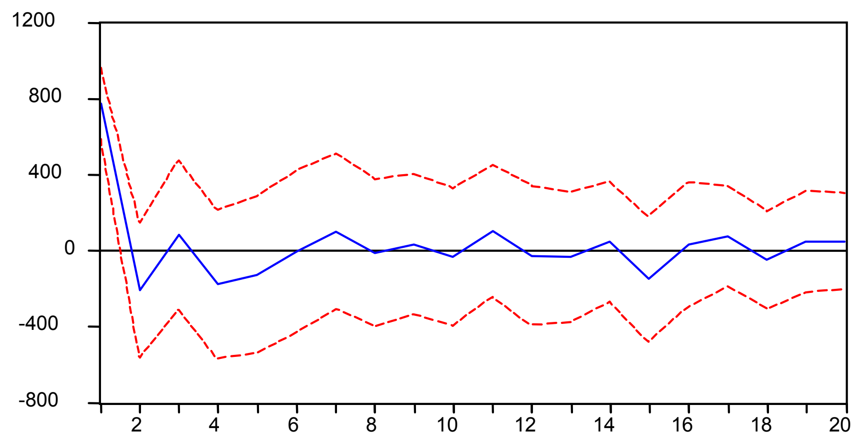
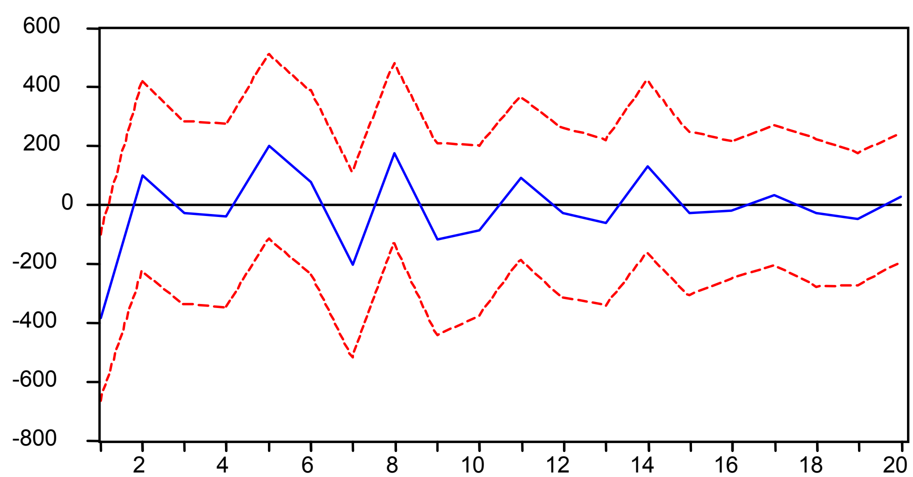


FIGURE 12: Response of DBD_REAL to Cholesky one S.D. DTD_REAL Innovation



Findings from the Impulse Response Function for Budget Deficit

Figure 11 shows that the shocks transmitted through the channel of budget deficit: (a) exhibited immediate rise above the base line at t = 1, (b) declined below the base line at t = 2, (c) established damped oscillations around the long run equilibrium level for $t \geq 8$ and (d) almost collapsed on the equilibrium base line for $t \geq 19$.

Similarly, Figure 12 demonstrates that the impulses transmitted through trade deficit channel as budget deficit (a) exhibited a sharp decline at t = 1; (b) registered a rise above the base level at t = 2; (c) remained below the base level at t = 3, 4 ; and (d) exhibited damped oscillations for $5 \leq t \leq 19$ and (e) almost collapsed on the base level for $t \geq 20$.

The joint analysis of Figures 11 and 12 indicates that (a) short-run variations in budget deficit were mainly due to impulses transmitted through the channel of budget deficit and (b) both types of shocks were short-lived since these failed to change the long-run equilibrium base of budget deficits.

It is, therefore, observed from the above analysis that (a) budgetary deficit shocks were the predominant cause behind the short-run variations in budget deficit; (b) budgetary deficit accounted for increasingly large part of short-run variations in trade deficit; (c) shocks, transmitted through budgetary deficit, changed the equilibrium base of trade deficit as a result of which budgetary shocks were not short-lived for trade deficit and (d) shocks, transmitted through the channels of budget deficit and trade deficit, failed to change the equilibrium base of budget deficit. Consequently, both of these shocks were short-lived for budget deficit.

VI. VARIANCE DECOMPOSITION

Variance Decomposition

It has been shown that how shocks to one endogenous variable may affect the other endogenous variables in the VAR model through impulse response functions. In this section, with the help of variance decomposition, efforts have been made to separate the variations in an endogenous variable into some component shocks. The forecast error variance decomposition tells us the proportion of the movement in a sequence due to its own shocks versus shocks of other variables.

Variance Decomposition for Trade Deficit

Variations in trade deficit under study were basically the effects of responses of trade deficit to shocks transmitted through both trade deficit and budget deficit channels. So, a part of total variation in trade deficit was due to trade deficit shocks and the other part of the variation was due to the budgetary deficit shocks. The break-up of the total variations in trade deficit into the two deficit parts across different periods (*t = 1, 2,……, 20*) constitute the variance decomposition of trade deficit. Such variance decomposition of trade deficit (TD_t) is given in the Table 13. The graphical presentation of variance decomposition for TD_t is presented in the Figure 13.

TABLE 13: Variance Decomposition of Trade Deficit (TD_t)

Periods	S.E.	TD_t	BD_t	Periods	S.E.	TD_t	BD_t
1	865.1375	100.0000	0.000000	11	1013.290	59.86616	40.13384
2	895.0773	95.62824	4.371758	12	1013.977	59.30670	40.69330
3	899.2978	95.61352	4.386481	13	1016.373	58.84937	41.15063
4	916.9793	95.47282	4.527184	14	1025.900	58.75670	41.24330
5	946.8167	90.86401	9.135991	15	1036.946	56.38812	43.61188
6	950.0875	79.01070	20.98930	16	1037.604	56.13048	43.86952
7	976.6063	67.57134	32.42866	17	1040.931	56.16586	43.83414
8	992.1744	64.10422	35.89578	18	1042.397	56.12102	43.87898
9	999.5758	64.15113	35.84887	19	1044.576	56.20171	43.79829
10	1003.936	60.71300	39.28700	20	1046.111	55.86769	44.13231

Cholesky Ordering: DTD_REAL DBD_REAL

FIGURE 13: Variance Decomposition of DTD_REAL

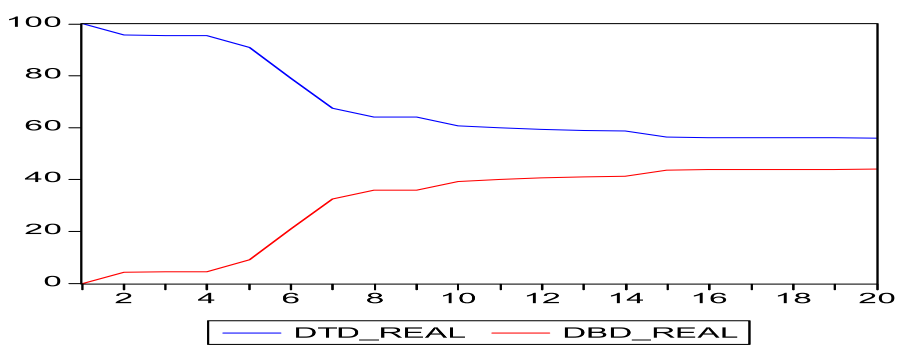


Table 13 and Figure 13 show that (a) variations in trade deficit were mainly due to trade deficit shocks in the very early part of projections periods ($t \leq 4$); (b) shocks, transmitted through budgetary deficit, assumed greater role in explaining variations in trade deficit since t > 4 periods; (c) budgetary shocks became the dominant factor behind short-run variations in trade deficit since t > 6 periods; and (d) for $t \rightarrow \propto$, the contribution of budgetary deficits shocks to total variations in budget deficit was about 44% while that of trade deficit was at about 56%.

Variance Decomposition for Budget Deficit

Variances in budget deficit over the periods of study were basically the results of budget deficit to the shocks transmitted through budget deficit and trade deficit. So a part of total variations in budget deficit was due to budget shocks and the other part was due to trade deficit shocks. The break-up of variances in budget deficit into these two definite parts across different periods ($t = 1, 2, \ldots\ldots, 20$) constituted the 'variance decomposition' of budget deficit and is given in Table 14. The graphical presentation of the variance decomposition presented in Figure 14.

FIGURE 14: Variance Decomposition of DBD_REAL

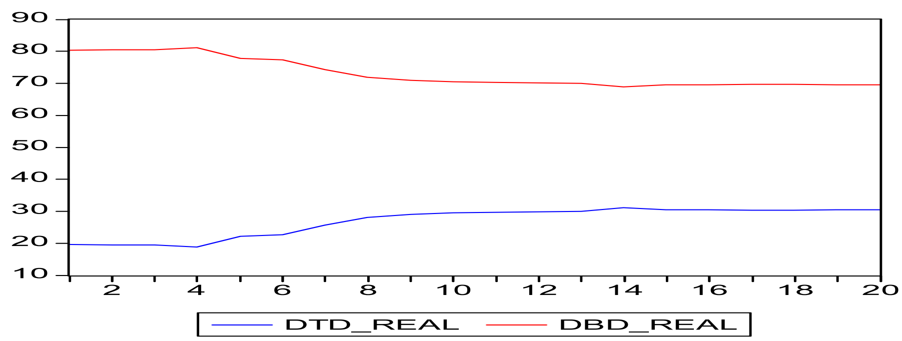


TABLE 14: Variance Decomposition of Budget Deficit

Periods	S.E.	TD_t	BD_t	Periods	S.E.	TD_t	BD_t
1	865.1375	19.57296	80.42704	11	1013.290	29.75352	70.24648
2	895.0773	19.51808	80.48192	12	1013.977	29.78438	70.21562
3	899.2978	19.42901	80.57099	13	1016.373	30.01057	69.98943
4	916.9793	18.85850	81.14150	14	1025.900	31.07589	68.92411
5	946.8167	22.12617	77.87383	15	1036.946	30.49318	69.50682
6	950.0875	22.66100	77.33900	16	1037.604	30.48517	69.51483
7	976.6063	25.72704	74.27296	17	1040.931	30.38887	69.61113
8	992.1744	28.02646	71.97354	18	1042.397	30.36970	69.63030
9	999.5758	28.97491	71.02509	19	1044.576	30.45319	69.54681
10	1003.936	29.48246	70.51754	20	1046.111	30.42907	69.57093

Cholesky Ordering: DTD_REAL DBD_REAL

Table 14 and Figure 14 indicate that, (a) budget deficit shocks dominated the trade deficit shocks in generating short-run variations in expenditure. For example, for $1 < t \leq 4$, at least 81% of the short-run variations were due to budgetary deficit shocks while trade deficit shocks accounted for at most 19% of such variations; (b) budget deficit shocks took the dominant role in constituting the long-run equilibrium level for the budget deficit profile; for example, budget deficit shocks constituted about 70% of the long-run equilibrium level of the budget deficit profile while trade deficit shocks, on the other hand, contributed at most 30% to their account; and (c) at $t = 1$, the total budget deficit variations was mainly due to budget deficit shocks. So, at $t \rightarrow \propto$, the contribution of budgetary shocks to total variations never fell short of 70% level. On the other hand, contributions of trade deficit shocks to this account never exceeded 30% level.

Findings on Variance Decomposition

The foregoing observations show that: (a) shocks transmitted through the budget deficit took a significant role in constituting the long-run equilibrium levels for both budget deficits and trade deficit profiles; and (b) shocks transmitted through the budget deficit channel dominated over the trade deficit channel in generating short-run variations in short-run in both budget deficit and trade deficit profiles.

All of these findings, therefore, confirm that causality running from 'trade deficit' to 'budget deficit' is 'weak'. On the other hand, 'budget deficit' shocks contributed significantly to the constitution of trade deficit profile. Consequently, causation running from' budget deficit' to 'trade deficit' was 'stronger' and dominant.' Therefore, the direction of causality (BD_t Granger Caused TD_t) has been reinforced trough the VAR modeling and intervention analysis also.

VII. Conclusions and Policy Implications

The initial objective of this study was to analyze whether the twin deficit hypothesis (TDH) is supported or 'otherwise' in Nepal. The findings derived from the study are summarized as follows: (i) trade deficit was found to be Granger Caused by budget deficit; (ii) change in budget deficit Granger Caused more than proportionate change in trade deficit; (iii) budget deficit has been 'exogenous' to the VAR (2, n) system; (iv) budget deficit, being 'exogenous' to the system, implies that other considerations of fiscal and socio-economic policies took the leading role in establishing revenue-expenditure schedules as a result of which budget deficit has been the outcome of the other socio-economic-political considerations and exercises in the economy of Nepal; and (v) since the trade deficit has been 'Granger Caused' by budget deficit, rational economic measures are needed for containing trade deficit and budget deficit.

There is a continuous rise in budget deficit in Nepal as well as in trade deficit, too. Prevalence of continued budget deficit would nullify any measures taken such as import substitution, export promotion, or deficit control efforts as such reform measures may not always be workable for containing the trade deficit. The straightforward suggestion for containing budget deficit would be a measure of reducing budget deficit through bridging the gap between expenditure and revenue. However, one may argue that such attempt of reducing budget deficit would have no meaningful impact in solving the twin deficit problem in view of the fact that fiscal policy measures under globalization and flexible exchange rate regime would produce only little perceptible impact on economic growth. In such situation, other supporting policies such as monetary policies and financial sector policies need to be revamped for solving such a twin deficit dilemma.

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ANNEX 1: Trade Deficit and Budget Deficit Time Series (Rs. in million)

Year	Trade Deficit	Budget Deficit	GDP Deflator (1985=100)	TD Real	BD Real
1964	-419	-3	20.6	-2034	-15
1965	-384	25	22.4	-1714	112
1966	-184	-36	25.8	-713	-140
1967	-85	-40	24.3	-350	-165
1968	-74	22	27	-274	81
1969	-307	62	28.8	-1066	215
1970	-334	24	30.8	-1084	78
1971	-373	-39	31.8	-1173	-123
1972	-275	-126	35.7	-770	-353
1973	-427	-223	34.5	-1238	-646
1974	-721	-248	41.7	-1729	-595
1975	-788	-236	47.5	-1659	-497
1976	-806	-422	53.5	-1507	-789
1977	-1097	-576	51.6	-2126	-1116
1978	-1577	-582	56.4	-2796	-1032
1979	-1747	-588	62	-2818	-948
1980	-3143	-705	66.8	-4705	-1055
1981	-2818	-728	72.1	-3908	-1010
1982	-4076	-1591	78.8	-5173	-2019
1983	-5385	-2954	88.5	-6085	-3338
1984	-4738	-2985	94.1	-5035	-3172
1985	-5352	-3380	100	-5352	-3380
1986	-6746	-3637	108.9	-6195	-3340
1987	-9154	-3902	123	-7442	-3172
1988	-11388	-4280	133.3	-8543	-3211
1989	-11468	-8014	145.9	-7860	-5493
1990	-13733	-7013	159.7	-8599	-4391
1991	-17602	-9915	174.5	-10085	-5681
1992	-17451	-10054	208.4	-8376	-4825
1993	-24591	-10359	231.2	-10638	-4481
1994	-39176	-7463	250.7	-15628	-2977
1995	-51133	-7894	274.9	-18603	-2872
1996	-57417	-10976	295.2	-19449	-3718
1997	-74419	-10908	317.8	-23421	-3433
1998	-50613	-13846	329.6	-15357	-4201
1999	-55969	-13349	357.6	-15651	-3733
2000	-54569	-12545	374.1	-14587	-3353
2001	-55141	-18498	386.8	-14255	-4782
2002	-66368	-16506	398.8	-16642	-4139
2003	-83089	-11391	418.2	-19866	-2724
2004	-82001	-15828	439.6	-18655	-3601

Source: *International Financial Statistics*.

ANNEX 2: Summary of Literature Survey on Twin Deficit Hypothesis

Authors	Sample Countries	Results/Findings
Darrat (1988)	USA	Bi-directional causality between TD & BD.
Bahmani-Oskooee (1989)	USA	Unidirectional causality from BD to current account deficit (CAD).
Latif-Zaman & DaCosta (1990)	USA	Unidirectional causality from BD to CAD.
Enders & Lee (1990)	USA	Positive innovation of government debt to consumption spending and in the CAD.
Zietz & Pemberton (1990)	USA	BD was transmitted to the TD primarily through the impact on imports.
Bachman (1992)	USA	Unidirectional causality from BD to CAD.
Mohammadi & Skaggs (1996)	USA	Maximum effect of an innovation in the budget surplus (BS) on the TD is relatively modest. So, shocks in the BS are not the major factors in determining the behavior of TD.
Laney (1984)	58 countries	Causality form BD to CAD in developing countries. Amongst world's largest economies, Canada & Italy only demonstrate a statistically significant positive relationship between BD and CAD.
Bernheim (1988)	6 countries	$ 1.00 increase in the BD is associated with roughly a $ 0.30 decline in CA surplus for USA, UK, Canada, and West Germany but $ 0.85 decline in CA for Mexico. No effect on CA for Japan.
Kearney & Monadjemi (1990)	8 countries	Causality from CAD to BD in USA. No causality in Australia and France.
Vamvoukas (1997)	Greece	One-way causality from BD to TD.
Khalid & Guan (1999)	10 countries	Unidirectional causality from BD to CAD in USA, France and Canada. No causality between BD & CAD in UK and Australia. Weaker support for bidirectional causality too in Canada. Two-way causality for India. Causality from CAD to BD in Pakistan and Indonesia. Unidirectional causality from BD to CAD for Egypt and Mexico.
Olga Vyshnyak (2001)	Ukraine	Unidirectional causality from BD to CAD
Elif Akbostanci and Gul Ipec Tunk (2002)	Turkey	Unidirectional causality from BD to CAD
Mamdouh Alkswani (2000)	Saudi Arabia	Unidirectional causality from TD to BD
Michel Normandin (1999)	Canada	TDH supported