RELATIONSHIP BETWEEN TWIN DEFICITS IN NEPAL

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by

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To Whom It May Concern

This is to certify that the doctoral thesis entitled **"Relationship between Twin Deficits in Nepal"** is a record of genuine research work done by Mr. Shankar Prasad Acharya, Director of Nepal Rastra Bank and Academic Counselor of Indira Gandhi National Open University, IGNOU Centre 9600, Kathmandu, Nepal under my supervision. The thesis or part there of, has not been submitted to any other University or Institution for any research degree.

I wish him all successes in his academic and professional career progression.

1/9/2008

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This thesis is dedicated

to my parents

Sri Madhav Prasad Acharya

and

Smt. Mahamaya Acharya

who have inspired me to work hard and taught me the value of life, culture and time

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Twin Deficit phenomenon has received greater concern during the 1980s in the macroeconomic literatures concerning to huge current account deficit in USA. Nepal is also observing this sort of phenomenon for the past five decades. Econometric verifications with application of contemporary time series analytical tools haven't been studied for twin deficit data in Nepal. So, this research endeavor is deemed to be valuable in policy matters and an addition to a new stock of knowledge in the Nepalese macroeconomic literature.

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University of North Bengal

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ACRONYMS

A/Cs	Accounts
ACF	Autocorrelation Function
ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
ARIMA	Autoregressive Integrated Moving Average
BD	Budget Deficits
BPL	Below Poverty Line
BOP	Balance of Payments
CAD	Current Account Deficit
CAB	Current Account Balance
CLRM	Classical Linear Regression Model
CRDW	Durbin-Watson Cointegrating Regression
DF-GLS	Dickey-Fuller Generalized Least Squares
ECM	Error Correction Mechanism
ESAF	Enhanced Structural Adjustment Facility
ERS	Elliott-Rothenberg-Stock
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNP	Gross National Product
IFS	International Financial Statistics
IMF	International Monetary Fund
KPSS	Kwiatkowski-Phillips-Schmidt-Shin
LDCs	Least Developed Countries
MA	Moving Average
MAXLAG	Maximum Lag
MPC	Marginal Propensity to Consume
MTEF	Medium Term Expenditure Framework
NRB	Nepal Rastra Bank
NPC	National Planning Commission

NBD	Budget Deficit (Nominal)
NTD	Trade Deficit (Nominal)
OECD	Organization For Economic Cooperation and Development
OGL	Open General License
OMO	Open Market Operation
PACF	Partial Autocorrelation Function
PRGF	Poverty Reduction Growth Facility
PP	Phillips-Perron
REH	Ricardian Equivalence Hypothesis
SAP	Structural Adjustment Program
SAF	Structural Adjustment Facility
SIC	Squartz Information Criterion
TD	Trade Deficits
TDH	Twin Deficit Hypothesis
VAR	Vector Autoregression
WTO	World Trade Organization

CHAPTER – I

INTODUCTION

1.1 Précis of Nepalese Economy and Economic Policy Issues

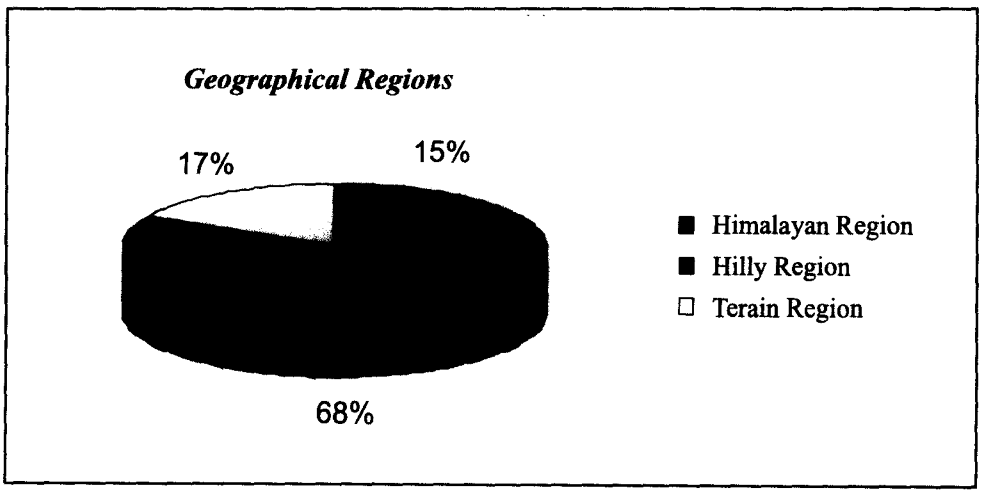
This chapter emanates some light on overall economic features, macroeconomic policy issues and alleyway of socio-economic condition of Nepal, global economic scenario, objectives and plan of the study.

1.1.1 Characteristics of Nepalese Economy[1]

In between the two gigantic neighbors, India and China, Nepal is a small landlocked country. With a total area of 147 thousand kilometer, Nepal has geographically been divided into main three regions, namely, Himalayan region and inner Himalayas; sub-Himalayan (hilly) or the mountainous region; and inner Terai and the main Terai region.

Figure – 1.1

Geographical Division of Nepal



[1] Refer Nepal Rastra Bank, Kathmandu "40 Years of the Nepal Rastra Bank", April, 1996, pp 1-6 and Acharya S. P., Features of Nepalese Economy, "Mirmire Monthly", May 2000, Vol. 29, No. 176, pp 123-127.

She is one of the least developed countries in the world with per capita income \$ 250 per annum. She extends to 500 miles along the Himalayas between $26^0 25'$ and $30^0 27'$ north latitudes and $80^0 4'$ and $88^0 12'$ east longitudes. Her northern boundary adjoins to Tibet region of the People's Republic of China. On the east, she borders with the states of Sikkim and West Bengal of India. She touches the Indian states of Uttar Pradesh and Bihar to the southern part and the state of Uttarakhanda to the western part of Nepal.

Climate varies with the jingle of altitudinal diversity, that is, from very cold to very warm. She has only 23 percent of arable land. Nepal is known as one of the most beautiful countries of the world endowed with both natural scenic beauty and rich cultural heritage. The vast potential harnessing water resources, the abundant rainfall due to proximity of Himalayas, Indian Ocean and Bay of Bengal and the scenic beauties and ancient civilization with rich cultural heritage offer tremendous scope for the all-round development of the country. Nepal was opened to the outside world since the 1950s. Road links to India and Tibet (China) as well as air links to third world have helped to augment openness. Access to the sea for international connections is available through the port of Calcutta, India.

Economic characteristics of any country may vary significantly with the physical location, political setup, socio-economic structure and policy adoption. Since Nepal is a landlocked and developing country, she deserves usual underlying features of developing countries in general. Cultural diversities, economic duality, geographical hardships, agro-based economy, transitional and mixed economy, centralized district and zonal headquarters or capital, open and foreign loan/grant dependent economy etc are the some principal features to quote for.

1.1.2 Economic Policy Issues

Nepal has experienced nearly five decades of planned economy since 1956. Prior to mid 80s, she had adopted almost controlled economic policies with decisive government even in fixing day-to-day commodity prices through public enterprises. She had purely an import substitution policy until the inception of 4^{rth} Five Yearly Planning (1969-74). Export promotion concepts were introduced only in the 4^{rth} Plan documents. Government had an influential role not only in the socio-political issues but also in economic matters too. In this line, government had a sole power in fixing monetary, fiscal, financial issues, industrial, pricing, exchange rate fixation, trade, and other relevant economic policies for the nation. Central bank was not fully autonomous. Role of the private sector was not recognized and almost negligible in the economy.

In reference to a severe balance of payment (BOP) crisis, which appeared in 1989, she formally started liberalization by devaluing her currency significantly (nearly 15 percent). Thereafter, banks were allowed to quote their rate of return and cost of fund at their own discretion. Exchange rate quoting system initially embraced partial convertibility and later full convertibility regime on current account later. Economic policies (fiscal as well as monetary) were transformed. Structural Adjustment Program (SAP), Structural Adjustment Facility (SAF), and Enhanced Structural Adjustment Facility (ESAF) programs were launched in collaboration with International Monetary Fund (IMF) and the World Bank. Industrial policies were renewed and followed by open general license (OGL) system in foreign trade.

Multiparty democratic system had been reinstated on 1989. Contemporaneously, the global orientation was also inclined towards economic liberalization and globalization. Nepal also could not abstain from this wave accordingly. She also adopted her policies in line with the full liberalization in a speedy fashion from the mid 80s. She has taken membership of World Trade Organization (WTO) in 2004. Recently, Nepal is on the move for further policy transformation and liberalization in obtaining and utilizing Poverty Reduction and Growth Facility (PRGF) as announced by the IMF. For that matter, government has unchained central bank in implementing its monetary policy. At the same time, government itself is trying to refrain from unnecessary expenses and so-called white elephants are kicked off for complete privatization. Medium Term Expenditure Framework (MTEF) is the notable policy embracing on public expenditure front.

1.1.3 Socio-Economic Conditions

Having nearly a 23.5 million population with 2.1 percent natural growth, approximately the 81 percent population is dependent on subsistence agriculture that contributes nearly 40 percent share to the gross domestic product (GDP) and this sector provides opportunity of employment of nearly 75 percent of the total labor force of the country. Efforts had been made by five yearly planning systems (1956 AD) for her accelerated economic development. However, absolute poverty is visible notably everywhere in the country. Dual economy persists with nearly 15 percent privileged urban having every possible luxuries and 85 percent bucolic with destitution and adversities.

Despite the rigorous effort of the public sector, private sector and international donors on Nepal's development dynamics, recent per capita income of her dependents is repugnantly limited to around 250 in US dollar term. Year 2002 appeared to be very disgusting as this year incurred negative growth rate of 0.6 percent. Subsequent years achieved around 2-3 percent growth rate and nearly 5-6 percent inflation. Thus, the growth of GDP, population and inflation, when taken into consideration jointly resulted in a decline in real per capita income followed by discouraging economic growth. Unemployment, and specially disguised unemployment, is rather high with nearly 7 percent and 68 percent respectively.

Human development indicators are also not so much optimistic. Nineth plan (ended at 2002) records 49.2 percent literacy rate followed by 60.9 years of life expectancy and 64.2 per thousand child mortality which are considered to be higher than the average standard of the Asian nations. Population below poverty line (BPL) is estimated to be 38 percent by the end of the 9th plan and these people earn less than one US dollar a day. However, the situation has improved recently and BPL population came down to 32.5 percent as revealed through a survey launched by the National Planning Commission (NPC) on 2003. According to that report, such decline in BPL was dependent on inflow of workers' remittances in majority.

Human development index below 0.50 normally indicates low level of development. Poverty having around 32.5 percent is the main problem, which has come up due to unscientific traditional farming, uneven distribution of land holding, high population growth and poor development of industrial sector along with other socio-economic infrastructures. Compared to other developing countries the growth rate of GDP in 2004/05 remained 2.3 percent and in 2005/06. However, it registered a rise only by 2.3 percent, with agriculture and non-agriculture sector remaining 1.7 percent and 2.8 percent respectively. Complex topography and landlocked situation have always limited the scope of socio-economic and infrastructure development. Owing to poor economic base, saving is quite low and the Saving-Investment gap in Nepal has ascended to two digits. It is the outcome of poor domestic resource generation in productive venture.

The economy is still dependent on agriculture and about 89 percent of the people live in the rural areas of the country. The diversification in the economy has not taken place and this led to over-concentration in agriculture. However, this dominant agriculture has been facing several problems, like, lack in human and physical capital, economic infrastructures, appropriate strategic planning and commercialization. The productivity of the agriculture sector has been largely stagnant because of its dependence on the monsoon, almost primitive methods of production and unavailability of adequate irrigation facilities. The industrial sector is contributing about 10 percent of the GDP. The trading, construction and services have been contributing about 50 percent of the GDP and these sectors are recently providing employment to a large section of the population.

1.1.4 History of External and Fiscal Policies in Nepal:

Nepal has been an independent country governed by monarchy ranging from absolute monarchy to constitutional monarchy in different time horizon in the past. Now she has taken move for the federalist and absolute democratic system. After the Nepal-British war (1814-16), which led to the Treaty of Sugauli with British East India Company in March 1816, the country was totally closed for protecting her national interest and thwarting the possibility of British rule in Nepal. The modern era started from 1951 following the end of Rana reign in the country. The absolute monarchy continued until 1992 after the downfall of Ranas. Nepal adopted planned economy. The first economic plan was launched for the period 1956-61. The subsequent economic plans were for 5 year period in which economic goals of the country were to ensure growth acceleration and poverty alleviation. These five yearly (sometime 3 yearly or interim period as per the requirement) plans also led to changes in economic policies of the country. The fiscal policies were mainly intended for resource mobilization in order to support growth and these policies were normally reflected through yearly budget announcements and specification of medium term expenditure framework (MTEF), while trade policies, on the other hand, were designed for consumption management and export promotion. Until the fourth plan, Nepal had no export promotion oriented policies to achieve favorable balance of payment (BOP) situation. Now that the country has entered into the WTO system (in 2004), Nepal has adopted professional orientation towards import substitution, export promotion and free trade (except for few banned goods like narcotic products, alcohol etc) policies.

1.2 Global[2] vs. National[3] Economy

Global economy grew by 4.1 percent in 2003. This was possible with the expansion in the trade of goods and services and efficient macroeconomic management during this period. Similarly, the global economy in 2004, as compared to 2003, further grew by 5.3 percent. This growth was mainly due to the outcome of the adoption and implementation of expansionary fiscal policy and foreign direct investment (FDI) policies by the United States and the East Asian nations. Such pace of growth and recovery was maintained for 2005 and 2006 and is believed to be further improving and sustaining for the coming years too, following high growth rates in China and India.

The economic growth rate of Developing Asian Countries, which was 8.6 percent in 2005, according to IMF estimates, was exhibited to grow by 8.2 percent in 2006 and 8.0 percent in 2007. On the regional level, the economic growth rate of emerging Asian nations has also been higher. The growth rate of this region was 8.2 percent in 2005 and the projections for 2006 and 2007 were 7.9 percent and 7.6 percent

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[2] See World Economic Outlook, IMF, Washington D.C., September 2005, April 2006

[3] See Economic Survey, Ministry of Finance, Nepal, 2006

respectively. The South Asian Economy, which grew at an increasing rate of 7.7 percent in 2004 and 7.9 percent in 2005, was expected to grow by 7.1 percent and 6.9 percent respectively in 2006 and 2007. In India and China, the neighboring countries of Nepal, economic growth rate was 8.3 percent and 9.9 percent respectively in 2005. The economy in India in 2006 and 2007 is projected to grow at 7.3 percent and 7.0 percent respectively, whereas for China the growth rate is projected to hover around 9.5 percent and 9.0 percent respectively during the same period. At the same time Nepalese economy suffered from several economic and non-economic hindrances (set backs) and got very low growth rate of 3.3 percent in 2003, 3.8 percent in 2004 and 2.7 percent in 2005. The IMF projected that the Nepalese economy would grow at a constant rate of 3.0 percent in 2006 and 2007, and this rate is a slight improvement over that of previous year (Ministry of Finance: 2006). However, a current revision indicates that the projected growth would not be achieved due to the present investment climate and political instability. The basic concern regarding growth to Nepal is China and India. They are thriving for double-digit growth. In contrast, Nepal is suffering from high level of inflation (6 percent now) and low level of growth resulting in net loss of growth in real term, thereby, leading towards the low quality of life.

1.3 Budget Deficit and Trade Deficit in Nepal

Chronological data recording on Time Series of Trade Deficit (TD) and Budget Deficit (BD) in Nepal in International Financial Statistics (IFS) published by International Monetary Fund (IMF) is found from 1964. We have used the same in our Twin Deficit Hypothesis analysis from 1964 – 2004 for 41 years.

The nominal and real (1985=100) figures of the TD and BD have been presented at Annexure – 1. By going through the data presented in the Annexure – 1, it is observed that,

(i) the yearly volume of the TD is bigger than BD all years under study both in nominal and real terms.

(ii) both the variables (TD and BD) are seen in increasing trend over the years with volatility. This means majority of the years (within 41 years - TD nominal has increased for 31 years and TD real has increased for 27 years; and BD nominal has increased for 27 years and BD real has increased for 17 years) have registered increments in the both deficits.

(iii) however, TD has never shown positive sign testifying for the absence of trade surplus over the 41 years under study. BD has also registered positive balances only in very few years as in 1965, 1968, 1969, and 1970 respectively.

(iv) the graphical presentation (see Fig 1.1) also suggests that both the TD and BD balances (nominal as well as real) in Nepal for 1964-2004 are in increasing trend with frequent upswings and downswings during these periods.

These movements of the TD and BD variables have motivated us to examine the Twin Deficit Hypothesis (TDH) which is widely tested for the other countries, but not yet in the Nepalese context. Superimposed time plots of the TD and BD have been presented through the Figures 1.1 and 1.2.

Figure - 1.2

Time Plots of Real Trade Deficits and Budget Deficits (41 Years)

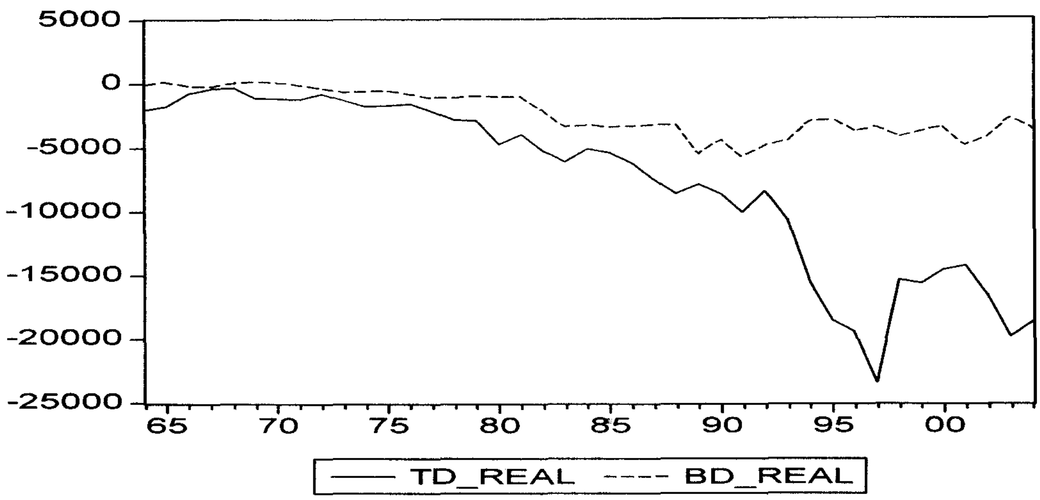
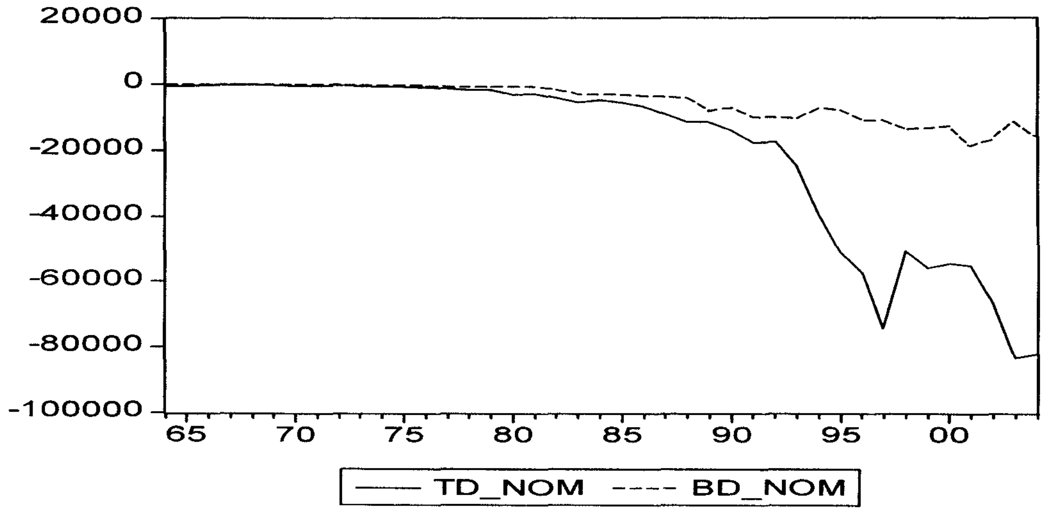


Figure - 1.3

Time Plots of Nominal Trade Deficits and Budget Deficits (41 Years)



1.4 Objectives of the Study

Twin deficits have multidimensional 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 whole economy forward (or, backward) accordingly. Considering their importance in the economy, we seek to specify the following objectives in this present study.

i To explore the causal relationship between trade deficit and budget deficit in Nepal.

ii To assess the causes and effects of budget deficit and trade deficit on principal macroeconomic variables in Nepal.

iii To examine the ongoing relation of twin deficits.

iv To set forth alternative measures for sustainable export-boost and appropriate fiscal management.

1.5 Two Main Hypotheses for Testing

The work is mainly concerned with Twin Deficit Hypothesis, and therefore, we seek to verify the following widely noted hypotheses for testing in the present study:-

i. The Budget Deficit causes the Trade Deficit in Nepalese Economy - Twin Deficit Hypothesis (Null Hypothesis), against

ii. The Trade Deficit is caused by the Budget Deficit in Nepalese Economy (Alternative hypothesis).

Different time series econometric tools will be applied for this purpose to derive the conclusions.

1.6 Sub-Objectives of the Study

The sub-objectives of the present study are as follows:

i. To assess the applicability of the policy effectiveness/ineffectiveness theorem in Nepalese economy with special reference to government expenditure and trade.

ii. To examine the Stationarity of the macroeconomic variables concerned.

iii. To explore if there exists any co-integrating relationships between the variables (Trade Deficit and Budget Deficit).

iv. To investigate the causal relationships between the variables concerned.

1.7 Plan of The Study

The present study consists of the following chapters:

Chapter - II presents the theoretical foundation and survey of empirical studies relating to Twin Deficit Hypothesis. Findings of several relevant studies related to TDH have been presented in Chapter II.

Chapter - III deals with source and nature of the data, methodological issues and period of the study. Some econometric methods, which are applied in the present study, have also been delineated in this chapter.

Chapter - IV is devoted to the study of stationarity of variables used in the study. Augmented Dickey Fuller, Phillips-Perron, DF-GLS (ERS), KPSS, ERS Point-Optimal and Ng-Perron modified unit root tests have been run. Stationarity of the variables have also been checked on the basis of correlogram (ACF and PACF) and nature of time plots.

Chapter - V presents to the study of long-run relationship between the variables concerned. In order to verify the long-run relationship between variables concerned, we have performed co-integration tests.

Chapter - VI is devoted to examine the short-run dynamics in order to analyze the stability of the long-run relationship. For this purpose, we have performed the *Vector Error Correction Modeling* for the variables concerned.

Chapter - VI is mainly concerned with the causality test between variables through the Residual tests method and *Conventional Granger Causality test* to examine the direction of causality between Budget Deficit and Trade deficit in Nepal.

Chapter - VIII analyzes *Vector Autoregression (VAR) Modeling* for further verification of the causality between variables. VAR has a quality of treating all the variables as 'endogenous' and finding the relationships between them.

Chapter - IX deals with *Impulse Response Function* in finding the dynamic responses of concerned variables across different periods in response to shocks transmitted through channels of different endogenous variables. To this concern, we analyzed the same for TD and BD.

Chapter – X focuses on *Variance Decomposition* analysis of the model variables i.e. TD and BD. VAR helps separating the variations in an endogenous variable into some component shocks.

Chapter – XI presents the summary, and conclusions along with public policy implications of our findings and future scope of the study. As a matter of fact, policy implications and policy prescriptions constitute the main theme of this chapter.

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CHAPTER – II

SURVEY OF THE LITERATURE

2.1 Literature Synthesis

This chapter presents the theoretical aspects of twin deficits and some relevant empirical works on Twin Deficit Hypothesis. Relevant models with interpretation of empirical findings are being discussed in detail in subsequent sections.

2.2 Introduction

Twin Deficit Hypothesis tells about the causal relationship between government budget deficit and trade (external) deficit. More specifically, the hypothesis indicates that government deficit will 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 macroeconomic variables concerned depending upon the market scenario and policy measures taken by the country. Mainly, there are four types of possible transmission mechanism proposed so far regarding the relationship between budget deficit and trade deficit.

i. Mundel Fleming perspective is the one. 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 highly regulated and the economy is not fully opened since lots of investment areas are still highly regulated and outflow of the capital is in total control.

ii. Second one is 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 level of marginal propensity to consume (MPC), high volume of consumption and capital expenditure of the government as well as of the public.

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 opposing 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 entirely because of rational expectations of the taxpayers. They assume that present tax cut is a future burden and government would extract it ultimately in future so that they start saving at present for meeting future burden. Such behavior would nullify the net effect so that twin deficit hypothesis would not appear.

By evaluating the aforesaid propositions, we can infer four possibilities of relationships, which are usually found in empirical investigations. Those are,

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 emergence of fiscal deficit in response to trade deficit. [Reverse proposition of (i)].

iii. by natural deduction from (i) and (ii), both of them might 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*).

2.3 Twin Deficits in Theory

Theoretical aspects of the relationship between budget deficit and external deficit, their configuration and twin deficit concept are being presented through two-dimensional geometrical displays and mathematical expressions in this section.

2.3.1 Budget Deficit

Existence of a government in the system underlies with a simple intuition of factors necessitating land (boundary), population, and sovereignty. It is the government that initially embarks upon floating activities in the country for maintaining security and legal system. It also interferes in mobilizing the economic activities and in building socio-economic infrastructures. For that, it starts mobilizing resources form individual level (citizens) and institutional level (corporate houses, multinational companies, and other institutions) by imposing taxes, non-taxes, or mobilizing grants and borrowings in meeting expenditures. As any government tends to achieve fuller employment and income generation, it needs more and more wherewithals, thereby exceeding expenditure over generated resources (revenues). This leads to the emergence of budget deficit (BD_t).

BD_t is derived mathematically by subtracting total tax (T_t) from total expenditures (G_t such that, $BD_t = (T_t) - (G_t)$. If total tax and other resources exceed total government expenditures, budget surplus results in.

In Nepalese context, composition of government expenditure is a sum total of current and development (capital) expenses. Similarly, total resource is composed of direct and indirect taxes, non-tax revenues (administrative charges, royalties, dividends and fines etc) and grants. Decomposition of budget deficit is reflected in internal borrowing, foreign debt and seigniorage. This is how Nepalese fiscal system is guided by. Additionally, budget deficit can be financed by exhausting foreign exchange reserves; receipts from privatizing public enterprises and running government budget arrears. Out of these additional means, Nepal's budget deficit is occasionally financed by the 'privatization receipts' since she is on the move for privatization. However, unutilized, accumulated foreign exchange (currently it covers the more than nine month’s imports cover in terms of goods and services) would be the other occasional source of financing if any severity crops up in the country. Nevertheless, possibility of forced government borrowing seems out of practice at least in the short future to come.

2.3.2 Trade Deficit

Trade deficit is a net result of import (domestic absorption) exceeding over export i.e. (M-X). If any country's production pattern is not responsive to contemporary market behavior or policy shocks or is in structural rigidity with poor human resource, capital deficiency and obsolete technology, then it had to depend more on import with suppressed export. In such a situation, trade deficit becomes really a problem to the nation. Furthermore, if country needs more capital-intensive goods, it is quite natural that it even augments more import, thereby, incurring higher trade deficit. Simultaneously, if efficiency parameters and morale values were in question in the nation, the nation would even further run more and more trade deficit for the cost of simple basic consumption to luxury. Internal disorder again fuels the fire. Nepal holds almost all properties discussed above and is running very high trade and current account deficits for almost the entire period under study (1964 - 2004).

2.4 Behavior of Twin Deficits & Their Impacts

Straight effects of the twin deficits are reflected in real sector and monetary sector through interest rates or exchange rates etc. So, familiarization with the behavior of the twins and their transmission mechanism is indispensable before embarking upon our research study.

2.4.1 Floating Exchange Rate and Full Capital Mobility

Under this regime, an increase in government expenditures elevates interest rate within the home economy. As the interest rate goes up, chance of inflow of foreign capital rises if the economy is open. Due to the capital inflow, investment activity would prosper and if the economy is not responsive to the newly availed opportunity, the importing behavior would rise at least mainly for the capital expenditure. As a consequence, import would escalate and export may not increase compared to import and the resultant effect would be the current account or the trade deficit. This is explained through a graphical presentation below:

Figure – 2.1

IS-LM Model Under Floating Exchange Rate & Full Capital Mobility

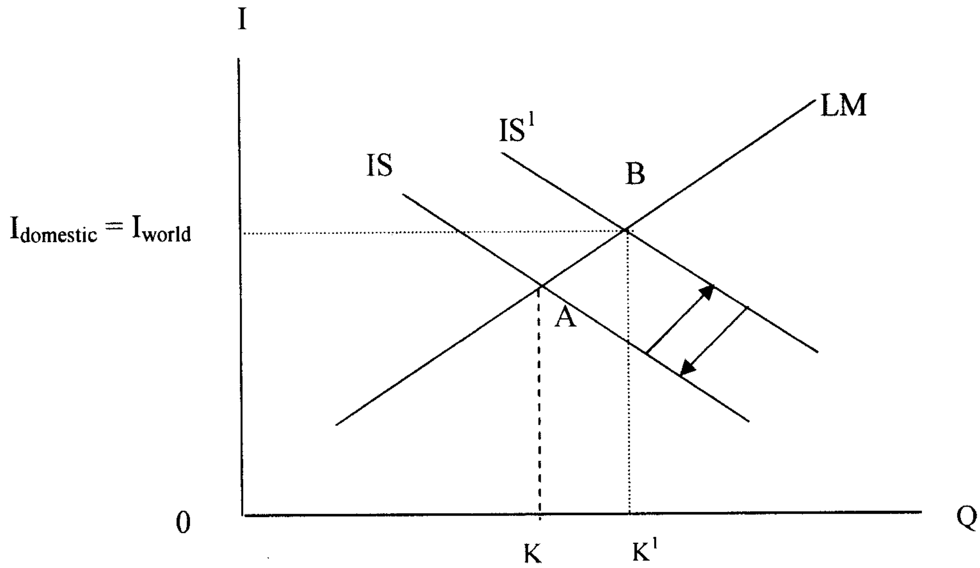


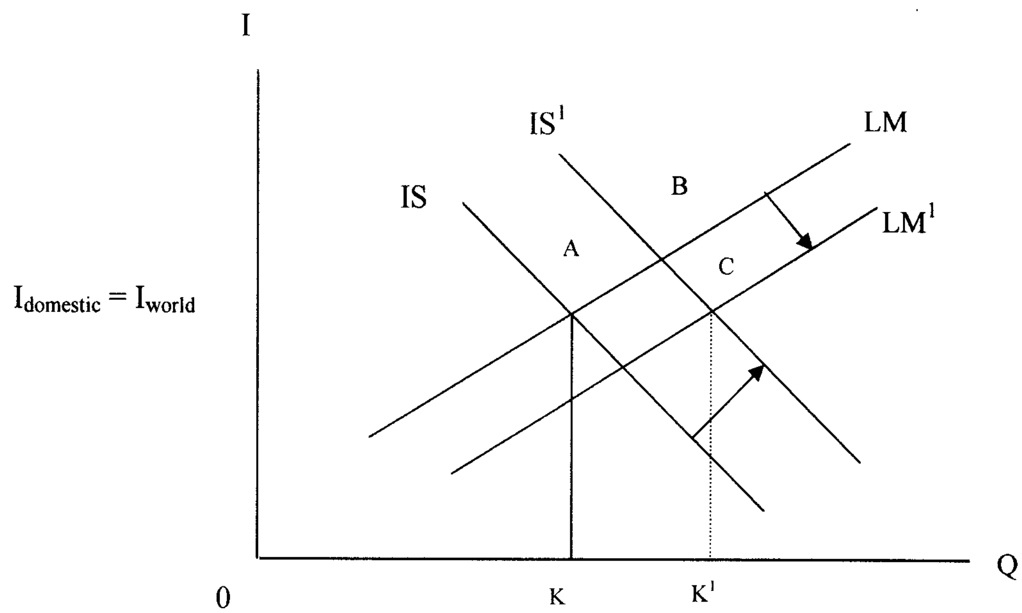
Figure - 2.1 represents the same message as discussed above. As the government expenditure expands by augmenting the fiscal deficit, IS curve shifts towards right to IS^1. However, since the international capital mobility is free to enter into the country and it comes to reap the higher rate of domestic interest, as a consequence exchange rate appreciates, thereby, rise in import and fall in export leading to current account deficit. This scenario provokes IS curve to shift back to initial position (at IS) so that domestic interest rate and international interest rate tend to be equal leading to no increment in aggregate demand with appreciated domestic currency resulting in current account or trade deficit.

2.4.2 Fixed Exchange Rate and Full Capital Mobility

In the fixed exchange rate regime with full capital mobility, escalation in government spending, which shifts the IS curve towards right to IS^1, causes domestic interest rate to rise and capital inflow ascends. When flow of foreign currency rises in such regime, economic agents incline to exchange (buy) foreign currency in order to reap exchange rate arbitrage leading to rise in money supply which forces to shift the LM curve towards right-hand-side at LM^1.

Figure – 2.2

IS-LM Model Under Fixed Exchange Rate & Full Capital Mobility



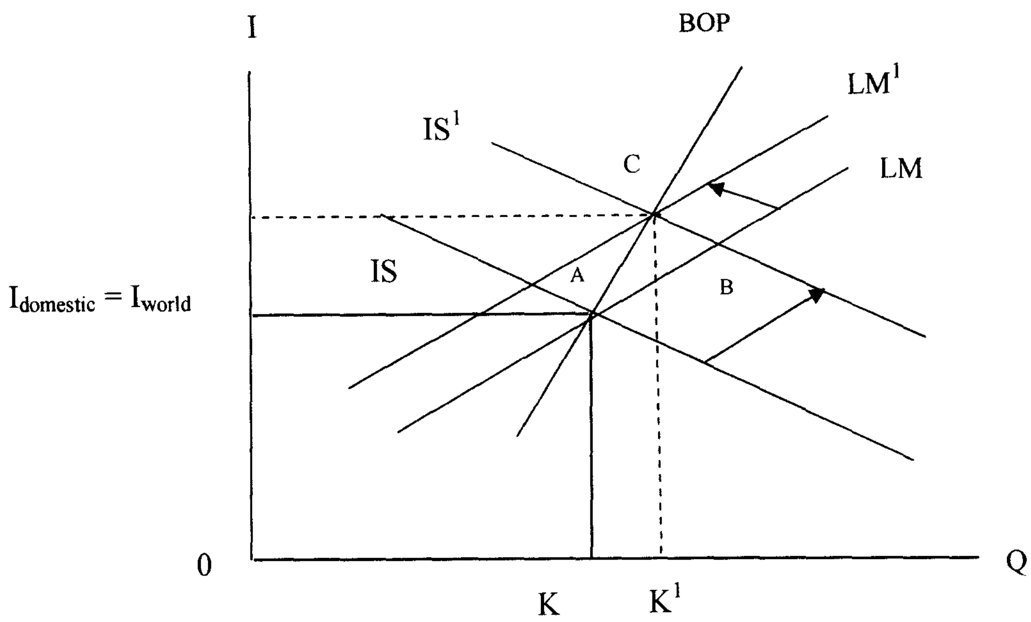
Rise in aggregate demand caused by excess money supply and government spending would augment imports resulting in high trade deficits in the long run. However the global and domestic interest rates will be at par in equilibrium with deficit in the current account.

2.4.3 Fixed Exchange Rate and Limited Capital Mobility

Perfect capital mobility is always not a subject of regular custom in the real world situation. For this purpose, let us cite an example of limited capital mobility with fixed exchange rate regime and try to dig out its consequences in the economy.

Figure – 2.3

IS-LM Model Under Floating Exchange Rate & Limited Capital Mobility



Let us assume that the economy is in initial equilibrium at point A. When the government spending escalates augmenting fiscal deficit, IS curve shifts to right at IS^1. In this course, let us draw a BOP line steeper than LM curve implying limited capital mobility. The intersection of IS^1 occurs in the LM curve at point B below the BOP line. At point B, CAD/TD occurs. Since the exchange rate is fixed, the monetary authority loses its foreign exchange reserves in protecting exchange rate so that devaluation pressure crops up. Domestic money supply falls as the demand increased for foreign exchanges by the domestic residents. As a consequence, domestic money supply falls after some time because of high amount of foreign exchange hoarding by the residents. Due to the decrease in money supply, LM curve shifts to LM^1 and new equilibrium point is restored at C, where BOP also remains in equilibrium. At this point, domestic interest is higher so that AD increases following trade balance deterioration leading to current account deficit

2.5 How Budget Deficit (BD) and Trade Deficit (TD) are Twin Deficits: Exposition

By terminology, so-called twin deficits are not new to us since they represent budget deficit and trade deficit. Fiscal deficit had affected external deficit to move positively during 1980s and early 1990s in USA and then political economists had shown deep concern on its effects and given its name as *'inseparable twins'*. Martin Feldstein had popularized this terminology first time (1985) in USA. Onwards, they have secured popular place as *'twin deficits'* in economics literature. There was a hypothesis that budget deficit (BD) was the cause of trade deficit (TD) since its secular type of positive relationship observed empirically too in USA at that time. This proposition has been widely tested with cross-country data. In Nepal's case also fiscal deficit and trade deficit are moving in the same direction with negative balances for almost all periods incorporated under study.

Let us consider a macroeconomic system and find how these are twins. As such,

$$Y = C + I + G + (X - M) \quad \text{......} \quad (2.1)$$

$$Y = C + S + T \quad \text{......} \quad (2.2)$$

$$C + I + G + (X - M) = C + S + T \text{ (By substituting equation 1 on 2)} \ldots\ldots\ldots \quad (2.3)$$

$$(I - S) + (G - T) - (M - X) = 0 \quad \text{(S stands for Saving)} \ldots\ldots\ldots \quad (2.4)$$

$$(I - S) + (G - T) = (M - X) \quad \text{(By manipulation)(Symbol of twin behavior)} \ldots \quad (2.5)$$

$$(I - S) = (M - X) + (T - G) \ldots\ldots\ldots \quad (2.6)$$

The three terms in the parentheses represent there different deficits such as,

(i) (I –S) implies Domestic Savings Deficit

(ii) (G – T) implies Budget (Fiscal) Deficit

(iii) (M – X) implies External Trade Deficit

If the sign changes in the all concerned deficits, the drama turns to a situation of "hell to heaven" i.e. all deficits to surpluses. However, excess surpluses are also subjects of other debates because of their demerits. Basically, (i) the Keynesian and Tobin problem of surpluses, aggregate demand and private sector balance sheets; (ii) the *Greenspan problem* i.e. what should we do with excess surplus when the publicly held national debt is paid off?; (iii) the *Minksy problem* about implications of repaying the publicly held national debt for financial markets; and (iv) the open market operations (OMO) problem i.e. implications of repaying government debt for the conduct of monetary policy are four[4] major concerns that describe the problems of excess government surpluses.

The equation (2.5), if doesn't turn to the form of the equation (2.6), budget deficit and trade deficit always behave as twins implying budget deficit being the source of financing of trade deficit where investment and saving are not responsive to

4 See: Thomas I. Palley, The Case Against Budget Surpluses: Why Government Debt is Good and Moderate Budget Deficits are Needed in a Growing Economy, (Public Policy, AFL-CIO, Washington DC), Paper presented at the meetings of the Canadian Economics Association, McGill University, Montreal, Quebec, May 31-June 3, 2001. (tpalley@aflcio.org)

policy shocks or where investment and saving have fairly negligible role in the economy owing to high level of consumption.

2.6 Empirical Models and Findings

Many scholars have attempted to evaluate the hypotheses on all possible grounds. TDH had especially been made more popular and gone through series of empirical investigations after the emergence of secular nature of simultaneous movement of the twins in the United States from the early 1980s. In economic literature, many researches focused on the inter-link between twin deficits. Mrs. Olga Vyshnyak of National University, Kyiv-Mohyla Academy, Ukraine mentioned several research findings from literature review in her research paper, "*Twin Deficit Hypothesis: The Case of Ukraine.*" These findings are being presented through the Table 2.1.

Olga Vyshnyak (2000) in her own research study found for Ukrainian data that past movements in government budget Granger-caused movement in current account deficit (CAD) meaning a *unidirectional causality from budget deficit to current account deficit in the long-run.*

For this verification, she had run a bi-variate regression model as -

$$CAB_t = c(1) + c(2)BB_t + u_t$$

Table – 2.1[5]

Relationship Between Twin Deficits

Authors/s	**Sample Countries**	**Results/Findings**
Darrat (1988)	USA	Bi-directional causality between TD & BD.
Bahmani-Oskooee (1989)	USA	Unidirectional causality from BD to CAD.
Latif-Zaman & DaCosta (1990)	USA	Unidirectional causality from BD to CAD.
Enders & Lee (1990)	USA	Positive innovation in government debt is associated with an increase in 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.

She attempted verification of *co-integration test*[6] between model variables and *Granger causality* between them. In verifying the *Ganger causality*, he had run the following specifications:

5 Source: Ms Olga Vyshnyak, Twin Deficit Hypothesis: The Case of Ukraine, National University 'Kyiv-Mohyla Academy', Department of Economics, Ukraine, 2001

$$BB_t = \alpha + \sum_{j=1}^{l} \beta_t CAB_{t-1} + \sum_{j=1}^{l} \gamma_j BB_{t-1} + u_{1t}$$

$$CAB_t = \theta + \sum_{j=1}^{l} \delta_j BB_{t-1} + \sum_{j=1}^{l} \lambda_j CAB_{t-1} + u_{2t}$$

However, she did not run Error Correction Mechanism (ECM) for the short run relationship between BD and CAB. The data used in the study were just for 8 years, since Ukraine was running through a political transition period.

Elif Akbostanci and Gul Ipec Tunk (2002) have found on their "*Turkish Twin Deficits: An Error Correction Model of the Trade Balance*" that the Recardian Equivalence Hypothesis (REH) is not validated both in the long run and in the short run as well. In arriving at this result, they had used ECM by specifying following equation.

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \Pi X_{t-k} + \mu + \varepsilon_t$$

where, $\Pi = \alpha\beta'$ and,

$$\alpha = \begin{bmatrix} \theta_0 \\ \theta_1 \\ \theta_2 \\ \theta_3 \end{bmatrix} \begin{array}{l} bbal \\ trbal \\ mon \\ ipi \end{array} \qquad \beta_1 \begin{bmatrix} bbal & trbal & mon & ipi \\ \theta_4 & \theta_5 & \theta_6 & \theta_7 \end{bmatrix}$$

This model has supported persistence of *Twin Deficit Hypothesis* both for short run and long run with sample data of Turkey for 15 years (1987 - 2001) of the model variables.

6 The two time series are co-integrated, if the residuals from the regression results of the model are stationary. (Gujarati, 1995, Pages 726-727)

Ahmet Zengin worked on *"The Twin Deficits (The Turkish Case)"*, using Vector Autoregressive (VAR) Model. The evidence from the eight - variable (budget deficit, trade deficit, seasonal adjusted external revenue, seasonal adjusted internal revenue, trade weighted effective real exchange rate, average interest rates on securities, money supply-M2, and GNP deflator) *VAR system* also supported the *Twin Deficit* notion that budget deficits led to the emergence of trade deficit.

In arriving at this conclusion, he used the following model with forecasting matrix and variance decomposition.

$$xX = c + a(L)X_{t-1} + U_t$$

where,

Σ = uu', with Σ to be the covariance matrix of VAR residuals

C = vector of constant terms *(C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8)*,

X_t = the vector of the model variables *(BD, TD, DG, IG, TE, HF, M_2, EN)*

u_t = a vector of random disturbances

a(L) = the matrix of polynomial in the lag operator L.

where forecasting matrix is formulated in the vein of following modality,

<u>Forecasting Matrix</u>

$$\begin{bmatrix} BD_t \\ TD_t \\ DG_t \\ IG_t \\ TE_t \\ HF_t \\ M_{2t} \\ EN_t \end{bmatrix} = \begin{bmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \\ C_5 \\ C_6 \\ C_7 \\ C_8 \end{bmatrix} + \begin{bmatrix} 0 & 0 & 0 & 0 & a_{15}(L) & a_{16}(L) & 0 & 0 \\ a_{21}(L) & a_{22}(L) & 0 & 0 & 0 & a_{26}(L) & 0 & 0 \\ 0 & 0 & a_{33}(L) & 0 & a_{35}(L) & a_{36}(L) & 0 & 0 \\ 0 & 0 & a_{43}(L) & 0 & 0 & 0 & a_{47}(L) & a_{48}(L) \\ 0 & 0 & 0 & a_{54}(L) & a_{55}(L) & a_{56}(L) & a_{57}(L) & 0 \\ 0 & a_{62}(L) & a_{63}(L) & 0 & 0 & a_{66}(L) & 0 & 0 \\ 0 & 0 & 0 & a_{74}(L) & a_{75}(L) & 0 & a_{77}(L) & a_{78}(L) \\ 0 & 0 & 0 & a_{84}(L) & a_{85}(L) & 0 & 0 & a_{88}(L) \end{bmatrix} \begin{bmatrix} BD_{t-1} \\ TD_{t-1} \\ DG_{t-1} \\ IG_{t-1} \\ TE_{t-1} \\ HF_{t-1} \\ M_{2t-1} \\ EN_{t-1} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \\ e_{3t} \\ e_{4t} \\ e_{5t} \\ e_{6t} \\ e_{7t} \\ e_{8t} \end{bmatrix}$$

Mamdouh Alkswani (2000) studied "*On the Twin Deficits Phenomenon in Petroleum Economy: Evidence from Saudi Arabia*". Saudi Arabian database did not support long run equilibrium relationship between the deficits. Rather the direction of causality from trade to budget deficit persisted in petroleum economy's case.

To arrive at this conclusion, he used two-step ECM as follows. First step OLS regressions were run as,

$$BD_t = \alpha_0 + \alpha_1 TD_t + \varepsilon_t \quad \textit{and}$$

$$TD_t = \beta_0 + \beta_1 BD_t + \mu_t$$

The second step to estimate the ECM representation was,

$$\Delta BD_t = \alpha_0 + \sum_{i=1} \alpha_{1i} \Delta TD_{t-i} + \sum_{j=1} \alpha_{2j} \Delta BD_{t-j} + \lambda e_{t-1}$$

$$\Delta TD_t = \beta_0 + \sum_{i=1} \beta_{1i} \Delta BD_{t-i} + \sum_{j=1} \beta_{2j} \Delta TD_{t-j} + \delta \mu_{t-1}$$

Again, for Granger causality verification, he did use the following specifications.

$$X_t = \sum_{i=1}^{m} a_i X_{t-i} + \sum_{j=1}^{n} b_j Y_{t-j} + u_t$$

and,

$$Y_t = \sum_{i=1}^{r} c_i Y_{t-i} + \sum_{j=1}^{s} d_j X_{t-j} + v_t$$

where, X_t and Y_t are represented BD_t and TD_t respectively. Saudi Arabian data for 30 years (1970-1999) were incorporated in the study.

Stilianos Fountas and Christopher Tsukis (2000) did the cross country study on *'Twin Deficits, Real Interest Rate and International Capital Mobility'* and concluded that the TDH was upheld only in the cases of Germany and the UK and that was also in the short run. The opposite hypothesis of *'current account targeting'* carried some weight in case of Canada in the short run. In case of the Netherlands, there was some evidence consistent with current account targeting as shown by the sign of co-integrating vector. However, the result was not supported by the long-run exogeneity tests.

Abdulnasser Hatimi-J and Ghaji Shukur tested twin deficit hypothesis in *"Multivariate – Based Causality Tests of Twin Deficits in the US"*. They used alternative method for testing the direction of causality between US twin deficits with *Rao's 'Multivariate F-test'* combined with *Bootstrap Simulation Technique*. For this purpose, they identified the VAR model as,

$$Y_t = \eta + A_1 Y_{t-1} + \cdots\cdots + A_p Y_{t-p} + \varepsilon_t$$

where,

$\varepsilon_t = (\varepsilon_{1t}, \ldots\ldots, \varepsilon_{kt})$ is a *Zero Mean Independent White Noise Process* with *Nonsingular Covariance Matrix* $\sum \varepsilon$, *and for* $j = 1, \ldots, k$, $E / \varepsilon_{jt} /^{2+\tau} < \infty$ *for some* $\tau > 0$.

Using quarterly US data from 1975Q1 - 1998Q2 from IFS with multivariate Rao's F test and *Bootstrap Test applying VAR (2)*[7], they found very interesting result that twin deficits did not Granger cause each other for the whole sample period. While identifying structural break and using sub-periods data separately, first sub-period data

7 For detail, vide Abdulnasser Hatimi-J and Ghaji Shukur, Multivariate – Based Causality Tests of Twin Deficits in the US, International School, Jonkoping University, Sweden, JEL classification, C32, H62.

supported *BD Granger causing Current Account Deficit (CAD)* while second sub-period data supported *CAD Granger causing BD*. So, they inferred that the *'Lucas Critique'* might have been in effect owing to internal policy shifts and international economic shocks.

Michel Normandin (1999) summarizes in his most technical research paper on *'Budget Deficit Persistence and the Twin Deficit Hypothesis,'* by using Blanchard's *Overlapping Generation Model*, and held that "........ the relevant Canadian consumer's horizon (which can be long) and the persistence of the Canadian budget deficit produces responses that are statistically positive. In contrast, the relevant U.S. consumer's horizon (which can be long) and the dynamic behavior of the U.S budget deficit yield responses that are statistically insignificant."

G. Karras and F. Song (1994) also carried out a highly mathematical research on "*Government Spending and the Current Account: Some International Evidence*." They presented their empirical results on neoclassical framework i.e. transitory (permanent) changes in government spending reduced (left unaffected) the trade balances. It means, transitory change in government spending motivated the utility maximizing consumers to consume out of permanent income, which remained almost unaffected by government spending. Changes of this nature, therefore, created a desire to smooth consumption, which was accommodated by corresponding changes in the current account. Permanent change on the other hand, created no such smoothing motivation and hence had no impact on current account. Using data for Australia, Italy, Sweden, the UK and the US, they found that the current effects of permanent changes in government spending in all five countries were statistically not different from zero, as predicted by the theory. The effects of transitory changes in government spending however were found to be consistent with the model only for the UK and the USA. The Australian, Italian and Swedish current accounts were not statistically related to transitory changes in government spending. They held that adoption of a textbook Keynesian model or a model with liquidity constraints could not resolve these puzzling findings.

Daniel L. Thornton[8] (2003) offered a very innovating research paper, "*Do Government Deficits Matter?*" He first explored the relations of deficits to private saving, interest rates, trade deficit, output, and inflation. Then he further elaborated Keynesian Hypothesis and Recardian Equivalence as well. He used the data for 16 OECD countries over the period 1975-86. His data were of pooled time series/cross section representation. He introduced first the general equation as,

$$DV_{it} = \alpha_{it} + \beta_{it} DEF_{it} + \varepsilon_{it,} \quad i = 1,\ldots\ldots, K, \; and \; t = 1,\ldots\ldots, T, \; \ldots\ldots \text{(a)}$$

where,

$DV_{it} = t^{th}$ observation of the i^{th} country of Dependent Variable

$DEF_{it} = t^{th}$ observation of the i^{th} country of the deficit measure

α_{it}, β_{it} = fixed parameters and

$\varepsilon_{it,}$ = the disturbances

But the equation (a) could not be estimated as the numbers of parameters exceeded the numbers of observations. This problem had been circumverented by obtaining time series/cross section representations of equation imposing the restrictions as:

8 The author is Assistant Vice President at the Federal Reserve Bank of Saint Louis, USA.

$\alpha_{it} = \alpha_t$ *and* $\beta_{it} = \beta_i$ *for all t* for time series, and

$\alpha_{it} = \alpha_t$ *and* $\beta_{it} = \beta_t$ *for all i* for cross sectional data.

Thus, the following specifications were ensured,

$$DV_{it} = \alpha_t + \beta_i DEF_{it} + \varepsilon_{it}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(b)}$$

$$DV_{it} = \alpha_t + \beta_i DEF_{it} + \varepsilon_{it}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(c)}$$

A pooled time series/cross section representation could be obtained by imposing the restrictions $\alpha_{it} = \alpha$ *and* $\beta_{it} = \beta$ *for all .i and t* to obtain equation (d),

$$DV_{it} = \alpha + \beta\ DEF_{it} + \varepsilon_{it}, \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad \text{(d)}$$

This was just equivalent to imposing the restrictions $\alpha_i = \alpha$ *and* $\beta_i = \beta$ *for all i* on the time series model or $\alpha_i = \alpha$ *and* $\beta_t = \beta$ *for all t* on the cross sectional model.

Equations (b) to (d) were estimated with annual observations on the government deficits, nominal interest rate, the trade deficit, the price level (1980 = 100), the inflation rate, real output growth and private saving of the 16 OECD countries (k = 16 and T = 12). The equations were estimated both at levels and first differences.

Estimates of equations for both the levels and first differences data suggested that increase in deficit spending was associated with decrease in personal saving. It means that, as the public savings decreased, so did the private savings. This result was not consistent with the Ricardian view that public and private savings were substitutes. Thus, this research paper suggested the prospect of prevalence of *Twin Deficit Hypothesis (TDH)*.

Amelie Clement deliberated on REH and TDH in *"Twin Deficits: A Cyclical Phenomenon?"* In explaining REH, in a two-period economy, the researchers held that the consumers tried to maximize their utility function,

$$U(C_1) + \beta U(C_2)$$

which was subject to an inter-temporal budget constraint as follows,

$$C_1 + \frac{1}{1+r}C_2 = (Y_1 - T_1) + \frac{1}{1+r}(Y_2 - T_2) + (1+r)\beta_1^P$$

where,

r = interest rate

β = a subjective discount factor and

β_1^P = individual holding of financial assets at the end of period T = 0.

The government, for its part, had also to satisfy its budget constraint as,

$$G_1 + \frac{1}{1+r}G_2 = T_1 + \frac{1}{1+r}T_2 + (1+r)\beta_1^G$$

which means that the present value of government expenditures should be equal to the present value of its revenues, i.e. taxes, added to the discounted value of its financial assets at the end of the previous period.

Assuming that the consumers were perfectly informed, forward looking and, therefore, could see "through" the government budget constraint by understanding the relation between spending and taxation ultimately, they integrated it to their own budget constraint given below,

$$C_1 + \frac{1}{1+r}C_2 = (Y_1 - G_1) + \frac{1}{1+r}(Y_2 - G_2) + (1+r)(\beta_1^P + \beta_1^G)$$

where,

$\beta_t^P + \beta_t^G = \beta_t$ is the stock of foreign assets of the whole economy.

REH has very strong assumption that taxes have no effect on budget constraint of consumers. In the long-run, present value of taxes remained the same and, therefore, there was no effect on current account through consumption channel.

Again variation in government spending, allowing taxes remaining unchanged with zero CAB in small economy did not affect CAB. In this new fiscal policy shift, government savings would decrease because it issued debt or sold assets matching the spending in order to satisfy the following budget constraint,

$$\beta_2^G - \beta_1^G = r\beta_1^G + T_1 - G_1$$

Given this behavior of government, private sector adjusted its consumption and saving to match expected tax rise in future to meet the newly issued debt.

Clement again tried to verify the TDH through testing of both hypotheses for US data of 1980s and 1990s. The main issue in this study was to examine if government deficit affected the CAD. This study showed that neither REH nor TDH were able to explain correctly the effects of fiscal behavior.

Carlous Fonseca Marinheiro's (2001) study on *"Recardian Equivalence: An Empirical Application to the Portuguese Economy"* had many attention-grabbing outcomes on REH (alternatively TDH). For this, he had gone through various models[9] like Reduced Form and Structural Consumption Functions of Kormendi's (1983), Modigliani and Sterling (1986), Bernheim (1987a), Pereleman and Pestieau(1993), Cardia (1997), Leachman (1996) and Euler equation approach on a *Generalized*

9 Though the elaborations of the scrutinized models were at good length in the paper, however mentioning all the details here is beyond the scope of this research paper. Kindly vide Carlos Fonseca Marinheiro, Ricardian Equivalence: An Empirical Application to the Portuguese Economy, Faculty of Economics of the University of Coimbria and Katholieke Universiteit Leuven, Portugal, March 2001 for detail study.

Permanent Income Model, *Excess Sensitivity and Permanent Income Hypothesis*, and a *'Permanent Income Hypothesis'* with a consolidated government sector.

The author had run ADF test to check the order of integration of the data series as following,

Let X_t be generated by the process

$$X_t = \delta + \phi_1 X_{t-1} + \varepsilon_t$$

where, $\varepsilon_t \sim iid\ N(0, \alpha_t^2)$

If X_t were a stationary process, then X_t would have a constant average

$$E(X_t) = E(X_{t-1})$$

Consequently,

$$E(X_t) = \delta + \phi(X_{t-1})$$

$$or \ \ \mu = \delta + \phi_1 \mu$$

$$or \ \ \mu = \frac{\delta}{1-\phi}$$

In order to have finite average, one should have $\phi \neq 1$. With $\phi = 1 + \alpha$ we obtain: $\Delta X_t = \delta + \alpha X_{t-1} + \varepsilon_t$.

When $\alpha = 0$, the variable defines a random walk process, and therefore, it is not stationary. Stationary implies a negative value for α. The test to be valid requires that the error term be white noise. In order to fulfill this requirement one adds lagged difference of the series until the residuals of the regression are white noise. This is the ADF test. The null of non-stationarity is tested by $\alpha = 0$ in the following equation:

$$\Delta X_t = \delta + \alpha X_{t-1} + \sum_{j=1}^{k} \Delta X_{t-j} + \varepsilon_t$$

When empirical application to the Portuguese economy was done, the Komerandi (1983) specification, which was in line with Ricardian predictions, was rejected. The standard Keynesian view that public expenditures have negative influence on consumption was accepted.

Andrew B Abel and Ben S Bernanke (2003) analyzed in their book, 'Macroeconomics'[10], the relationship between the US government budget deficit and current account deficit for the period 1960-1998. They found that the twin deficit relation had gone in opposite direction barring the period of whole 1980s and first half of the 1990s.

The authors also mentioned some evidences on this issue from other countries in the same book referring the paper[11], *'Investigating U.S. Government and Trade Deficits'*. They reported mixed observations for other countries. For example, Germany's budget deficit and current account deficit both increased in the early 1990s following the reunification of Germany. During mid 1980s, however, Canada and Italy both ran government budget deficits that were considerably larger than those in the United States (as percentage of GDP), without experiencing severe current account problems.

Finally the authors concluded, if an increase in the government budget deficit was not offset by an equal increase in private saving, the result must be a decline in domestic investment and rise in the current account deficit.

10 Andrew B Abel (The Wharton School of the University of Pennsylvania) and Ben S Bernanke (Woodrow Wilson School of Public and International Affairs, Princeton University) have written very excellent book i.e. Macroeconomics, Pearson Education Inc., 2001 (First Indian Reprint, 2003).

11 Ellis Tallman and Jeffery Rosenweig, Investigating U.S. Government and Trade Deficits, Federal Reserve Bank of Atlanta, Economic Review, May/June 1991, pp. 1-11

2.7 Chapter Summary

This Chapter presents a survey of some relevant literatures and books regarding the *Twin Deficit Hypothesis (TDH)*. Researchers used different models and estimated the models with different time horizons. Accordingly, test results were not unanimous and on the contrary, the findings varied widely. Such diversified and contradictory results might be due to country-wise economic policy divergence, nature of data and their definitions (possibility of lacking uniform practices of aggregation in countries), model specification constraints (e.g. partial modeling instead of full modeling), variable-identification problem and the time span.

However, all the empirical studies mentioned in this chapter had gone through some battery of tests, which ranged from sequential order of stationary testing to causality verification under time series econometric framework.

❖❖❖

CHAPTER – III

DATA AND METHODOLOGY

3.1 Introduction

This chapter presents the research framework of the study, methodology, models and their support on *a priori* and empirical grounds, testing methods, properties of the data to be employed and the related econometric issues.

3.2 Research Framework

It is a time-honored practice to follow some theoretical guidelines whenever practicable and, therefore, it seems appropriate to present the flow chart (Figure – 3.1) upon which our research is based. An attempt has been made to tag on the succeeding edifice regarding our research program implementation. Our study is purely dependent on secondary data and we have tried this framework to the extent applicable to its nature of work.

3.3 Sources, Nature and Periods of Data

Present study is related to the relationship between budget deficit and trade deficit in Nepal for the period 1964 - 2004. The source of the data sets of the present study is *International Financial Statistics (IFS)*, a publication of International Monetary Fund (IMF). We have mainly used the Year Books of 1992, 2004 and 2007 of the IFS as an authenticated secondary source of data. We have used the nominal as well real data of Budget Deficits and Trade Deficits under study. Base period is 1985

(1985=100) for the real data. . For cross checking, publications of Nepal government and Nepal Rastra Bank (Central Bank of Nepal) have been used since these are the sole and authentic sources to IMF too.

3.4 General Methodology and Hypothesis Testing

This research study takes into considerations of the propositions of the *'Lucas Critique'*, because macroeconomic variables of the national income identity are more inclined to policy shifts which affect their simultaneous relationships. For example, economic performances would exhibit completely different sketches corresponding to controlled or decontrolled economic policies. So, we have also attempted to utilize the testing modality in a way to "*let the data speak for themselves*".

A shower of research articles has described the testing apparatus of a time series sequence for the presence of unit roots. Many kinds of testing methods and models are available in this field. In general, *"Unit Root Test"*; *"Co-integration Test"*; *"Vector Auto-regression (VAR)"*; *"Error Correction Model (ECM)"* and *"Granger Causality"* are the more pronounced and experimented techniques in the applied econometric literature. This research will also attempt to follow the same path for causality testing. Again *'Hypotheses Set'* in the aforesaid headings will be tested on the perspective of the models specified earlier.

Along this course, time series data may be found to be 'non-stationary' containing a unit root (Gujarati, 1995, p.714). VAR estimates are more efficient if variables included in the VAR model are either stationary or co-integrated. So, data will be tested for stationary of concerned variables by applying ***Augmented Dickey-Fuller Test (ADFT)***. Afterwards, *co-integration* of the variables will be checked. Then, *Granger causality* test will be conducted to find the direction of causality among the variables in the specified models.

This study is basically guided by classical econometric structure[12] and Classical Linear Regression Model (CLRM). For the analysis of the study we have used various econometric tools. Several models, which are based on econometric analysis, have been used for the present work. These models will be specified in appropriate chapters as and when needed. Testing for stationarity is based on *Unit Root Test* and ACF / PACF (correlogram). *Cointegration Test, Vector Error Correction Modeling, Granger Causality Test, Vector Autoregression (VAR)* model, *Impulse Response Function* and *Variance Decomposition* analysis are some of the important econometric tools used in the present study.

3.5 Research Methodology: Basic Features of Some Test Procedure:

We seek to explain some basic features of the Test Procedures for the study of stationarity of the variables concerned, *'Co-integration'* of the variables showing their long-term relationship, *Vector Error Correction Mechanism* for the study of short-run relationship among them, *Granger Causality* study and *VAR modeling* with *Impulse Response Function* and *Variance Decomposition* etc. These are being presented in the following sub-sections (3.5.1 – 3.5.8 and 3.6 – 3.12).

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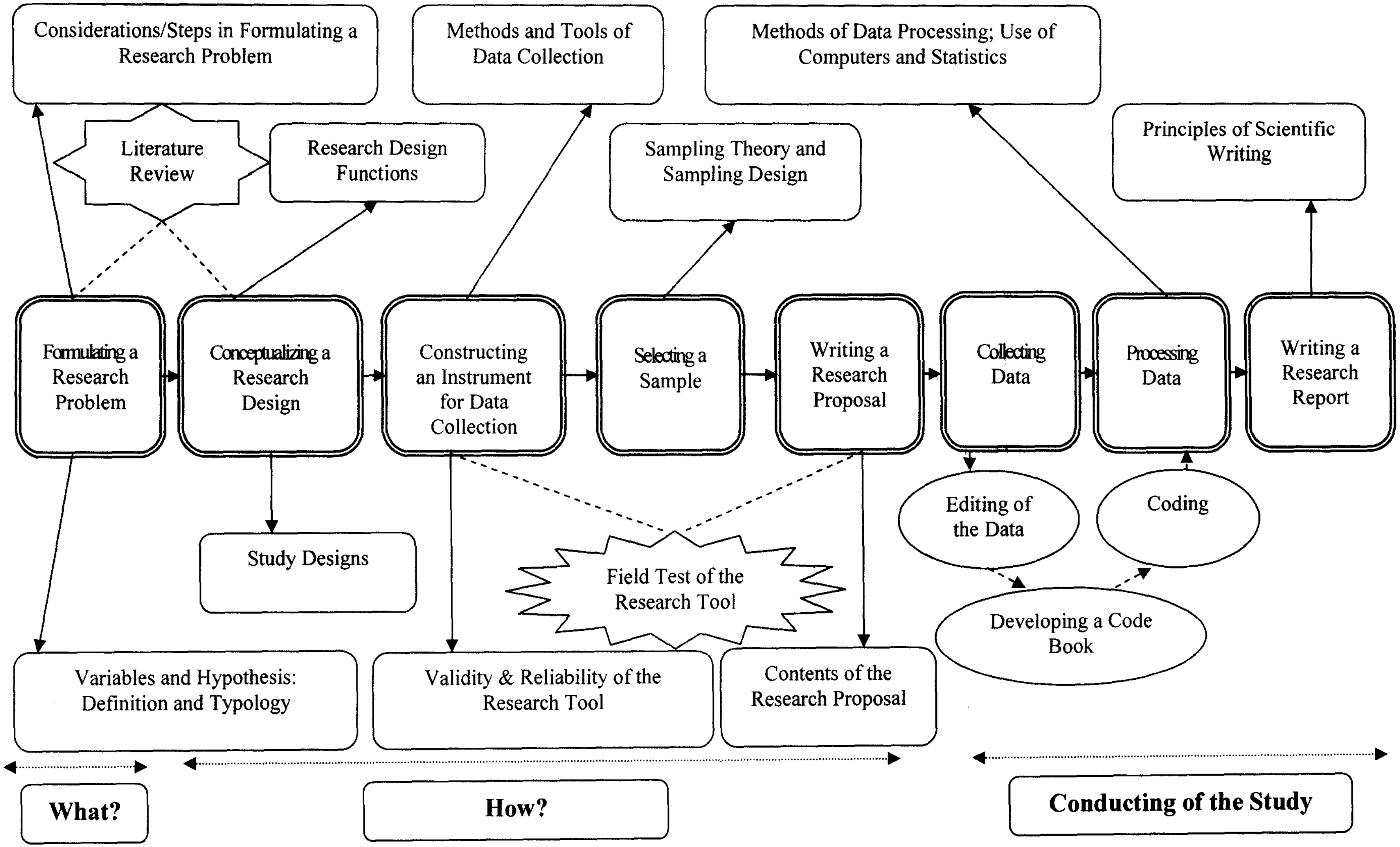
12 The other branch of econometrics is Bayesian Econometrics and enthusiastic readers are suggested to explore on it. Some of the interesting book are, Peter M lee, Bayesian Statistics: An Introduction, Oxford University Press, England, 1889 (Introductory); Dale J Porier, Intermediate Statistics and Econometrics: A Comparative Approach, MIT Press, Cambridge, Massachusetts, 1995 (Intermediate) and Arnold Zeller, An Introduction to Bayesian Inference in Econometrics, John Willey & Sons, New York, 1971 (Advanced).

Figure - 3.1

The Research Process[13]



13 Ranjit Kumar, Research Methodology, A Step-by-Step Guide for Beginners, SAGE Publication, 1999, pp 17.

3.5.1 Unit Root Tests (Stationarity Test)

When time series data are used in econometric analyses, the preliminary statistical step is to test the stationary of each individual series. Unit root tests provide information about stationarity of the data. Non-stationary data would contain unit roots. The main objective of unit root tests is to determine the degree of integration of each individual time series. Results derived from the regression models would produce 'Spurious Results' if we used the data without checking their Stationarity Properties.

We can examine the stationarity of the datasets through following three methods:

(i) Graphics

Graphical representation of the data gives an initial idea about the possibility of stationarity or non-stationarity in the data concerned. If the time series is non-stationary, its moving trend (path) is normally seen in continuous rise or decline in the variable concerned (See Fig. 1.1 also). We will present the individual graphical representations of the concerned variables to examine if these were stationarity or non-stationarity by nature.

(ii) Battery of Tests

Battery of Tests suggests a set of relevant tests for examining the nature of stationarity of the datasets concerned. Such methods are being discussed in sub-sections (3.5.2 – 3.5.8) in the text follows.

(iii) Correlogram

Correlogram is also one of the popular ways of having idea whether there is any stationarity or no-stationarity in the datasets concerned.

3.5.2 Dickey Fuller Unit Root Test

The test of unit root was proposed by David A. Dickey and Wayne A. Fuller in 1976.

For the Dickey-Fuller tests, the relevant model is,

$$y_t = \beta_0 + \beta_1 t + u_t \tag{3.1}$$

where,
$$u_t = \alpha u_{t-1} + \varepsilon_t \tag{3.2}$$

Here ε_t is a covariance stationary process with zero mean. The reduced form for this model is

$$y_t = \gamma + \delta t + \alpha y_{t-1} + \varepsilon_t \tag{3.3}$$

where $\gamma = \beta_0 (1-\alpha)$ and $\delta = \beta_1 (1-\alpha)$.

This equation is said to have a unit root if $\alpha=1$ (in which case $\delta=0$)

3.5.3 Augmented Dickey Fuller Unit Root Test

In order to test for the existence of unit roots, and to determine the degree of differencing necessary to induce stationarity, we have applied the *Augmented Dickey-Fuller test.* Dickey and Fuller (1976, 1979), Said and Dickey (1984), Phillips (1987), Phillips and Perron (1988), and others developed modified version of the Dickey-Fuller tests when ε_t is not white noise. These tests are called *Augmented Dickey-Fuller (ADF) tests.* The results of the *Augmented Dickey-Fuller test (ADF)* help determine the form in which the data should be applied in any econometric analysis. The alternative forms are as follows:

$$\Delta y_t = \gamma + \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \tag{3.4}$$

$$\Delta y_t = \gamma + \delta t + \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \tag{3.5}$$

$$\Delta y_t = \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \tag{3.6}$$

where, y_t = Model Variables (TD and BD) of Nepal;

Δy_t = First differenced series of y_t.

Δy_{t-j+1} = First differenced series of y_t at $(t-j+1)^{th}$ lags. ($j = 2$ -------- k)

The equation (3.4) contains a constant as exogenous, while equation (3.5) bears a constant along with a linear trend. However, equation (3.6) presents an auto-regressive process with no constant and linear trend.

3.5.4 The D-F GLS Unit Root Test

The DF-GLS test has been developed by Elliott, Rothenberg and Stock (1996), and the test possesses grater precision than ADF Test in identifying non-stationarity. This test has also been used in this study

The DF-GLS t-test is performed by testing the hypothesis $a_0=0$ in the regression equation:

$$\Delta y_t^d = a_0 y_t^d + a_1 \Delta y^d_{t-1} + \text{------} + a_p \Delta y^d_{t-p} + \text{error} \tag{3.7}$$

where, y_t^d is the locally de-trended series y_t .The local de-trending depends on whether we consider a model with drift only or a linear trend.

(i) DF-GLS unit root test without time trends (a model with drift only):

$$y_t^{\mu} = \alpha y^{\mu}_{t-1} + \sum_{i=1}^{k} \Psi i \, \Delta y^{\mu}_{t-i} + u_t \tag{3.8}$$

(ii) DF-GLS unit root test with time trends (a model with linear trend):

$$y_t^{\tau} = \alpha y^{\mu}_{t-1} + \sum_{i=1}^{k} \Psi i \, \Delta y^{\tau}_{t-i} + u_t \tag{3.9}$$

3.5.5 Phillips –Perron Unit Root Test

Phillips (1987), Phillips and Perron (1988) have generalized the Dickey-Fuller (DF) tests to situations where disturbance processes, ε_t are serially correlated. The PP is intended to add a 'correction factor' to the DF test statistic.

Let the AR (1) model be,

$$Yt = \mu + \varphi_1 Y_{t-1} + \varepsilon_t, \ [t = 1, \text{---------}, T] \tag{3.10}$$

with $Var(\varepsilon_t) \equiv \sigma_\varepsilon^2$.

If ε_t is serially correlated, the ADF approach is to add lagged ΔY_t to 'whiten' the residuals. To illustrate the alternative approach, the test statistic $T(\varphi_1\text{-}1)$ has been considered which is distributed as ρ_μ in the maintained regression with an intercept but no time trend. The PP modified version is,

$$Z\rho_\mu = T(\varphi_1\text{-}1) - CF \tag{3.11}$$

where the correction factor CF is,

$$CF = 0.5(s^2_{Tl} - s_\varepsilon^2) / \left(\sum_{t=2}^{T} (Y_{t-1} - \overline{Y}_{-1})^2 / T^2\right) \tag{3.12}$$

and,

$$s_\varepsilon^2 = T^{-1} \sum_{t=1}^{T} \varepsilon_t^{\,2} \tag{3.13}$$

$$s^2_{Tl} = s_\varepsilon^2 + 2\sum_{s=1}^{l} W_{sl} \sum_{t=s+1}^{T} \varepsilon_t \varepsilon_{t-s} / T \tag{3.14}$$

$W_{sl} = 1 - s/(l+1)$ and $\varepsilon_t = Y_t - \mu - \varphi_1 Y_{t-1}$

$$\bar{Y}_{-1} = \left(\sum_{t=2}^{T} Y_t\right)/(T-1) \tag{3.15}$$

3.5.6 The KPSS unit root test

Another frequently used method for the test of stationarity is the KPSS Test developed bby Kwiatowski et al. The KPSS test is an analog of Phillips-Perron test. The model for KPSS test is:

$$\varphi(L)y_t = \alpha_t + \beta t + \varepsilon_t \tag{3.16}$$

$$\alpha_t = \alpha_{t-1} + \eta_t \qquad \alpha_0 = \alpha \qquad (t = 1,2,\text{----------}T)$$

$$\text{where } \varepsilon_t \sim \text{IID}(0, \sigma_\varepsilon^2), \quad \eta_t \sim \text{IID}(0, \sigma_\eta^2)$$

ε_t and η_t are independent and $\varphi(L)$ is a p^{th} order lag polynomial. The relevant hypotheses for the test of stationarity in this model are,

H_0: $\sigma_\eta^2 = 0$

against,

$H_1 > 0$

Under H_1 the process defines an ARIMA model structure.

It has been argued that tests with stationarity as null can be used to confirm the results of the usual unit root tests. The two tests are:

Test 1 (usual test)	Test 2 (KPSS test)
H_0: y_t is non-stationary (unit root) H_1: y_t is stationary	H_0: y_t is stationary H_1: y_t is non-stationary (unit root)

If both tests reject their nulls, their will be no confirmation. But if test 1 rejects the null but test 2 does not (or vice versa) the confirmation can be drawn (G. S. Maddala 2001:553).

3.5.7 ERS Point Optimal Test

The *ERS Point Optimal test* is largely based on the following quasi-differencing regression equation:

$$d(y_t/\alpha) = d(x_t/\alpha)'\delta(\alpha) + \eta_t \qquad (3.17)$$

where, x_t stands for either a constant or a constant along with trend and $\delta(\alpha)$ be the ordinary least square (OLS) estimates from this regression. The residual from this equation is:

$$\eta_t(\alpha) = d(y_t/\alpha) - d(x_t/\alpha)'\delta(\alpha) \qquad (3.18)$$

Let, SSR (α) = $\sum \eta_t^2(\alpha)$ be the sum of squared residuals function. The ERS point optimal test statistic of the null that α =1 against the alternative that $\alpha = \bar{\alpha}$, is then defined as;

$$P_T = SSR(\bar{\alpha}) - \bar{\alpha}\, SSR(1) / f_0 \qquad (3.19)$$

where, f_0, is an estimator of the residual spectrum at frequency zero. In order to compute the ERS test, it is necessary to specify the underlying set of exogenous regressors x_t and a technique for estimating f_0.

3.5.8 Ng and Perron (NP) Tests

Ng and Perron (2001) estimate four test statistics that are based upon the GLS de-trended data y_t^d. These test statistics are modified forms of Phillips and Perron Z_α

and Z_t statistics, the Bhargava (1986) R_1 statistics and the *ERS Point Optimal statistic*. The terms are defined as following:

$$k = \sum_{t=2}^{T} (y^d{}_{t-1})^2 \Big/ T^2 \tag{3.20}$$

The modified statistics can be represented as:

$$MZ^d{}_\alpha = [T^{-1}(y_t^d)^2 - f_0] / 2k$$

$$MZ^d{}_t = MZ_\alpha \times MSB$$

$$MSB^d = (k/f_0)^{1/2} \tag{3.21}$$

$$MP^d{}_t = \{ \bar{c}^2 k - \bar{c} T^{-1} (y^d{}_T)^2 \Big/ f_0 \qquad \text{if } x_t = \{1\}$$

$$= \{ \bar{c}^2 k - (1-\bar{c}) T^{-1} (y^d{}_T)^2 \Big/ f_0 \qquad \text{if } x_t = \{1, t\}$$

Where, $\bar{c}$ = {-7 if x_t = {1}

= -13.5 if x_t = {1, t}

The NP tests require a specification for x_t and a choice of method for estimating f_0.

3.6 Correlogram

One of the simple, intuitive and interesting methods of testing 'stationarity' is running a correlogram. Correlogram is nothing but simply a graphical representation of Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF). The nature of stationarity can also be found almost accurately in most of the cases with the help of Correlogram.

3.7 Co-integration Test

The co- integration test represents the gesticulation of long-run equilibrium relationships between two variables say y_t and x_t. Let, $y_t \sim I(1)$ and $x_t \sim I(1)$. Then y_t and x_t are said to be co-integrated if there exists a β such that $y_t - \beta x_t$ is I (0).This is denoted by saying y_t and x_t are CI (1, 1). Different types of co-integration techniques are available for the time series analyses. These tests include the Engle and Granger test (1987), Stock and Watson procedure (1988) and Johansen's method (1988).

3.7.1 Engle-Granger Co-integration Test

The Engle and Granger approach is also known as a residual test. If the variables included in an equation are integrated of the same order, say (1), the error term should be stationary, i.e., I (0). Let us consider M time horizon time series (Y_{t1}-----Y_{tM}), each of which is I(1), and the following two regression models, the first with drift and no trend and the second with drift and trend, which help running Engel-Granger cointegration test.

$$Y_{t1} = \beta_0 + \sum_{j=2}^{M} \sum \beta_j y_{t-j+1} + \varepsilon_t \tag{3.22}$$

$$Y_{t1} = \beta_0 + \beta_1 t + \sum_{j=2}^{M} \beta_j y_{t-j+1} + \varepsilon_t \tag{3.23}$$

A test for no cointegration is assigned by a test for a unit root in the estimated error terms e_t of ε_t. This can be achieved by applying ADF test to the residuals using the following equation:

$$\Delta e_t = \alpha e_{t-1} + \sum_{j=1}^{p} \Phi_j e_{t-j} + v_t \qquad (3.24)$$

The null hypothesis $\alpha = 0$ is tested using the τ statistic.

3.7.2 Johansen Maximum Likelihood Co-integration Test

The Johansen maximum likelihood procedure analyses the relationship among stationary or non-stationary variables using the following equation:

$$X_t = \sum_{i=1}^{p} \prod_i X_{t-1} + \varepsilon_t \qquad (3.25)$$

This function can be presented according to the following VAR system:

$$\Delta X_t = \prod Xt-1 + \sum_{i=1}^{p-1} \phi i \Delta X_{t-1} + \mu + \varepsilon_t \qquad (3.26)$$

in which X_t is an n × 1 random vector, ε_t is NIID (0, Σ_ε), and μ is deterministic terms. The long-run relationships are derived through the coefficient matrix of $\prod$, denoted by r, which is between 0 and n. Then there are r linear combinations of the variables in the system that are I (0) or cointegrated. Under Johansen (1991), and Johansen and Juselius (1990) procedures, two tests are available for the determination of cointegrating vectors and for the estimation of their values. These tests are the Trace Test and the Eigen Value Test. In this method, a two-stage testing procedure has been followed. In the first stage, the null hypothesis of no cointegration hypothesis is tested against the alternative hypothesis that the data are cointegrated with an unknown cointegrating vector. If the null hypothesis is rejected, a second stage test is implemented with cointegration maintained under both the null and alternative.

Gonzalo (1994) has suggested that Johansen's procedure has certain properties which are superior to alternative co-integration testing methods.

3.8 Vector Error Correction Modeling

Vector Error Correction Modeling provides important information on the short-run relationship (short-run dynamics) between any two cointegrated variables. *Vector Error Correction test* has provided empirical evidence on the short run causality between real and nominal trade deficits and budget deficits in Nepal.

In the present study the vector error correction estimates have been specified using the following models. The models have been used in both cases i.e. involving TD and BD.

$$\Delta TD_t = \gamma_1+\rho_1 z_{t-1}+\alpha_1\Delta TD_{t-1}+\alpha_2\Delta TD_{t-2}+\alpha_3\Delta BD_{t-1}+\alpha_4\Delta BD_{t-2}+\varepsilon_{1t} \quad (3.27)$$

$$\Delta BD_t=\gamma_2+\rho_2 z_{t-1}+ \beta_1\Delta TD_{t-1}+ \beta_2\Delta TD_{t-2}+ \beta_3\Delta BD_{t-1}+ \beta_4\Delta BD_{t-2}+ \varepsilon_{2t} \quad (3.28)$$

$$\Delta NTD_t=\gamma_3+\rho_3 z_{t-1}+\alpha_1\Delta NTD_{t-1}+\alpha_2\Delta NTD_{t-2}+\alpha_3\Delta NBD_{t-1}+\alpha_4\Delta NBD_{t-2}+\varepsilon_{3t} \quad (3.29)$$

$$\Delta NBD_t=\gamma_4+\rho_4 z_{t-1}+\beta_1\Delta NTD_{t-1}+\beta_2\Delta NTD_{t-2}+\beta_3\Delta NBD_{t-1}+\beta_4\Delta NBD_{t-2}+\varepsilon_{4t} \quad (3.30)$$

Where, ΔTD_t = first difference of trade deficit (real); ΔBD_t = first difference of budget deficit (real); ΔNTD_t is first difference of the nominal trade deficit; ΔNBD_t is the nominal budget deficit; z_{t-1} = first lag of error term of co-integrating equation; ε_{1t} and ε_{2t} are white noise errors; $\alpha_1, \alpha_2, \alpha_3$ and α_4 and $\beta_1, \beta_2, \beta_3$ and β_4 are the coefficients of lagged variables in the above models.

The focus of the vector error correction analysis is on the lagged z_t terms. These lagged terms are the residuals from the previously estimated cointegration equations. In the present case the residuals from two lag specifications of the cointegrating equations have been used in the vector error correction estimates. Lagged z_t terms provide an explanation of short-run deviations from the long-run equilibrium for the test equations above. Lagging these terms means that disturbance of the last period impacts upon the current time period. Statistical significance tests are conducted on each of the lagged z_t terms in equations (3.27) through (3.30). In general, finding a statistically insignificant coefficient of the z_t term implies that the system under investigation is in the short-run equilibrium as there are no disturbances present. If the coefficient of the z_t term is found to be statistically significant, then the system is in the state of the short-run disequilibrium. In such a case the sign of z_t term gives an indication of the causal direction between the two test variables.

3.9 Conventional Granger Causality Test

The model for *Conventional Granger Causality test* is based on the following equations:

$$BD_t = \sum_{j=1}^{m} a_j TDt_{-j} + \sum_{j=1}^{m} b_j BD_{t-j} + \varepsilon_t \qquad (3.31)$$

$$TD_t = \sum_{j=1}^{m} a_j BD_{t-j} + \sum_{j=1}^{m} b_j TD_{t-j} + \eta_t \qquad (3.32)$$

where,

BD_t and TD_t represent first difference of Budget Deficit (real) and Trade Deficit (real) respectively.

3.10 Vector Autoregression (VAR) Modeling

While testing the long-run dynamic relationship between modelriables concerned, we may not make any *a-priori* assumption of endogenity and exogeneity of variables concerned. In such situation, Vector Auto-regressive Model (VAR) can be applied. This model treats all variables systematically without making reference to the issue of dependence or independence. A VAR 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 us to study the 'Variance Decompositions' for these variables and this help us understand the interrelationships among the variables concerned. We, therefore, seek to develop following models for the Twin Deficit Relationship for the economy of Nepal.

3.10.1 The VAR 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 (3.33) and (3.34) as:

$$\Delta TD_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1i} \Delta TD_{t-i} + \sum_{i=1}^{k} \gamma_{1i} \Delta BD_{t-i} + u_{1t} \qquad (3.33)$$

$$\Delta BD_t = \alpha_2 + \sum_{i=1}^{k} \beta_{2i} \Delta BD_{t-i} + \sum_{i=1}^{k} \gamma_{2i} \Delta TD_{t-i} + u_{2t} \qquad (3.34)$$

Where,

α_s = intercepts

u_{1t} and u_{2t} = Stochastic error terms (alternatively called as impulses or innovations or shocks in VAR Modeling)

$\sum_{i=1}^{k} \beta_{1i} \Delta TD_{t-i}$ and $\sum_{i=1}^{k} \gamma_{2i} \Delta TD_{t-i}$ = All Summation Values of Lagged Variables of Trade Deficit (TD_t) in the model

$\sum_{i=1}^{k} \gamma_{1i} \Delta BD_{t-i}$ and $\sum_{i=1}^{k} \beta_{2i} \Delta BD_{t-i}$ = All Summation Values of Lagged Variables of Budget Deficit (TD_t)

Furthermore, the VAR model consists of equations (3.33) and (3.34) which requires that

(i) ΔTD_t and ΔBD_t be stationary, and

(ii) u_{1t} and u_{2t} be white noise terms such that: $u_{1t} \sim iid\ N(0,\ \sigma^2 u_1)$, and $u_{1t} \sim iid\ N(0,\ \sigma^2 u_2)$

3.10.2 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 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 (IRS)* in VAR System is widely used in describing the dynamic behaviors variables in the system concerned to shocks in the residual of the time series under study.

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

$$\upsilon_t = P^{\text{TM}}{}_t \sim (O, D) \qquad (3.35)$$

Where,

D = Diagonal co-variance matrix

3.10.3 Variance Decomposition

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 in the question of its effects to the variables concerned in the VAR system.

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CHAPTER - IV

STATIONARITY AND INTEGRABILITY OF BUDGET DEFICITS AND TRADE DEFICITS

4.1 Introduction

Stationarity of time-series dataset is indispensable for developing the time series models. The series, invariant with respect to time, are called 'stationary.' If the characteristics of the time series data vary over time, the series are non-stationary. Stationary and non-stationary data series would pursue different patterns in graphical presentation. 'Unit Root Test' is an exercise for looking into the time invariant properties of a series concerned. The properties are stated below:

(i) A stationary series varies around a constant long run mean.

$E[Y_t]$ is independent of t.

or,

$$E[Y_t] = E[Y_{t-s}] = \mu \tag{4.1}$$

(ii) It has a finite variance.

$$E(Y_t - \mu)^2 = E(Y_{t-s} - \mu)^2 = \sigma_y^2 \tag{4.2}$$

$Var(Y_t)$ is a finite, positive constant and independent of t.

(iii) $Cov[Y_t, Y_s]$ is a finite function of $t-s$, but not of t or s.

$$E[(Y_t - \mu)(Y_{t-s} - \mu)] = E[(Y_{t-j} - \mu)(Y_{t-j-s} - \mu)] = \gamma_s$$

$$[cov(Y_t, Y_{t-s}) = cov(Y_{t-j}, Y_{t-j-s})] \tag{4.3}$$

where, μ, σ_y^2 and all γ_s are constants.

That is, the mean, variance and co-variance of the underlying process are invariant with time.

Stationarity can be performed examined through unit root test and/or correlogram.

4.2 Unit Root Test

Let $\{Y_t\}$ be generated by an $AR\ (1)$ process, such that,

$$Yt = \alpha + \rho Y_{t-1} + \xi_t \tag{4.4}$$

where $|\rho| < 1$ and ξ_t is a white noise error term. We can estimate the parameters in (4.4) by OLS. Our estimator is efficient and the series is stationary since $|\rho| < 1$. If the value of $\rho = 1$, the series $\{Y_t\}$ is non-stationary. That is, if the coefficient of Y_{t-1} is equal to one, we face with unit root problem. Hence, the unit root null hypothesis is: H_o: $\rho = 1$ against H_1: $\rho < 1$

While testing the null hypothesis of unit root, we use the following equation:

$$\Delta Y_t = \alpha + \gamma Y_{t-1} + \xi_t \tag{4.5}$$

where, $\gamma = \rho - 1$, ΔY_t is the First difference of the series Y_t. The null hypothesis of unit root is,

Ho: $\gamma = 0$.

If 'γ' is in fact 0, we can write eq^n (4.4) as, $\Delta Y_t = Y_t - Y_{t-1} = \xi_t$.

Time series data, which are frequently used in practice for economic modeling, normally have a unit root at level and such series are known as non-stationary time series. They are often called *'random walk'* time series if they entail higher frequencies. If the series have the characteristics of non-stationarity or random walk at level, its successive differences to test the stationarity of the series. The Table 4.1 briefly presents different patterns that might be tested along with the formats of the tests:

Table – 4.1

Stationary and Non-Stationary Expressions

Stationary		Non-Stationary	
Situation	***Expression***	***Situation***	***Expression***
White Noise	$Y_t = \mu + \varepsilon_t$	Random Walk	$Y_t = Y_{t-1} + \varepsilon_t$
Autoregressive	$Y_t = \mu + \gamma Y_{t-1} + \varepsilon_t\ (l\gamma l<1)$	Random Walk with Drift	$Y_t = \mu + \gamma Y_{t-1} + \varepsilon_t$
Trend Stationary	$Y_t = \mu + \beta_t + \varepsilon_t\ (t=1,2,\ ...)$		

4.2.1 Study of Stationarity of Budget Deficits (BD) and Trade Deficits (TD)

We seek to test the stationarity of time series of Budget and Trade Deficit in Nepal. The time plots of the BD and TD are given in Figure 1.2 and 1.3. These plots indicate rising trend in the series concerned. These trends reflect the possibility of non-stationarity of the series BD and TD.

It, therefore, becomes pertinent for us to ascertain the nature of 'Stationarity' through 'definitive tests'. These are being done through ADF Tests and other tests.

4.2.2 Augmented Dickey-Fuller (ADF) Unit Root Test: Results of Estimation

Augmented Dickey-Fuller (ADF) test is based upon estimating the equations (3.4), (3.5) and (3.6) in this study.

$$\Delta y_t = \gamma + \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \quad (3.4)$$

$$\Delta yt = \gamma + \delta t + \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \quad (3.5)$$

$$\Delta y_t = \alpha y_{t-1} + \sum_{j=2}^{k} \theta_j \Delta y_{t-j+1} + e_t \tag{3.6}$$

We have taken Budget Deficit (BD) and Trade Deficit (TD) both in real and nominal terms for 1964 – 2004 to fit in the above equations. The data are tested at level, first difference and second difference to find out the stationarity.

The estimations of the parameters based on the equation (3.4) have been presented in the following Table 4.2.

Table - 4.2

Results of ADF Unit Root Tests

Dependent Variable	Explanatory Variable	Coefficient	t-statistic	probability
ΔTD_t	TD_{t-1}	-0.017912	-0.368688	0.7144
	constant	-547.4056	-1.145492	0.2592
$\Delta^2 TD_t$	ΔTD_{t-1}	-1.083699	-6.567820	0.0000
	constant	-472.6542	-1.420399	0.1639
ΔBD_t	BD_{t-1}	-0.096393	-1.505199	0.1405
	constant	-307.5771	-1.663292	0.1045
$\Delta^2 BD_t$	ΔBD_{t-1}	-1.270458	-7.906743	0.0000
	constant	-113.9916	-0.969875	0.3384
ΔNTD_t	NTD_{t-1}	0.039849	0.967443	0.3394
	constant	-1307.192	-1.030631	0.3092
$\Delta^2 NTD_t$	ΔNTD_{t-1}	0.903131	-1.872707	0.0739
	constant	-1701.347	-1.280173	0.2132
ΔNBD_t	NBD_{t-1}	0.046115	0.856955	0.3975
	constant	-554.8916	-1.476707	0.1490
$\Delta^2 NBD_t$	ΔNBD_{t-1}	-1.919419	-7.373906	0.0000
	constant	-759.7011	-2.629998	0.0126

*, **, *** *indicates the 10%, 5% and 1% level of significance.*

The 't-statistics' of the coefficients of the explanatory variables in the table present the Augmented Dickey Fuller test statistic. Again findings of the estimations based on equations (3.5) and (3.6) have been presented in the first part (exogenous:

constant), second part (exogenous: constant & linear trend) and third part (exogenous: none) respectively of the following table (Table 4.3).

Table - 4.3

Results Augmented Dickey Fuller Unit Root Tests

Exogenous: Constant **Null Hypothesis**: The variable has a unit root

Lag length: (Automatic based on SIC, MAXLAG=9) [**Sample**: 1964 - 2004]

Variable	ADF test statistic	Prob* Value	Lag Length**	Test critical values		
				1%	5%	10%
TD_t	-0.368688	0.9049	0	-3.605593	-2.936942	-2.606857
ΔTD_t	-6.567820	0.0000	0	-3.610453	-2.938987	-2.607932
$\Delta^2 TD_t$	-6.027795	0.0000	4	-3.639407	-2.951125	-2.614300
BD_t	-1.505199	0.5208	0	-3.605593	2.936942	-2.606857
ΔBD_t	-7.906743	0.0000	0	-3.610453	-2.938987	-2.607932
$\Delta^2 BD_t$	-7.904260	0.0000	1	-3.621023	-2.943427	-2.610263
NTD_t	0.967443	0.9954	0	-3.605593	-2.936942	-2.606857
ΔNTD_t	-1.872707	0.3403	7	-3.653730	-2.957110	-2.617434
$\Delta^2 NTD_t$	-4.735739	0.0006	5	-3.646342	-2.954021	-2.615817
NBD_t	0.856955	0.9938	2	-3.615588	-2.941145	-2.609066
ΔNBD_t	-7.373906	0.0000	1	-3.615588	-2.941145	-2.609066
$\Delta^2 NBD_t$	-1.491005	0.5239	9	-3.679322	-2.967767	-2.622989

Exogenous: Constant and Linear Trend

TD_t	-2.813337	0.2011	0	-4.205004	-3.526609	-3.194611
ΔTD_t	-6.567892	0.0000	0	-4.211868	-3.529758	-3.196411
$\Delta^2 TD_t$	-4.607459	0.0043	5	-4.262735	-3.552973	-3.209642
BD_t	-2.417415	0.3655	0	-4.205004	-3.526609	-3.194611
ΔBD_t	-7.870555	0.0000	0	-4.211868	-3.529758	-3.196411
$\Delta^2 BD_t$	-7.781406	0.0000	1	-4.226815	-3.536601	-3.200320
NTD_t	-1.209836	0.8949	0	-4.205004	-3.526609	-3.194611
ΔNTD_t	-6.120168	0.0001	4	-4.243644	-3.544284	-3.204699
$\Delta^2 NTD_t$	-4.597986	0.0044	5	-4.262735	3.552973	-3.209642
NBD_t	-3.040370	0.1345	0	-4.205004	-3.526609	-3.194611
ΔNBD_t	-7.734761	0.0000	1	-4.219126	-3.533083	-3.198312
$\Delta^2 NBD_t$	-1.366736	0.8494	9	-4.309824	-3.574244	-3.221728

Exogenous: None

TD_t	0.734105	0.8693	0	-2.624057	-1.949319	-1.611711
ΔTD_t	-6.328605	0.0000	0	-2.625606	-1.949609	-1.611593
$\Delta^2 TD_t$	-6.130527	0.0000	4	-2.634731	-1.951000	-1.610907
BD_t	-0.319064	0.5642	0	-2.624057	-1.949319	-1.611711
ΔBD_t	-7.856254	0.0000	0	-2.625606	-1.949609	-1.611593
$\Delta^2 BD_t$	-8.020852	0.0000	1	-2.628961	-1.950117	-1.611339
NTD_t	1.970831	0.9869	0	-2.624057	-1.949319	-1.611711
ΔNTD_t	-1.353289	0.1596	7	-2.639210	-1.951687	-1.610579
$\Delta^2 NTD_t$	-4.807611	0.0000	5	-2.636901	-1.951332	-1.610747
NBD_t	2.289387	0.9937	2	-2.627238	-1.949856	-1.611469
ΔNBD_t	-7.644428	0.0000	0	-2.625606	-1.949609	-1.611593
$\Delta^2 NBD_t$	-1.179029	0.2121	9	-2.647120	-1.952910	-1.610011

MacKinnon (1996) One-sided P-values* * Automatic based on SIC, MAXLAG=9*

4.2.3 The Findings of the ADF Unit Root Tests:

It is observed from the Table 4.3 that:

(i) the ADF Test statistics for real Budget Deficit (BD) and real Trade Deficit (TD) series indicate 'non-stationary' at 1% level.

(ii) the ADF Test Statistics for nominal Budget Deficit (NBD) and nominal Trade Deficit (NTD) series also testify for 'non-stationarity' at 1% level.

(iii) the ADF Test Statistics for ΔBD and ΔTD indicate that ΔBD and ΔTD series are 'stationary' at 1% level.

(iv) the ADF Test Statistics series testify for 'non-stationarity' of ΔNBD and ΔNTD series.

(v) ΔNBD and ΔNTD are 'stationary' only if 'linear trend' is considered in estimation.

(vi) Second Differenced Series fir NDB and NTD are, however, found 'non-stationary.

(vii) Second Difference Series for TD and BD are 'stationary' but these testify for 'over-differencing.'

4.2.4 Further Discussion on the Findings

It is observed from the Table 4.2 that:

(i) in the estimated equations for ΔBD_t and ΔTD_t the absolute values of the coefficients of BD_{t-1} and TD_{t-1} are 0.017912 and 0.096393 respectively. These values are significantly different from (lower than) 1. These indicate that the first differenced series for BD an TD are stationary.

(ii) In the estimated equation for $\Delta^2 BD_t$ and $\Delta^2 TD_t$, the absolute values of the coefficients of BDt_{-1} and TD_{t-1} are 1.270458 and 1.083699 respectively. These values significantly exceed 1. These confirm that the second differenced series for ΔBD_t and ΔTD_t are over differenced.

The findings obtained through the ADF Unit Root test on variables concerned have been verified through battery of other Unit-Root tests and the results are being presented through Tables 4.4 – 4.9.

Tables 4.3 and 4.4 are related to DF-GLS Unit Root test, Table 4.5 explains Phillips-Perron test results, Tables 4.6, 4.7 and 4.8 are related to Kwiatkowski-Phillips-Schmidt-Shin test, ERS-Point Optimal test and Ng-Perron Modified tests respectively.

4.2.5 Dickey-Fuller-GLS Unit Root Test

The findings from the DF –GLS Unit Rroot tests, which are based on equations (3.8) and (3.9) are being presented through following Tables 4.3 and 4.4:

Table - 4.4

Results of Dickey-Fuller-GLS Unit Root Tests

Exogenous: Constant **Null Hypothesis**: The variable has a unit root

Variable	ERS DF-GLS test statistic	Lag*** length	Test critical values*		
			1%	5%	10%
TD_t	-0.133972	0	-2.624057	-1.949319	-1.611711
ΔTD_t	-6.371896	0	-2.625606	-1.949609	-1.611593
$\Delta^2 TD_t$	-10.31676	0	-2.627238	-1.949856	-1.611469
BD_t	-1.076626	0	2.624057	-1.949319	-1.611711
ΔBD_t	-7.998055	0	-2.625606	-1.949609	-1.611593
$\Delta^2 BD_t$	-10.26246	0	-2.627238	-1.949856	-1.611469
NTD	-1.372664	7	-2.636901	-1.951332	-1.610747
ΔNTD_t	-1.761267	7	-2.639210	-1.951687	-1.610579
$\Delta^2 NTD_t$	-0.960872	6	-2.639210	-1.951687	-1.610579
NBD	-0.090483	0	-2.624057	-1.949319	-1.611711
ΔNBD_t	-7.382957	1	-2.627238	-1.949856	-1.611469
$\Delta^2 NBD_t$	-0.558966	9	-2.647120	-1.952910	-1.610011

Table - 4.5

Results of Dickey-Fuller-GLS Unit Root Tests

Exogenous: Constant, Linear trend **Null Hypothesis**: The variable has a unit root

Variable	ERS DF-GLS test statistic	Lag*** length	Test critical values*		
			1%	5%	10%
TD_t	-2.441329	0	-3.770000	-3.190000	-2.890000
ΔTD_t	-6.702676	0	-3.770000	-3.190000	-2.890000
$\Delta^2 TD_t$	-10.79951	0	-3.770000	-3.190000	-2.890000
BD_t	-2.522327	0	-3.770000	-3.190000	-2.890000
ΔBD_t	-7.821034	0	-3.770000	-3.190000	-2.890000
$\Delta^2 BD_t$	-11.09408	0	-3.770000	-3.190000	-2.890000
NTD	-1.167228	0	-3.770000	-3.190000	-2.890000
ΔNTD_t	-2.691850	7	-3.770000	-3.190000	-2.890000
$\Delta^2 NTD_t$	-0.569652	6	-3.770000	-3.190000	-2.890000
NBD	-2.770778	0	-3.770000	-3.190000	-2.890000
ΔNBD_t	-7.166851	1	-3.770000	-3.190000	-2.890000
$\Delta^2 NBD_t$	1.858605	9	-3.770000	-3.190000	-2.890000

* *Mackinnon (1996)* ** *Elliott-Rothenberg-Stock (1996, Table 1)* *** *Automatic based on SIC, MAXLAG=9*

4.2.6 Findings of the Dickey-Fuller-GLS Unit Root Tests

The results of the DF-FLS Unit Root tests have been summarized below:

(i) All the data series included in the models are non-stationary at level for the exogenous constant and exogenous constant linear tend.

(ii) For exogenous case, all the data series are stationary at their first difference at 1% significance level except nominal trade deficit. It is found to be stationary only at 10 percent level of significance at its first difference.

(iii) For exogenous constant linear tend, all the variables have been found stationary at their first difference except nominal trade deficit.

(iv) First difference data series are found to be stationary for the case of 'exogenous constant'. However, 'exogenous constant liner trend' case doesn't explain the existence of unit root consistently since nominal trade deficit has been found non-stationary even at its second difference.

4.2.7 Phillips-Perron (P-P) Unit Root Test: Results of Estimation

Phillips-Perron (P-P) Unit Root Test is also one of the very important tests for examining stationarity of the variables concerned. For that purpose we have tested with the following formulae as presented in Chapter III as:

$$Yt = \mu + \varphi_1 Y_{t-1} + \varepsilon_t, \ [t = 1, \text{---------}, T] \qquad (3.10)$$

with $Var(\varepsilon_t) \equiv \sigma_\varepsilon^2$.

$$Z\rho_\mu = T(\varphi_1 - 1) - CF \qquad (3.11)$$

$$CF = 0.5(s^2_{Tl} - s_\varepsilon^2) / \left(\sum_{t=2}^{T} (Y_{t-1} - \overline{Y}_{-1})^2 / T^2\right) \qquad (3.12)$$

and, $$s_\varepsilon^2 = T^{-1}\sum_{t=1}^{T}\varepsilon_t^2 \qquad (3.13)$$

$$s^2_{Tl} = s_\varepsilon^2 + 2\sum_{s=1}^{l} W_{sl}\sum_{t=s+1}^{T}\varepsilon_t\varepsilon_{t-s}/T \qquad (3.14)$$

$W_{sl} = 1 - s/(l+1)$ and $\varepsilon_t = Y_t - \mu - \varphi_1 Y_{t-1}$

$$\overline{Y}_{-1} = \left(\sum_{t=2}^{T} Y_t\right)/(T-1) \qquad (3.15)$$

Based on the formulae, we have calculated the test-statistics and critical values presented in the Table 4.6.

Table - 4.6

Results of Phillips-Perron Unit Root Tests

Exogenous: Constant **Null Hypothesis**: The variable has a unit root

Variable	P-P test statistic	Prob* value	Band-width**	Test critical values		
				1%	5%	10%
TD_t	-0.368688	0.9049	0	-3.605593	-2.936942	-2.606857
ΔTD_t	-6.567820	0.0000	0	-3.610453	-2.938987	-2.607932
$\Delta^2 TD_t$	-11.08193	0.0000	0	-3.615588	-2.941145	-2.609066
BD_t	-1.392070	0.5766	1	-3.605593	-2.936942	-2.606857
ΔBD_t	-8.018897	0.0000	3	-3.610453	-2.938987	-2.607932
$\Delta^2 BD_t$	-25.77930	0.0001	9	-3.615588	-2.941145	-2.609066
NTD	0.967443	0.9954	0	-3.605593	-2.936942	-2.606857
ΔNTD_t	-6.308111	0.0000	2	-3.610453	-2.938987	-2.607932
$\Delta^2 NTD_t$	-12.46528	0.0000	1	-3.615588	-2.941145	-2.609066
NBD	-0.051470	0.9478	1	-3.605593	-2.936942	-2.606857
ΔNBD_t	-8.145870	0.0000	1	-3.610453	-2.938987	-2.607932
$\Delta^2 NBD_t$	-14.47988	0.0000	4	-3.615588	-2.941145	-2.609066

Exogenous: Constant and Linear Trend

Variable	P-P test statistic	Prob* value	Band-width**	Test critical values		
				1%	5%	10%
TD_t	-2.819749	0.1990	1	-4.205004	-3.526609	-3.194611
ΔTD_t	-6.567844	0.0000	1	-4.211868	-3.529758	-3.196411
$\Delta^2 TD_t$	-10.92145	0.0000	0	-4.219126	-3.533083	-3.198312
BD_t	-2.373083	0.3873	2	-4.205004	-3.526609	-3.194611
ΔBD_t	-8.001475	0.0000	3	-4.211868	-3.529758	-3.196411
$\Delta^2 BD_t$	-25.38008	0.0000	9	-4.219126	-3.533083	-3.198312
NTD	-1.209836	0.8949	0	-4.205004	-3.526609	-3.194611
ΔNTD_t	-6.887759	0.0000	1	-4.211868	-3.529758	-3.196411
$\Delta^2 NTD_t$	-12.26809	0.0000	1	-4.219126	-3.533083	-3.198312
NBD	-2.866853	0.1836	3	-4.205004	-3.526609	-3.194611
ΔNBD_t	-9.286505	0.0000	4	-4.211868	-3.529758	-3.196411
$\Delta^2 NBD_t$	-14.01612	0.0000	4	-4.219126	-3.533083	-3.198312

Exogenous: None

Variable	P-P test statistic	Prob* value	Band-width**	Test critical values		
				1%	5%	10%
TD_t	0.734105	0.8693	0	-2.624057	-1.949319	-1.611711
ΔTD_t	-6.329376	0.0000	2	-2.625606	-1.949609	-1.611593
$\Delta^2 TD_t$	-11.23464	0.0000	0	-2.627238	-1.949856	-1.611469
BD_t	-0.101243	0.6427	2	-2.624057	-1.949319	-1.611711
ΔBD_t	-7.860769	0.0000	1	-2.625606	-1.949609	-1.611593
$\Delta^2 BD_t$	-26.20234	0.0000	9	-2.627238	-1.949856	-1.611469
NTD	1.970831	0.9869	0	-2.624057	-1.949319	-1.611711
ΔNTD_t	-5.855196	0.0000	3	-2.625606	-1.949609	-1.611593
$\Delta^2 NTD_t$	-12.63056	0.0000	1	-2.627238	-1.949856	-1.611469
NBD	1.022035	0.9165	1	-2.624057	-1.949319	-1.611711
ΔNBD_t	-7.754645	0.0000	3	-2.625606	-1.949609	-1.611593
$\Delta^2 NBD_t$	-14.80964	0.0000	4	-2.627238	-1.949856	-1.611469

** MacKinnon (1996) One-sided P-values* ***Newey-West using Bartlett kernel*

4.2.8 PP Unit Root Test Findings

The results of the P-P Unit Root tests have been presented below:

(i) The P-P test statistic, as presented in the table above, support the presence of a unit root (non-stationary) in variables when they are at level since all the relevant estimated coefficients are found to be significant at 1% level.

(ii) The hypothesis of 'non-stationarity' is rejected when all the variables (BD and TD) are at first differences, all the relevant coefficients are found to be insignificant at 1% level.

Hence, it can be concluded that the variables are stationary when they are in first differences and non-stationary at level in all the above-mentioned cases.

4.2.9 Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test

As an alternative, we have also performed the KPSS Unit Root Test to examine if the variables were stationary. For that purpose, we have used the formulae, presented in Chapter III as following:

$$\varphi(L)y_t = \alpha_t + \beta t + \varepsilon_t \qquad (3.16)$$

$$\alpha_t = \alpha_{t-1} + \eta_t \qquad \alpha_0 = \alpha \qquad (t = 1,2,\text{----------}T)$$

where

$$\varepsilon_t \sim \text{IID}\ (0, \sigma_\varepsilon^2), \quad \eta_t \sim \text{IID}\ (0, \sigma_\eta^2)$$

The results of the (KPSS) Unit Root tests are being presented below:

Table - 4.7

Results of KPSS Unit Root Tests

Exogenous: Constant **Null Hypothesis**: The variable is stationary

Variable	KPSS test statistic (LM-stat.)	Band-width**	Residual variance (no correction)	HAC Corrected Variance (Bartlett kernel)
TD_t	0.724566	5	44540035	2.23E+08
ΔTD_t	0.105950	0	3829489.	3829489.
$\Delta^2 TD_t$	0.037001	1	8417395.	3852707.
BD_t	0.669250	5	3190870.	15948577
ΔBD_t	0.119158	4	532858.2	280454.7
$\Delta^2 BD_t$	0.368319	28	1362309.	51995.49
NTD	0.665739	5	6.92E+08	3.34E+09
ΔNTD_t	0.385671	2	40323530	42210897
$\Delta^2 NTD_t$	0.116677	5	85419399	10901007
NBD	0.724792	5	31399361	1.58E+08
ΔNBD_t	0.096394	0	3330500.	3330500.
$\Delta^2 NBD_t$	0.086624	2	8411369.	2338641.
Asymptotic critical Values*		**1%**	**5%**	**10%**
		0.739000	0.463000	0.347000

Exogenous: Constant and Linear Trend **Null Hypothesis**: The variable is stationary

Variable	KPSS test statistic (LM-stat.)	Band-width**	Residual variance (No Correction)	HAC Corrected Variance (Bartlett kernel)
TD_t	0.154603	4	7054328.	19689616
ΔTD_t	0.049041	1	3771736.	3386067.
$\Delta^2 TD_t$	0.027824	1	8405811.	3847058.
BD_t	0.143250	4	847436.0	2518108.
ΔBD_t	0.109009	5	530999.6	221881.4
$\Delta^2 BD_t$	0.338327	27	1361632.	53794.19
NTD	0.199725	5	1.80E+08	7.49E+08
ΔNTD_t	0.040851	1	36753139	31331781
$\Delta^2 NTD_t$	0.054423	4	85363214	21234421
NBD_t	0.190723	5	4721077.	16069592
ΔNBD_t	0.064542	4	3270790.	962168.2
$\Delta^2 NBD_t$	0.059248	2	8384196.	2380723.
Asymptotic critical Values*		**1%**	**5%**	**10%**
		0.216000	0.146000	0.119000

**Kwiatkowski-Phillips-Schmidt-Shin (1992, Table-1)* ***Newey-West using Bartlett kernel*

4.2.10 Findings from KPSS Unit Root Tests

It is observed from the Table 5.6 that,

(i) LM statistics for TD_t, BD_t, NTD_t, and NBD_t exceed the Asymptotic Critical Values at 5% level. Consequently, the null hypothesis of 'stationarities of variables have been rejected at 5% level for these variables and these variables are found to be 'non-stationary.'

(ii) LM statistics for ΔTD_t, ΔBD_t, ΔNTD_t, and ΔNBD_t are lower than the Asymptotic Critical Values at 5% level. This implies that the null hypothesis of 'stationarity' of variables has been accepted at 5% level and the first differenced series have become stationary.

(iii) $\Delta^2 TD_t$, $\Delta^2 BD_t$, $\Delta^2 NTD_t$ and $\Delta^2 NBD_t$ series are stationary. However, stationarity of the series is marked by rise in 'bandwidth' and 'Residual Variance' upon second differences. These observations testify for 'over differencing' for the variables concerned.

4.2.11 ERS Point-Optimal Unit Root Test: Results of Estimation

We have also performed the ERS Point-Optimal Unit Root Tests to further examine the stationarity nature of the data of BD and TD through the use of following formulae stated in Chapter III:

$$d(y_t/\alpha) = d(x_t/\alpha)'\delta(\alpha) + \eta_t \tag{3.17}$$

$$\eta_t(\alpha) = d(y_t/\alpha) - d(x_t/\alpha)'\delta(\alpha) \tag{3.18}$$

$$P_T = SSR(\bar{\alpha}) - \bar{\alpha}\, SSR(1)/f_0 \tag{3.19}$$

The results of the ERS Point-Optimal unit root tests are being presented through the following Table 4.8.

Table - 4.8

Results ERS Point-Optimal Unit Roots Test

Exogenous: Constant **Null Hypothesis**: The variable has a unit root

Variable	Elliott-Rothenberg-Stock test statistic (P-statistic)	Lag length**	HAC Corrected Variance (Spectral OLS auto regression)
TD_t	24.12515	0	3815839.
ΔTD_t	1.337115	0	3886425.
$\Delta^2 TD_t$	68.16738	4	193077.6
BD_t	13.95892	0	502875.9
ΔBD_t	1.538089	0	506502.7
$\Delta^2 BD_t$	1.020895	1	2346512.
NTD	42.25208	0	39354229
ΔNTD_t	0.211135	7	2.47E+08
$\Delta^2 NTD_t$	603.8285	5	249323.8
NBD	115.0430	2	627343.3
ΔNBD_t	0.617835	1	10619342
$\Delta^2 NBD_t$	2911.978	9	7844.518
Test critical values	**1%**	**5%**	**10%**
	1.870000	2.97000	3.91000

Exogenous: Constant and Linear Trend **Null Hypothesis**: The variable has a unit root

Variable	Elliott-Rothenberg-Stock test statistic (P-statistic)	Lag length**	HAC Corrected Variance (Spectral OLS auto regression)
TD_t	13.31884	0	3107083.
ΔTD_t	4.733044	0	3823855.
$\Delta^2 TD_t$	1241.982	5	34961.11
BD_t	8.967412	0	458571.4
ΔBD_t	5.178270	0	500469.1
$\Delta^2 BD_t$	3.144584	1	2380113.
NTD	30.82244	0	35354530
ΔNTD_t	68.83617	4	2551903.
$\Delta^2 NTD_t$	1974.484	5	233559.2
NBD	10.55700	0	2616980.
ΔNBD_t	1.320076	1	13294392
$\Delta^2 NBD_t$	5389.229	9	10473.34
Test critical values	**1%**	**5%**	**10%**
	4.220000	5.720000	6.770000

Elliott-Rothenberg-Stock (1996, Table 1)* * Spectral OLS AR based on SIC, MAXLAG = 9*

4.2.12 Findings From the ERS Point Optimal Unit Root Test

It is observed from the Table – 4.7 that,

(i) the series of TD_t, BD_t, NTD_t, and NBD_t at level are non-stationary since estimated P-statistics in each case exceed the corresponding critical values even at 5% level.

(ii) the first differenced series for these variables (i.e. ΔTD_t, ΔBD_t, ΔNTD_t, and ΔNBD_t) are stationary since the estimated corresponding P-statistics are lower than the corresponding critical values even at 1% level.

(iii) in case of estimation with 'constant' and 'linear trend' as exogenous register, ΔTD_t, ΔBD_t are found to be stationary at 5% level of significance while ΔNBD_t attains stationarity at 1% level. However, ΔNTD_t displays non-stationarity even upon second differencing.

4.2.13 Ng-Perron Modified Unit Root Test: Results of Estimation

Ng-Perron Modified Unit Root Tests have been performed on the basis of the following formulae as presented in Chapter III.

$$k = \sum_{t=2}^{T} (y^d_{t-1})^2 \Big/ T^2 \qquad (3.20)$$

The modified statistics can be represented as:

$$MZ^d_\alpha = [T^{-1}(y_t^d)^2 - f_0] /2k$$

$$MZ^d_t = MZ_\alpha \times MSB$$

$$MSB^d = (k/f_0)^{1/2} \qquad (3.21)$$

The results of estimation of Ng-Perron modified unit root tests are being presented through the following Table 4.9:

Table - 4.9

Results of Ng-Perron Modified Unit Root Tests

Exogenous: Constant **Null Hypothesis**: The variable has a unit root

Variable	Lag length*	Ng-Perron test statistics				HAC corrected variance
		MZa	MZt	MSB	MPT	
TD_t	0	-0.05927	-0.03103	0.52358	20.0402	4000309.
ΔTD_t	0	-21.1284	-3.23565	0.15314	1.21040	4415845.
$\Delta^2 TD_t$	0	-13.2786	-2.49529	0.18792	2.15445	6361900.
BD_t	0	-2.18999	-0.93081	0.42503	10.2775	525283.3
ΔBD_t	0	-19.2644	-3.05409	0.15854	1.44745	541015.4
$\Delta^2 BD_t$	0	-11.4300	-2.25342	0.19715	2.66487	930983.2
NTD	7	0.97453	0.43426	0.44561	19.2020	77289962
ΔNTD_t	7	-1402.42	-26.4799	0.01888	0.01773	3.04E+09
$\Delta^2 NTD_t$	6	1.58643	3.86240	2.43464	425.540	364070.2
NBD	0	0.05259	0.02451	0.46609	17.6300	3486288.
ΔNBD_t	1	-65.9899	-5.63608	0.08541	0.61177	10652758
$\Delta^2 NBD_t$	9	5.57526	55.2328	9.90677	12280.0	1869.808
Asymptotic Critical Values**	1%	-13.8000	-2.58000	0.17400	1.78000	
	5%	-8.10000	-1.98000	0.23300	3.17000	
	10%	-5.70000	-1.62000	0.27500	4.45000	

Exogenous: Constant and Trend **Null Hypothesis**: The variable has a unit root

Variable	Lag length*	Ng-Perron test statistics				HAC corrected variance
		MZa	MZt	MSB	MPT	
TD_t	0	-8.24286	-2.01699	0.24470	11.0949	3323482.
ΔTD_t	0	-19.8400	-3.11789	0.15715	4.78424	3960482.
$\Delta^2 TD_t$	0	-14.3047	-2.60156	0.18187	6.78706	6665932.
BD_t	0	-10.0462	-2.17609	0.21661	9.36134	458828.5
ΔBD_t	0	-18.3607	-2.99556	0.16315	5.16987	523244.8
$\Delta^2 BD_t$	0	-13.8456	-2.50716	0.18108	7.27588	1066783.
NTD	0	-2.81639	-0.96575	0.34291	26.2066	39018672
ΔNTD_t	7	-0.07161	-0.07770	1.08513	226.356	814497.3
$\Delta^2 NTD_t$	6	1.22105	3.25708	2.66744	1556.37	310182.1
NBD	0	-10.3823	-2.22895	0.21469	9.00756	2782738.
ΔNBD_t	1	-71.5625	-5.92211	0.08275	1.52858	12008510
$\Delta^2 NBD_t$	9	3.95469	24.3571	6.15905	11166.5	5251.213
Asymptotic Critical Values**	1%	-23.8000	-3.42000	0.14300	4.03000	
	5%	-17.3000	-2.91000	0.16800	5.48000	
	10%	-14.2000	-2.62000	0.18500	6.67000	

*** Ng-Perron (2001, Table 1)* ** Spectral GLS-detrended AR based on SIC, MAXLAG = 9*

4.2.14 Findings From the Ng-Perron Modified Unit Root Tests

It is observed from the Table 4.8 that,

(i) TD_t, BD_t, NTD_t, and NBD_t series at levels are non-stationary since in each case the null hypothesis (that the variable has a unit root) has been accepted at 5% level of significance. This occurs because in each case Ng-Perron Test Statistics like MSB and MPT exceed while $|MZ_a|$ and $|MZ_t|$ values fall short of the corresponding asymptotic critical values at 5% level.

(ii) The first difference series for TD_t, BD_t, NTD_t, and NBD_t (i.e. ΔTD_t, ΔBD_t, ΔNTD_t, and ΔNBD_t) are stationary series in each case. Ng-Perron test statistics like MSB and MPB fall short of and $|MZ_a|$ and $|MZ_t|$ exceed the corresponding asymptotic Critical Values at 5% level.

(iii) the stationarity of first difference series is justified since for each series (ΔTD_t, ΔBD_t, ΔNTD_t, and ΔNBD_t), the HAC Corrected Variances registered a rise after first differencing.

4.2.15 The Overview of the Findings

The level along with the first and second differenced datasets for TD_t, BD_t, NTD_t, and NBD_t have been subject to battery of relevant tests for stationarity. The test results and findings, as presented in section 4.21. – Section 4.2.14, show that,

(i) the level data for all the variables (TD_t, BD_t, NTD_t, and NBD_t) are non-stationary.

(ii) all the variables, barring NTDt, attain stationary at 5% level upon first differencing.

(iii) second differencing of the variables, barring NTDt, imply 'over-differencing' resulting in serious loss of information.

(iv) time series datasets for real variables would be more 'appropriate' for econometric analysis in this study in view of the asymmetric nature of stationarity of NTD_t.

4.3: Graphical Representation of the Series

The following figures 4.1 through 4.4 exhibit the nature of stationarity of the variables of trade deficit and budget deficit (real and nominal term) with the help of line graphs of the series. The Figures (1.2 and 1.3) show the line graph of the variables at level, which are seemed non-stationary. The figures (4.1 – 4.4) represent the line graphs of the variables at first difference that are seemed stationary. The nature of stationarity or non-stationarity can be compared with the help of line graphs and the fundamental difference between such series can easily be observed by looking at their plots. The line graph of non-stationary series of trade deficit and budget deficit starts from the left corner of the box and moves downward (since the series values are in negative sign) towards right corner of the box while the line graph of stationary series normally begins from the middle part of left vertical axis of the box and moves rightward with fluctuations towards the middle part of right vertical axis of the box. This behavior hints for non-stationarity (of second case) since it has no continual increasing or decreasing trend in the data. In contrast, level data show such continual ascending or descending behavior as the time passes by.

4.3.1 Time Plots of the Budget Deficit and Trade Deficit Series (Real)

The time plots of the Real Trade Deficit (TD) and Real Budget Deficit (BD) at level are presented trough Fig 1.2. Again the time plots of the first differenced series for BD_t and TD_t are given in Fig 4.1 and 4.2 respectively.

It is observed from the figures that,

(i) the time plots of the TD_t, as given in Fig 1.2 displays trend of decline with a few marginal breaks since 1964 to 1997. Then it registers a rise in 1998, which continues until 2002. A spectacular decline occurs at 2003. Thus the series consists of a declining trend followed by a rising one. Consequently, the existences of trends signify non-stationarity of the series

(ii) the time plots of the differenced series for Trade Deficit , as given in 4.1, does not display any visible trend in it. The plots are marked by several ups and down. The pattern of upswings and downswings are indicative of 'stationarity' of the series concerned and this stationarity was upheld by the test-results in sections 4.2.1 – 4.2.10.

(iii) the time plots of the BD_t real, as given in Fig 1.2 displays trend of decline and rise with a few marginal breaks since 1964 to 1970 and continues moderate decline until the beginning of 1980. Then it registers a stable trend until 1987 and then it displays continuous significant rise and fall within the gap of 3-4 years. As a result, the existences of trends in BD real data at level signify non-stationarity of the series.

(iv) the time plots of the differenced series for real Budget Deficit displayed at Fig 4.2 does not display any visible trend in it. The plots are marked by several ups and down. The pattern of upswings and downswings are indicative of 'stationarity' of the series concerned and this stationarity was supported by the test-results in sections 5.2.1 – 5.2.10

4.3.2 Time Plots of the Budget Deficit & Trade Deficit Series (Nominal)

The time plots of the TD (Nominal) and BD (Nominal) series are given by the Fig 1.3. Again Fig 4.3 and Fig 4.4 present the time plots of the first differenced series for TD (Nominal) and BD (Nominal) respectively.

It is observed from the Figs 1.3 that

(i) the TD (Nominal) series at level displays almost exponential decline until 1997 with marginal rise at 1998. However, the series again displays a decline since 2002. The exponential type of declining trend in TD (Nominal) series testifies for the existence of non-stationarity in it.

(ii) BD (Nominal) series also displays almost a secular declining trend with a few marginal ups and downs until 2002. This declining pattern is indicative of the presence of non-stationarity in the dataset.

The non-stationarity in these two series were indicated by the test results also as presented in sections 4.2.10

(iii) the first differenced data set for Nominal BD (as given in the Fig 4.3) displays almost a secular constancy until 1990 followed by regular upswings and downswings. This pattern does not confirm the presence of stationarity in the series concerned.

(iv) the first differenced data for Nominal TD (as shown by the Fig 4.4) displays almost a constant trend until 1993 followed up marginal ups and downs. This pattern of the plot does not indicate stationarity in the dataset.

Figure - 4.1

Time Plot of Trade Deficit (Real) at First Difference (Stationary Series)

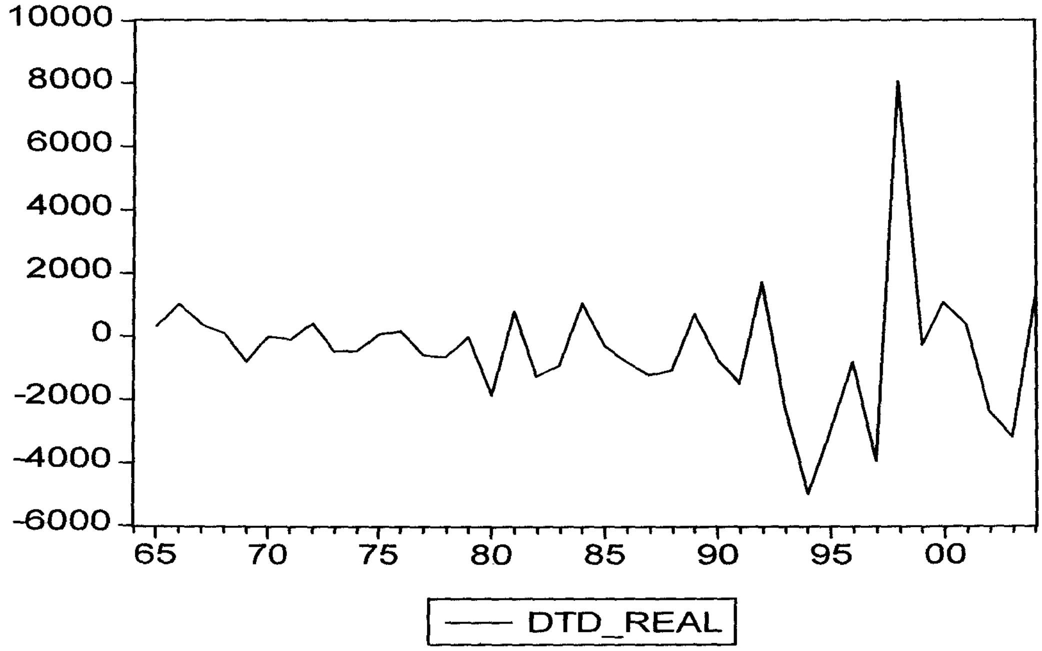


Figure - 4.2

Time Plot of Budget Deficit (Real) at First Difference (Stationary Series)

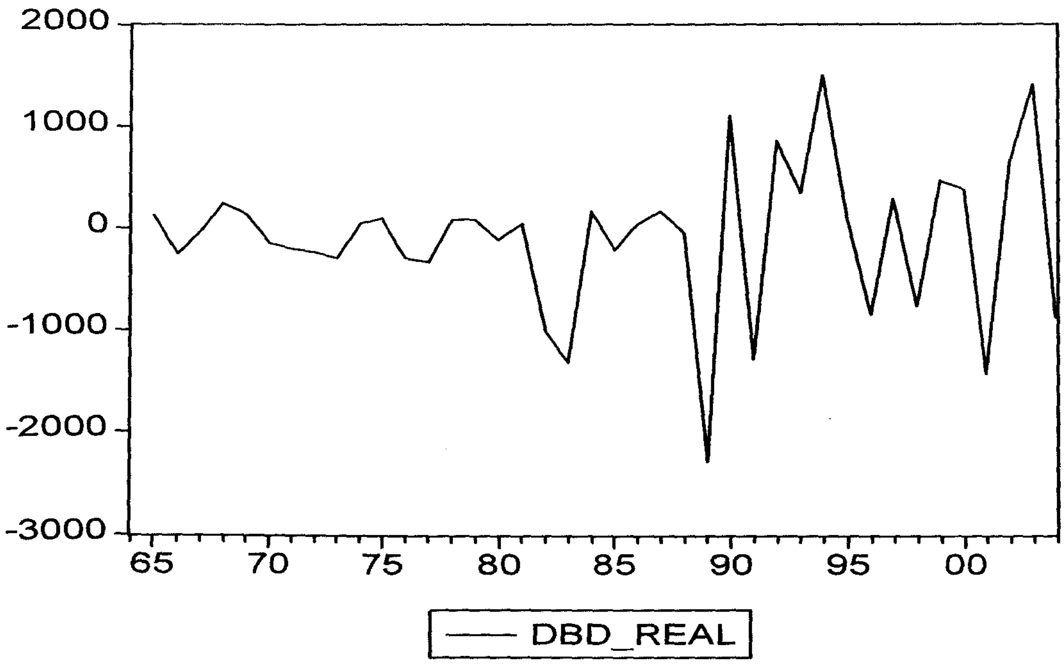


Figure - 4.3

Time Plot of Trade Deficit (Nominal) at First Difference (Stationary Series)

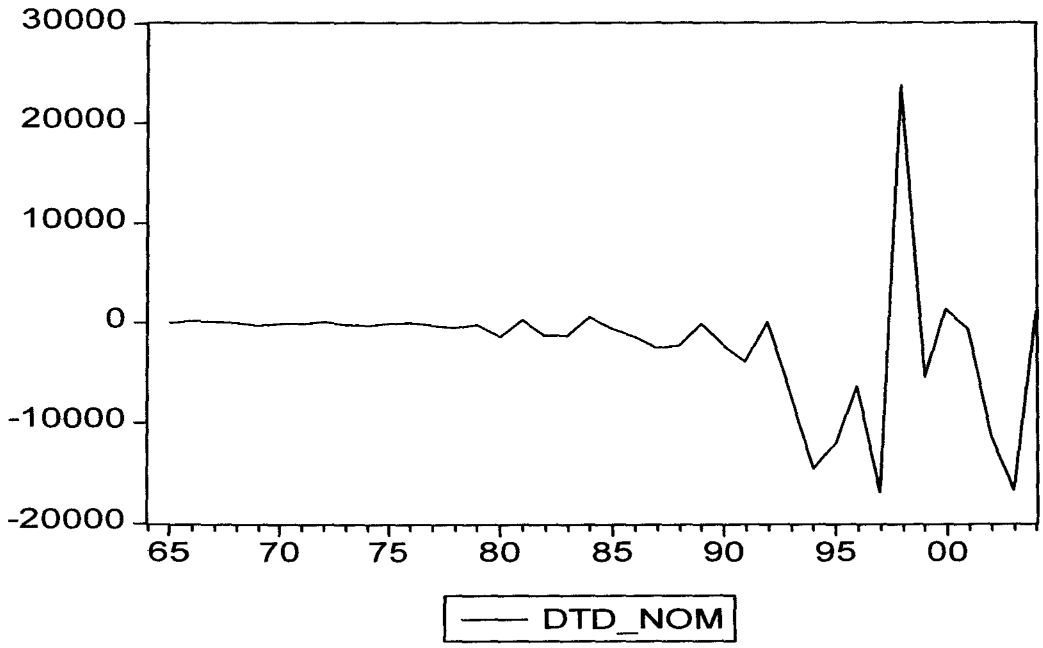
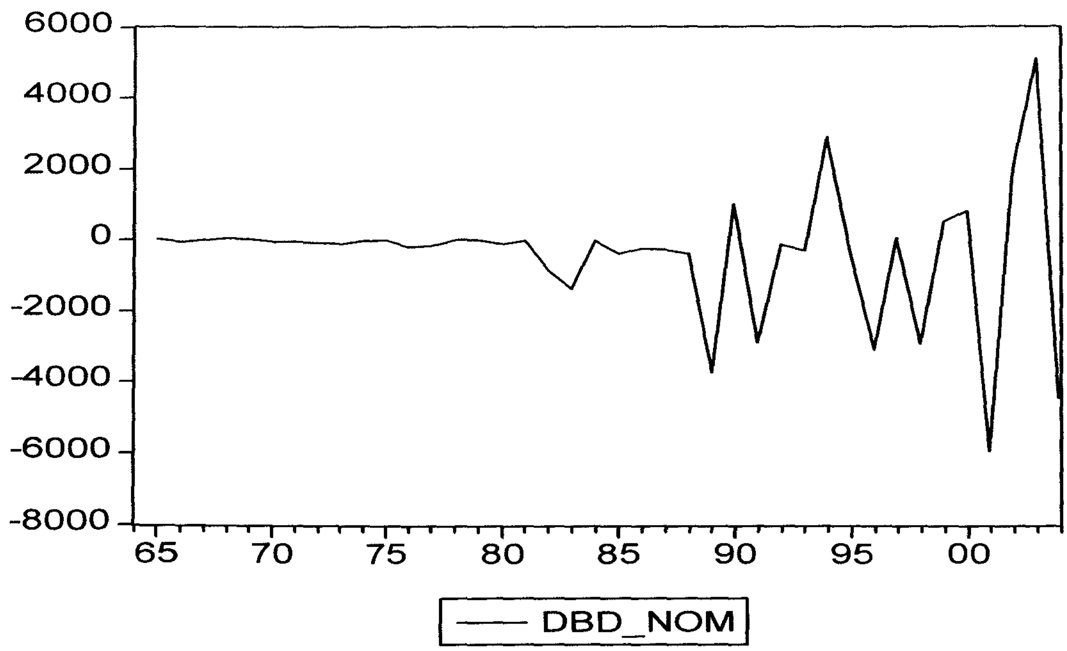


Figure - 4.4

Time Plot of Budget Deficit (Nominal) at First Difference (Stationary Series)



4.4 Study of the Stationarity through Correlogram

Correlogram is a graphical representation of Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) at different orders (lags) for any variable. The ACF and PACF of the Trade Deficit (Real) and Budget Deficit (Real) datasets at level are being presented through Fig 4.5 and Fig 4.7 respectively. Again, Fig 4.6 and Fig 4.8 present the correlograms for the first differenced datasets for TD and BD respectively. Again the correlograms for TD (nominal) and BD (nominal) series at level and first difference are being presented through Figures 4.9 – 4.12.

It is observed from the Figures 4.5 and 4.12 that,

(i) the ACF for TD (Real) displays a staircase like structure before it subsides at the 12^{th} lag. The first spike at lag 1 (in the partial autocorrelation function), is highly significant with the value 0.914. This is indicative of non-stationarity of the TD series at level.

(ii) the ACF for BD (Real) also subsides at lag 13 while the spike (the partial autocorrelation) at the first lag is the most significant one with the value 0.891. This testifies for the existence of non-stationarity in the dataset.

(iii) the first differenced real datasets for BD and TD display no significant spike in the ACF at the first lg. Moreover, the PACF is free from any significant spike at the first lag for both the differenced datasets. This confirms stationarity of BD and TD datasets upon first differencing.

(iv) the ACF for TD (Nominal) displays a staircase like structure before it subsides at the 12^{th} lag. The first spike at lag 1 (in the partial autocorrelation function), is highly significant with the value 0.894. This is indicative of non-stationarity of the Nominal TD series at level.

(v) the spikes in the ACF for BD (Nominal) also subside at lag 14 while the spike (the partial autocorrelation) at the first lag is the most significant one with the value 0.891. This testifies for the existence of non-stationarity in the dataset for Nominal BD.

(vi) the first differenced datasets for BD (Nominal) and TD (Nominal) display no significant spike in the ACF at the first lag. Moreover, the PACFs are free from any significant spike at the first lag for both the differenced datasets. This confirms stationarity of Nominal BD and TD datasets upon first differencing.

Figure - 4.5

Correlogram of Trade Deficit (Real) at Level (Non-Stationary)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.914	0.914	36.847	0.000
		2	0.823	-0.079	67.469	0.000
		3	0.741	0.006	92.925	0.000
		4	0.670	0.018	114.29	0.000
		5	0.621	0.091	133.15	0.000
		6	0.588	0.065	150.55	0.000
		7	0.532	-0.158	165.21	0.000
		8	0.427	-0.315	174.95	0.000
		9	0.329	-0.006	180.90	0.000
		10	0.219	-0.157	183.64	0.000
		11	0.136	0.044	184.73	0.000
		12	0.083	0.037	185.15	0.000
		13	0.041	-0.014	185.25	0.000
		14	-0.009	-0.018	185.26	0.000
		15	-0.057	0.053	185.48	0.000
		16	-0.105	-0.003	186.26	0.000
		17	-0.151	0.030	187.93	0.000
		18	-0.204	-0.222	191.12	0.000
		19	-0.236	0.020	195.59	0.000
		20	-0.262	-0.050	201.34	0.000

Figure - 4.6

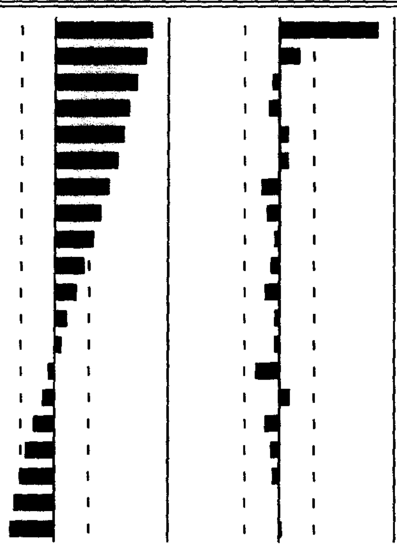
Correlogram of Trade Deficit (Real) at First Difference (Stationary)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.082	-0.082	0.2898	0.590
		2	0.043	0.036	0.3700	0.831
		3	-0.016	-0.010	0.3815	0.944
		4	-0.333	-0.340	5.5696	0.234
		5	-0.286	-0.387	9.5051	0.091
		6	0.253	0.250	12.670	0.049
		7	-0.064	0.037	12.877	0.075
		8	0.135	-0.068	13.837	0.086
		9	0.149	-0.072	15.037	0.090
		10	-0.121	-0.050	15.862	0.104
		11	-0.049	0.093	15.998	0.141
		12	0.000	-0.028	15.998	0.191
		13	-0.049	0.025	16.150	0.241
		14	0.087	0.063	16.634	0.276
		15	0.021	-0.060	16.664	0.339
		16	-0.042	-0.046	16.789	0.399
		17	0.113	0.161	17.720	0.407
		18	-0.134	-0.051	19.084	0.387
		19	-0.007	-0.061	19.088	0.451
		20	0.007	-0.068	19.092	0.516

Figure - 4.7

Correlogram Budget Deficit (Real) at Level (Non-Stationary)

Date: 12/01/07 Time: 14:14
Sample: 1964 2004
Included observations: 41



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.891	0.891	34.985	0.000
		2	0.829	0.172	66.067	0.000
		3	0.754	-0.056	92.424	0.000
		4	0.673	-0.088	113.98	0.000
		5	0.617	0.065	132.60	0.000
		6	0.569	0.059	148.94	0.000
		7	0.495	-0.154	161.63	0.000
		8	0.422	-0.108	171.14	0.000
		9	0.351	-0.027	177.90	0.000
		10	0.269	-0.072	182.02	0.000
		11	0.185	-0.126	184.02	0.000
		12	0.115	-0.030	184.82	0.000
		13	0.042	-0.030	184.93	0.000
		14	-0.057	-0.211	185.14	0.000
		15	-0.107	0.083	185.91	0.000
		16	-0.189	-0.119	188.44	0.000
		17	-0.259	-0.074	193.36	0.000
		18	-0.315	-0.049	200.99	0.000
		19	-0.366	0.005	211.74	0.000
		20	-0.407	0.017	225.64	0.000

Figure - 4.8

Correlogram of Budget (Real) Deficit at First Difference (Stationary)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.263	-0.263	2.9704	0.085
		2	0.007	-0.067	2.9725	0.226
		3	-0.023	-0.041	2.9959	0.392
		4	-0.109	-0.136	3.5512	0.470
		5	-0.110	-0.196	4.1300	0.531
		6	0.135	0.042	5.0273	0.540
		7	0.041	0.080	5.1127	0.646
		8	-0.020	-0.010	5.1342	0.743
		9	0.133	0.115	6.0859	0.731
		10	-0.006	0.095	6.0879	0.808
		11	-0.213	-0.158	8.7224	0.647
		12	0.006	-0.101	8.7249	0.726
		13	0.114	0.120	9.5281	0.732
		14	-0.245	-0.207	13.396	0.496
		15	0.098	-0.130	14.035	0.523
		16	0.058	-0.004	14.274	0.578
		17	-0.100	-0.068	15.000	0.595
		18	0.051	-0.030	15.201	0.648
		19	0.067	0.036	15.565	0.686
		20	-0.153	-0.049	17.525	0.619

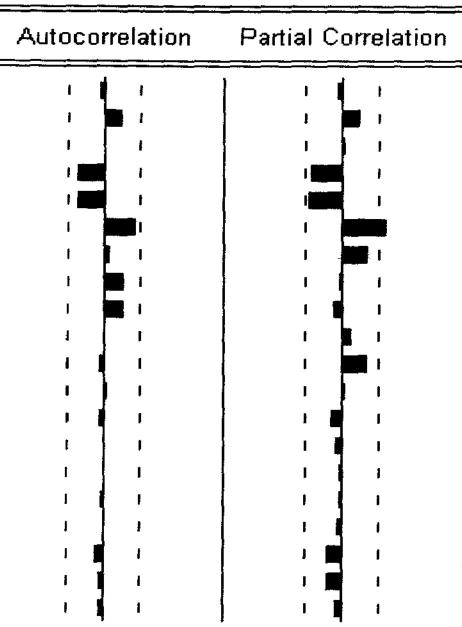
Figure - 4.9

Correlogram of Trade Deficit (Nominal) at Level (Non-Stationary)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.894	0.894	35.227	0.000
		2	0.782	-0.088	62.846	0.000
		3	0.692	0.054	85.092	0.000
		4	0.623	0.039	103.60	0.000
		5	0.564	0.010	119.16	0.000
		6	0.510	0.003	132.24	0.000
		7	0.448	-0.060	142.66	0.000
		8	0.326	-0.332	148.34	0.000
		9	0.227	0.056	151.18	0.000
		10	0.127	-0.156	152.10	0.000
		11	0.050	0.017	152.25	0.000
		12	0.004	0.071	152.25	0.000
		13	-0.031	0.002	152.31	0.000
		14	-0.067	0.000	152.60	0.000
		15	-0.098	0.113	153.25	0.000
		16	-0.126	-0.093	154.37	0.000
		17	-0.155	0.032	156.14	0.000
		18	-0.182	-0.106	158.67	0.000
		19	-0.202	-0.071	161.93	0.000
		20	-0.218	-0.046	165.94	0.000

Figure - 4.10

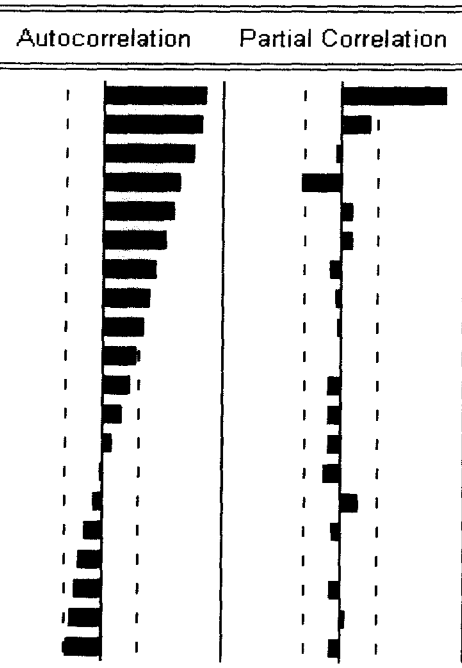
Correlogram of Trade Deficit (Nominal) at First Difference (Stationary)



Lag	AC	PAC	Q-Stat	Prob
1	-0.037	-0.037	0.0592	0.808
2	0.144	0.143	0.9804	0.612
3	0.004	0.014	0.9810	0.806
4	-0.230	-0.255	3.4417	0.487
5	-0.231	-0.272	6.0021	0.306
6	0.259	0.361	9.3145	0.157
7	0.038	0.215	9.3862	0.226
8	0.161	-0.024	10.747	0.216
9	0.159	-0.068	12.109	0.207
10	-0.007	0.075	12.112	0.278
11	-0.031	0.206	12.169	0.351
12	0.014	0.014	12.181	0.431
13	-0.026	-0.085	12.222	0.510
14	0.006	-0.042	12.224	0.588
15	-0.007	-0.020	12.227	[illegible]
16	-0.023	-0.023	12.263	0.726
17	-0.004	-0.040	12.264	0.784
18	-0.064	-0.124	12.580	0.816
19	-0.036	-0.115	12.684	0.854
20	-0.030	-0.047	12.759	0.888

Figure 4.11

Correlogram Budget Deficit (Nominal) at Level (Non-Stationary)



Lag	AC	PAC	Q-Stat	Prob
1	0.891	0.891	35.015	0.000
2	0.846	0.252	67.382	0.000
3	0.782	-0.034	95.772	0.000
4	0.667	-0.329	116.98	0.000
5	0.609	0.084	135.14	0.000
6	0.542	0.089	149.94	0.000
7	0.458	-0.089	160.81	0.000
8	0.409	-0.031	169.73	0.000
9	0.345	-0.019	176.27	0.000
10	0.284	-0.004	180.86	0.000
11	0.224	-0.114	183.79	0.000
12	0.151	-0.109	185.18	0.000
13	0.075	-0.099	185.53	0.000
14	-0.015	-0.145	185.54	0.000
15	-0.064	0.144	185.82	0.000
16	-0.137	-0.069	187.14	0.000
17	-0.182	0.004	189.59	0.000
18	-0.223	-0.088	193.40	0.000
19	-0.263	0.037	198.94	0.000
20	-0.299	-0.083	206.46	0.000

Figure - 4.12

Correlogram of Budget Deficit (Nominal) at First Difference (Stationary)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.295	-0.295	3.7513	0.053
		2	-0.277	-0.399	7.1369	0.028
		3	0.277	0.059	10.615	0.014
		4	-0.118	-0.126	11.261	0.024
		5	-0.027	0.014	11.296	0.046
		6	0.077	-0.021	11.590	0.072
		7	-0.135	-0.112	12.518	0.085
		8	0.095	0.030	12.996	0.112
		9	0.186	0.204	14.866	0.095
		10	-0.001	0.291	14.866	0.137
		11	-0.158	0.025	16.313	0.130
		12	0.027	-0.017	16.358	0.175
		13	0.098	0.034	16.957	0.201
		14	-0.190	-0.158	19.292	0.154
		15	0.111	0.056	20.115	0.168
		16	0.007	-0.065	20.118	0.215
		17	-0.046	0.011	20.273	0.261
		18	0.023	-0.206	20.315	0.315
		19	0.013	-0.085	20.328	0.375
		20	-0.083	-0.126	20.914	0.402

4.5 Summary

This chapter is devoted to examining stationarity of the time series datasets for trade deficits (TD) and budget deficits (BD). The stationarity of the variables concerned has been studied through:

(i) *examination of time plots of the variables at level and upon first degree differencing.*

(ii) *battery of Unit Root Tests which include Dickey-Fuller Test, ADF Test, P-P Test, KPSS Test, Ng-Perron Test, ERS Point Optimal Test and DG-GLS Unit Root Test.*

(iii) *the study of Correlograms of the variables concerned at level and upon first differencing.*

The time plots, battery of tests and Correlograms study of the variables confirm that:

(i) *Real times series for BD and TD datasets at level are non-stationary, and*

(ii) *these variables attain stationarity upon first order differencing i.e.*

BD (Real) ~ I (1)

and, *TB (Real) ~ I (1)*

(iii) *first order differencing ensures stationarity for BD (Nominal) dataset, i.e.*

BD (nominal) ~ I (1)

(iv) *TD (Nominal) dataset fails to attain stationarity even upon second differencing (as given by the Unit Root Tests).*

❖❖❖

Appendix to the Chapter IV

Notes on Correlogram and Q statistic

Correlogram

The 95% confidence interval for sample autocorrelation coefficients is $(\rho_k) = \pm 1.96\ (1/\sqrt{41}) = \pm 0.3061$. Hence, the autocorrelation coefficient should lie between -0.3061 to + 0.3061 for the data when they are at level for stationarity. For the first difference of the series the confidence interval is $(\rho_k) = \pm 1.96\ (1/\sqrt{40}) = 0.3099$ on either side of zero. The coefficient of ACF should lie between -0.3099 to +0.3099. If an estimated ρ_k falls inside the interval, the hypothesis that the true ρ_k is zero is not rejected. But if it lies outside this confidence interval, then the hypothesis that the true ρ_k is zero can be rejected. The 95% confidence interval has been shown as two dashed lines in the correlogram of different series on the figures (Figures 4.5 – 4.12)

For example, the Figure 4.5 shows the sample correlogram of the real trade deficit up to 20 lags. One notable and important feature of this sample correlogram is that it starts at a very high value (0.914 at lag 1) and tapers off very gradually. Even at lag 9 the autocorrelation coefficient is still a sizable value of 0.329. From this figure, two facts come out: First, the ACF declines very slowly; ACF up to 9 lags are individually statistically significantly different from zero, for they all are outside the 95% confidence bounds. Second, after the first lag, the PACF drops dramatically, and all PACFs after lag 1 are statistically insignificant. This type of pattern is generally an indication that the time series is non-stationary. Again for all the first differenced series, ACF and PACF are free from any significant spike at any lag. Again the spikes cross the base at the fourth and fifth lag.

Q statistic

In order to verify the joint hypothesis that all the autocorrelation coefficients (ρ_k) are simultaneously equal to zero, the 'Q statistic' developed by Box and Pierce can be used for this purpose. This has been defined as,

$$Q = n \sum_{k=1}^{m} \rho_k^{2} \qquad \text{where, } n = \text{sample size} \qquad m = \text{lag length}$$

The Q statistic is approximately distributed as a chi-square variate with m df. If the computed Q exceeds the critical Q value from the chi-square table at the selected level of significance, the null hypothesis that all ρ_k are zero can be rejected; at least some of them must be nonzero.

Omission of Nominal Data in the Study

Nominal time series datasets in use are normally influenced by the same price index/deflator affecting their movements. In our case, NTD dataset could not achieve stationarity even upon second differencing. Here, influence of respective year's price on TD might have caused to happen so. In real practice too, nominal data are seldom modeled for deriving conclusions. Moreover, if the nominal data are not transformed into 'real' data, probably we might be studying simply the relationship of price movements rather than analyzing 'actual relationship' between variables. For these reasons, we also dropped the Nominal Data of budget deficit (BD) and trade deficit (TD) from our study in the forthcoming chapters.

CHAPTER - V

TRADE DEFICIT AND BUDGE DEFICIT: CO-INTEGRATION ANALYSIS

5.1 Introduction

In economic analysis, it is necessary to examine if long-run equilibrium relationship among macroeconomic variable concerned exists. The study of long-run relationship among variables was formulated by Granger in 1981 through 'Co-integration Study' and it was developed and elaborated by Engle and Granger 1987. Engle and Granger established that long-run relationship among variables could exist if and only if the variables were co-integrated.

We have sought to examine the co-integrating relationship between the variables TD and BD by using Engle-Granger method. Moreover, Durbin Watson method of Co-integrating Regression (CRDW) and Johansen' method of Co-integration have also been employed for further confirmation in the present study.

5.2 Budget Deficit and Trade Deficit in Nepal – A Co-integration Study

Time plots of the Budget Deficit and Trade Deficit (at level) are presented through the Figures 1.2 and 1.3 in Chapter I. A close observation of these plots shows that

(i) both the time plots exhibit declining pattern until 1999.

(ii) both the time plots exhibit rising trend for a very brief period i.e. 2003 –2003.

(iii) the declining phases in both the time plots are marked by some finite numbers of ups and downs.

These observations seem to indicate that

(a) there might exist a long-run relationship between Budget Deficit (BD) and Trade Deficit (TD)

(b) The long-run relationship might have been stable

We seek to address these issues in this chapter. More specifically, we seek to examine if there exists any 'long-run' stable relationship between the Trade Deficits and Budget Deficits in Nepal over the period of our study (1964-2004).

5.3 Methodology of Co-integration

Let Y_t have a long-run relationship with X_t such that,

$$Y_t = \alpha + \beta X_t + u_t$$

or, $$u_t = Y_t - \alpha - \beta X_t$$

Therefore, Y_t and X_t will have a stable long-run relationship if u_t is stationery. In such case, Y_t and X_t are co-integrated in, CI (0).

If on the other hand, if u_t is not stationery, Y_t and X_t series at level cannot define a long-run relationship. In such case, differencing of the u_t series will be necessary. It u_t is stationary at first differencing, then

$$\Delta u_t = \Delta Y_t - \alpha - \beta \Delta X_t$$

defines a stationary process. In such case,

$$\Delta Y_t = \alpha + \beta \Delta X_t + \varepsilon_t$$

where, $t_i \sim iid\, N(0, a_n^2)$

indicates that ΔY_t has a long-run relation with ΔX_t. Consequently, Y_t and X_t are co-integrated in, CI (0).

5.4 The Models

The estimable cointegration models (5.1 and 5.2) for the present study of the long run relationship between budget deficit (BD) and trade deficit (TD) consist of the following equations:

$$TD_t = \alpha + \beta BD_t + u_t \quad (5.1)$$

$$u_t = TD_t - \alpha - \beta BD_t \quad (5.2)$$

where,

TD_t = Real Trade Deficit

BD_t = Real Budget Deficit, and

u_t = Residual term

5.4.1 Estimation of the Models

Equation (5.1) has been estimated. The corresponding estimated equation is given by equations (5.3) below:

$$TD_t = -1533.173 + 2.6618 BD_t \quad (5.3)$$

S.E.: (1220.41) (0.4198)

t-stat.: [-1.256] [6.3405]

$R^2 = 0.5076$

Adj. $R^2 = 0.4950$

Durbin-Watson stat.= 0.4608

From the estimated equations (5.3), the residual series for e_t has been estimated. TD_t and BD_t. will be co-integrated if e_t is stationary.

5.4.2 Tests of Stationarity of Residuals

Stationarity of the residuals e_t has been tested through ADF and Phillips- Perron methods. The results of the tests are being presented through the Tables 5.1 and 5.2.

Table - 5.1

Results of Augmented Dickey Fuller Unit Root Tests on Residuals

Null Hypothesis: The residual has a unit root

Exogenous: Constant **Lag length** :-(Automatic based on SIC, MAXLAG=9)

Variable	ADF test statistic	Prob* value	Lag Length	Test critical values		
				1%	5%	10%
e_t	-1.947387	0.3081	0	-3.605593	-2.936942	-2.606857
Exogenous: None						
e_t	-1.984000	0.0464	0	-2.624057	-1.949319	-1.611711

- *MacKinnon (1996) One-sided P-values*

Again the results of the Phillips-Perron unit root test on residuals has been presented in Table 5.2.

Table - 5.2

Results of Phillips-Perron Unit Root Test on Residuals

(Null Hypothesis: The residual has a unit root)

Exogenous: Constant **Bandwidth:** (Newey-West using Bartlett kernel)

Variable	P-P test statistic	Prob* value	Band**Width	Test critical values		
				1%	5%	10%
e_t	-2.059065	0.2617	3	-3.605593	-2.936942	-2.606857
Exogenous: None						
e_t	-2.100304	0.0358	2	-2.624057	-1.949319	-1.611711

- *MacKinnon (1996) One-sided P-values* ***Newey-West using Bartlett kernel*

5.4.3 Findings of the Unit Root Test of Residuals (of the Equation 5.3)

It is observed from the Tables 5.1 and 5.2 that,

(i) the ADF Test statistic indicate the presence of Unit Root in the in the residuals at 1% level with both the, 'exogenous constant' and 'no exogenous' cases.

(ii) the value of PP test statistic is lower than the absolute value of the critical value at 10% and 5% level. This also testifies for the non-stationarity of residuals.

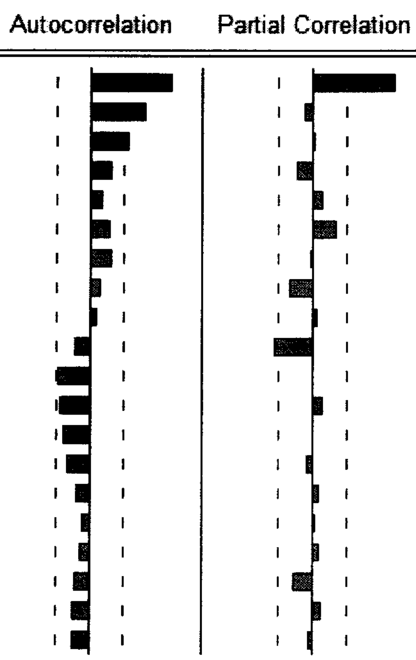
The non-stationarity of residuals (e_t) indicates that the series TD_t and BD_t at levels are not Co-integrated at level i.e BD and TD are not CI(1,1).

5.4.4 Correlogram of Residuals

Another important way of analyzing the stationarity of the residual (e_t) of the respective equation of the concerned data series is the study of Correlogram of the respective residual series. ACF and PACF of the residuals e_t as given in Figure 5.1 help us examine whether the residual is stationary.

Figure - 5.1

Correlogram of Residuals of $TD_t = \alpha + \beta BD_t + u_t$



	AC	PAC	Q-Stat	Prob
1	0.738	0.738	23.998	0.000
2	0.510	-0.076	35.748	0.000
3	0.353	0.009	41.516	0.000
4	0.182	-0.138	43.092	0.000
5	0.113	0.097	43.721	0.000
6	0.168	0.202	45.150	0.000
7	0.186	-0.013	46.942	0.000
8	0.095	-0.220	47.423	0.000
9	0.051	0.025	47.567	0.000
10	-0.145	-0.358	48.766	0.000
11	-0.293	0.005	53.809	0.000
12	-0.281	0.095	58.626	0.000
13	-0.246	-0.002	62.442	0.000
14	-0.209	-0.045	65.294	0.000
15	-0.116	0.042	66.208	0.000
16	-0.058	0.015	66.447	0.000
17	-0.092	0.054	67.065	0.000
18	-0.140	-0.168	68.563	0.000
19	-0.152	0.066	70.408	0.000
20	-0.156	-0.035	72.458	0.000

5.4.5 Findings from the Correlogram of the Residuals

The Correlogram of the residual is given by the Fig 5.1. The plots of the ACF and PACF of the residual show that,

(i) there is long declining step spike pattern in the ACF before it crosses the base, and

(ii) there exists a significant spike at lag one in the PACF

These findings confirm the existence of non-stationarity in the residuals. Consequently, it appears that the BD_t and TD_t series at level are not co-integrated and there exists no long-run relationship between the variables concerned.

5.4.6 Durbin-Watson method of Co-integrating Regression (CRDW)

An alternative method of testing whether the variables are co-integrated is the CRDW test. The critical values for the test statistics were provided by Sargan and Bhargava (Gujarati, 1995:727). In CRDW, significance of the Durbin-Watson statistic (d value) obtained from the co-integrating regression is determined. The null hypothesis is that d=0.

The results of the CRDW test along with critical values have been presented in Table 5.3.

Table - 5.3

Results of Durbin-Watson Test of Co-integrating Regression (CRDW)

Null Hypothesis	D-W statistic	Critical Values		
		1%	5%	10%
No cointegration between TD_t & BD_t	0.4608	0.511	0.386	0.322

It is observed from the Table 5.3 that the null hypothesis of no cointegration between trade deficit (TD) and budget deficit (BD) in real terms has been accepted at 1% level. Consequently, the BD and TD series at level are found not to maintain any long-run relationship between them.

5.4.7 Johansen's Method of Co-integration: Further Confirmation

The Johansen Method of Co-integration has been adopted for further confirmation of our findings on stationarity.

The Johansen Method of Co-integration is quite different from Engle-Granger and CRDW method. This test is based on trace statistic and max-eigen statistic (λ_{max}). The results of such test have been presented in the Table 5.4 and 5.5.

Table - 5.4

Results of Johansen Cointegration Test

Unrestricted Cointegration Rank Test **Lags interval** (in first differences): 1 to 2

Series: TD_t BD_t **Trend assumption**: Linear deterministic trend

Null Hypothesis.	Alternative Hypo.		Eigen value	Trace statistic	5% critical value	1% critical value	Max-eigen statistic	5% critical value	1% critical value
	λ_{max}-tests	Trace tests							
r=0	r =1	r≥1	0.135717	6.136599	15.41	20.04	5.688339	14.07	18.63
r≤1	r =2	r≥2	0.011428	0.448259	3.76	6.65	0.448259	3.76	6.65

**(**) denotes rejection of the hypothesis at the 5%(1%) level*

Max-eigenvalue test indicates no cointegration at both 5% and 1% levels

Table - 5.5

Results of Johansen Cointegration Test

Unrestricted Cointegration Rank Test **Lags interval** (in first differences): 1 to 2

Series: TD_t BD_t **Trend assumption**: No deterministic trend (restricted constant)

Null Hypothesis.	Alternative Hypo.		Eigen value	Trace statistic	5% critical value	1% critical value	Max-eigen statistic	5% critical value	1% critical value
	λ_{max}-tests	Trace tests							
r=0	r =1	r≥1	0.169694	11.00478	19.96	24.60	7.252469	15.67	20.20
r≤1	r =2	r≥2	0.091730	3.752315	9.24	12.97	3.752315	9.24	12.97

**(**) denotes rejection of the hypothesis at the 5%(1%) level*

Trace test indicates 1 cointegrating equation(s) at the 5% level and Trace test indicates no cointegration at the 1% level.

5.4.8 Findings from the Johansen's Co-integration Test Results

Table 5.4 and 5.5 provide the following observations,

(i) For r = 0, with assumption of liner deterministic trend in the series is smaller than the critical trace statistics (6.136599) at 5% and 1% level. So the null hypothesis of non-existence of co-integration between BD and TD has been accepted at 5% (and 1%) level of significance.

(ii) Again for r = 0, with the assumption of linear deterministic trend in the data series, Max-Eigen statistics (5.688339) is smaller than the critical values even at 5% level. Consequently, the null hypothesis of absence of Co-integration between BD and TD has been accepted even at 5% level.

(iii) For r = 0, without the assumption of linear deterministic trend in the series concerned, the estimated trace statistics and Max-Eigen statistics fall short of the corresponding critical values even at 5% level of significance.

These observations confirm our findings in sections 5.4.3 – 5.4.7 that

(a) BD and TD at level are not Co-integrated, and, therefore,

(b) there exists no long-run relation between BD and TD when datasets of these variables are considered at level.

5.5 Test of Co-integration with First Differenced Data

We now seek to examine if long-run relation existed between first differenced datasets for BD and TD. The relevant estimable models for this purpose are explained below.

5.5.1 The Model

The estimable co-integration models for the present study of the long run relationship between budget deficit (ΔBD) and trade deficit (ΔTD) consists of the following equations:

$$\Delta TD_t = \alpha + \beta\,\Delta BD_t + u_t \tag{5.4}$$

$$u_t = \Delta TD_t - \alpha - \beta\,\Delta BD_t \tag{5.5}$$

where,

ΔTD_t = First Difference of Real Trade Deficit

ΔBD_t = First Difference of Real Budget Deficit, and

u_t = Residual term

5.5.2 Estimation of the Models

The corresponding estimated equation is given by equation (5.6) below:

$$\Delta TD_t = -501.578 - 0.9599\Delta BD_t \tag{5.6}$$

S.E.: (298.632) (0.4061)

t-stat.: [-1.6796] [-2.364]

$R^2 = 0.128$

Adj. $R^2 = 0.105$

Durbin-Watson stat. = 2.215

From the estimated equations (5.6), the residual series for $\hat{u}_t$ has been estimated. ΔTD_t and ΔBD_t. will be co-integrated if $\hat{w}_t$ is stationary.

5.5.3 Tests of Stationarity of Residuals

Stationarity of the residuals $\hat{u}_t$ has been tested through ADF and Phillips- Perron methods. The results of the tests are being presented through the Tables 5.6 and 5.7.

Table - 5.6

Results of Augmented Dickey Fuller Unit Root Test on Residuals ($\hat{u}_t$)

Null Hypothesis: The residual has a unit root

Exogenous: Constant **Lag length**:- (Automatic based on SIC, MAXLAG=9)

Variable	ADF test statistic	Prob* value	Lag Length	Test critical values		
				1%	5%	10%
RESID	-6.827777	0.0000	0	-3.610453	-2.938987	-2.607932
Exogenous: None						
RESID	-6.918109	0.0000	0	-2.625606	-1.949609	-1.611593

- *MacKinnon (1996) One-sided P-values*

The Phillips-Perron unit root test on residuals u_t has been presented in the Table 5.7.

Table - 5.7

Results of Phillips-Perron Unit Root Test on Residuals ($\hat{u}_t$)

(Null Hypothesis: The residual has a unit root)

Exogenous: Constant **Bandwidth:** (Newey-West using Bartlett kernel)

Variable	P-P test statistic	Prob* value	Band**Width	Test critical values		
				1%	5%	10%
RESID	-6.926266	0.0000	4	-3.610453	-2.938987	-2.607932
Exogenous: None						
RESID	-7.024417	0.0000	4	-2.625606	-1.949609	-1.611593

- *MacKinnon (1996) One-sided P-values* ***Newey-West using Bartlett kernel*

5.5.4 Findings of the Unit Root on Residuals ($\hat{u}_t$)

It is observed from the Tables 5.6 and 5.7 that

(iii) the ADF Test statistic indicate the presence of no Unit Root in the residuals at 1% level with both the, 'exogenous constant' and 'no exogenous' cases.

(iv) the above value of PP test statistic is lower than the absolute value of the critical value at 1% level. This also testifies for the stationarity of residuals.

5.5.5 Correlogram of Residuals

Stationarity of the $\hat{u}_t$ residuals has further been examined through the study of Correlogram of the series concerned.

Figure - 5.2

Correlogram of Residuals ($\hat{u}_t$)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.114	-0.114	0.5568	0.456
		2	0.101	0.089	1.0042	0.605
		3	-0.153	-0.135	2.0683	0.558
		4	-0.245	-0.293	4.8732	0.301
		5	-0.202	-0.270	6.8393	0.233
		6	0.348	0.368	12.830	0.046
		7	-0.128	-0.096	13.663	0.058
		8	0.222	-0.039	16.259	0.039
		9	-0.030	-0.007	16.308	0.061
		10	-0.136	-0.031	17.340	0.067
		11	0.010	0.129	17.345	0.098
		12	-0.005	-0.106	17.347	0.137
		13	-0.022	0.053	17.378	0.183
		14	0.175	0.088	19.359	0.152
		15	-0.075	-0.061	19.734	0.182
		16	-0.115	-0.147	20.663	0.192
		17	0.064	0.051	20.967	0.228
		18	-0.128	0.045	22.222	0.222
		19	0.023	-0.100	22.263	0.271
		20	0.017	-0.184	22.286	0.325

5.5.6 Findings from the Correlogram of the Residual

The Correlogram of the residuals ($\hat{u}_t$) is given by the Fig 5.2 above, the plots of the ACF and PACF of the residual show that

(i) the residual ($\hat{u}_t$) dataset display no significant spike in the ACF at the first lag.

(ii) the PACF is free from any singularly significant spike at the first lag for the $\hat{u}_t$.

These findings confirm stationarity for $\hat{u}_t$. Consequently, it also indicates that the ΔBD and ΔTD are Co-integrated i.e. BD and TD are CI (1, 0).

5.6 Overview of Findings and Economic Interpretations

The study in sections 5.4 – 5.5 indicates that

(i) Budget Deficits (BD) and Trade Deficits (TD) series at level are not Co-integrated. Consequently, no long-run relationship can be expected to exist between TD and BD when level datasets are being considered.

(ii) since both BD ~ I (1) and TD ~ I (1), we could go for examining the existence of Co-integration between ΔBD and ΔTD series. It is found that ΔBD and ΔTD series are Co-integrated. Consequently, a long-run relation can be expected to exist between first differenced datasets for BD and TD. Consequently, BD and TD series are CI (1, 0).

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CHAPTER – VI

STABILITY OF THE LONG-RUN RELATIONSHIP BETWEEN TADE DEFICIT AND BUDGET DEFICIT IN NEPAL

6.1 Introduction

Co-integration study in Chapter V confirms the existence of long-run relationship between Trade Deficit (ΔTD_t) and Budget Deficit (ΔBD_t) series in Nepal. Stability of the long-run relationship is established if short-run short-run shocks transmitted through ΔTD_t or ΔBD_t channel converge before long. The stability of long-run relationship is in this chapter studied through the Vector Error Correction Model (VECM).

6.2 Vector Error Correction Modeling

Vector Error Correction (VEC) modeling is a restricted Vector Auto Regression (VAR) that has been developed for make use of non-stationary data series those are known to be co-integrated. The VEC shows co-integrating relationship built into the model and it restricts the long-run dynamics of the endogenous variable to converge to their co-integrating relationships while allowing short-run adjustments

In doing so, the co-integrating term is known as the 'Error Correction' because the deviation from long run equilibrium is corrected by a numbers of partial adjustments (dynamics). It is pertinent to run this model here in our study to analyze the nature and speed of adjustments concerned to the specified models. Likely possibilities of test results would be:

a. the short-period shocks might not have upset long-run relationship among variables

b. the short-run dynamics might be converging, and

c. the long-run relationship might have been stable.

6.3 VEC and the Estimable Models

In the present study the estimable Vector Error Correction model consists of the following equations:

$$\Delta TD_t = \gamma_1 + \rho_1 z_{t-1} + \alpha_1 \Delta TD_{t-1} + \alpha_2 \Delta TD_{t-2} + \alpha_3 \Delta BD_{t-1} + \alpha_4 \Delta BD_{t-2} + \varepsilon_{1t} \qquad (6.1)$$

$$\Delta BD_t = \gamma_2 + \rho_2 z_{t-1} + \beta_1 \Delta TD_{t-1} + \beta_2 \Delta TD_{t-2} + \beta_3 \Delta BD_{t-1} + \beta_4 \Delta BD_{t-2} + \varepsilon_{2t} \qquad (6.2)$$

where,

ΔTD_t = first difference of trade deficit (real) series

ΔBD_t = first difference of budget deficit (real) series

z_{t-1} = first lag of error term of co-integrating equation;

ε_{1t} and ε_{2t} are white noise errors;

$\alpha_1, \alpha_2, \alpha_3$ and α_4 are the coefficients of lagged $(\Delta TD_t, \Delta BD_t)$ in equation (6.1), and

$\beta_1, \beta_2, \beta_3$ and β_4 are the coefficients lagged $(\Delta TD_t, \Delta BD_t)$ in equation (6.2)

γ_1, and γ_2 are constants regression of equations in (6.1) and (6.2) respectively.

In the estimation of Vector Error Correction model, at least one of ρ_1, or ρ_2 of cointegrating terms in (6.1) and (6.2) should be nonzero. The lag length in estimation is determined through AIC and SIC criterion.

6.3.1 Vector Error Correction Estimates for Real Trade Deficits & Real Budget Deficits

The results of estimations of the Vector Error Correction Models consisting of equations (6.2) and (6.3) have been presented in Table 6.1

Table -6.1

Results of the Estimations of Vector Error Correction Model

Dependent Variable	Explanatory Variables	Coefficient	't' statistics
ΔTD_t	Constant (γ_1)	-634.5413	[-1.79508]**
	z_{1t-1}	-0.177630	[-2.50440]***
	ΔTD_{t-1}	-0.086450	[-0.49165]
	ΔTD_{t-2}	0.068210	[0.39323]
	ΔBD_{t-1}	-0.915835	[-1.72665]**
	ΔBD_{t-2}	-0.727554	[-1.38764]*
ΔBD_t	Constant (γ_2)	-68.99995	[-0.51069]
	Z_{1t-1}	0.034616	[1.27686]
	ΔBD_{t-1}	-0.162533	[-0.80169]
	ΔBD_{t-2}	0.089712	[0.44766]
	ΔTD_{t-1}	-0.007219	[-0.10741]
	ΔTD_{t-2}	0.072632	[1.09548]

*, **, *** *Indicates statistical significance at the 10%, 5%, 1% level.*

6.3.2 Findings from the VEC Model Estimation

The Table 6.1 shows that,

(ii) $\hat{\rho}_1$, the coefficient of z_{1t-1} (in equation 6.1 is significant at 1% level.

(iii) $\hat{\alpha}_3$, the coefficient of ΔBDt-1 is significant at 5% level.

(iv) $\hat{\alpha}_4$, the coefficient of ΔBD_{t-2} is significant at 10% level.

(v) $\hat{\rho}_2$, the coefficient of z_{1t-1} (in equation 6.2) is significant at 10% level.

(vi) $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$, and $\hat{\beta}_4$ are found to be insignificant even at 10% level.

6.4 Economic Interpretations of the Findings on the Short-run Dynamics

These findings provide valuable indications bout short-run dynamics and the nature of short-run causality between TD and BD in the economy of Nepal. These are as follows:

(i) Significant $\hat{\rho}_1$, (i.e. $\hat{\rho}_1 \neq 0$) shows that the shocks in the previous period significantly affect the long-run relationship between TD and BD.

(ii) $\hat{\rho}_1 < 0$ indicates that ΔTD_t falls short of its long-run equilibrium value because of the short-run shock.

(i) $/\hat{\rho}_1/ < 1$ indicates that the short-run deviation of ΔTD_t from its long-run equilibrium value is converging. This means that such deviation does not last long and ΔTD_t gets back to its long-run value again.

(ii) Significant values of $\hat{\alpha}_3$ and $\hat{\alpha}_4$ (i.e. $\hat{\alpha}_3 \neq 0$, $\hat{\alpha}_4 \neq 0$) indicate that the long-run values of ΔTD_t are determined by the current and the lagged values of ΔBDt. Consequently, variations in ΔTD_t are explained and caused by those in ΔBDt. The short-run causality runs from ΔBDt to ΔTD_t.

(iii) Insignificant values of the $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$, and $\hat{\beta}_4$ indicate that long-run values of ΔBDt are not determined by the lagged values of ΔTDt. Consequently, variations in ΔTD_t are not explained and caused by those, in ΔBD_t. This testifies that the short-run causality does not run from ΔTD_t to ΔBDt.

(iv) Insignificant values of $\hat{\rho}_1$, $\hat{\beta}_1$, $\hat{\beta}_2$, $\hat{\beta}_3$, and $\hat{\beta}_4$, as given by the statistical tests, indicate that ΔBDt is not an *endogenous variable* in the system. Consequently, any shock through the channels of BD or TD in the short-run fails to exert any effect on its values.

6.5 Summary:

This Chapter is devoted for the study of stability of long-run equilibrium relationship between Trade Deficits (TD) and Budget Deficits (BD).

More specifically, the findings of our study in this chapter are as follows:

(i) *ΔTD_t is the endogenous variable while ΔBDt is exogenous variable. In such case, TD maintains a long-run equilibrium relationship with BD.*

(i) *The shocks significantly affected the long-run equilibrium relationship between TD and BD in the short-run.*

(ii) *The 'long-run equilibrium relationship' that TD maintains with BD is 'stable' since the 'short-run dynamics' displays a converging pattern.*

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CHAPTER – VII

TWIN DEFICITS IN NEPAL – CAUSALITY TESTS

7.1 Introduction

The disagreement of propositions[14] between Fisher (1926) and Phillips (1958) concerned to the appropriate direction of causation between inflation and unemployment (Fisher believed that '*causation runs from price inflation to unemployment*' and Phillips believed that '*causation runs from unemployment to wage inflation*') has led the foundation for causality test historically.

Fisher-Phillips dichotomy tells 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) and X_t be the Budget Deficit (BD) under bi-variate postulates, the possible directions of casualty would be,

(i) $Yt \Rightarrow Xt$

(ii) $Xt \Rightarrow Yt$

(iii) $Yt \nRightarrow Xt$

(iv) $Xt \nRightarrow Yt$

(v) $Xt \Leftrightarrow Yt$

The symbols, $\Rightarrow$ implies one-way causation; $\nRightarrow$ implies no causation and $\Leftrightarrow$ implies mutual causations.

[14] See: Patterson K. (2000), "An Introduction to Applied Econometric – A Time Series Approach" Palgrave, NY, 2002 Reprint, Indian Edition, pp 518 - 551.

7.2 Grounds for Testing the Granger Causality in the Study

The estimated 'Error Correction Model' presented in Chapter - VI showed that, in the short-run Trade Deficit (TD) is Granger-caused by Budget Deficit (BD) while BD is not Granger-caused by TD. By the theoretical deductions discussed in section 5.1, it is possible to TD Granger-cause BD or 'no causation' at all or prevalence of possibility of 'bi-directional causation' too. So, we have decided to go for the 'Granger Causality Test' in its original form following the methodology presented below.

7.3 Granger-Causation Tests: Methodology

For the sake of simplicity, let γ_{1t} and γ_{2t} be the two variables under study. Along this course, the focal idea (hypothesis) is that γ_{1t} is not Granger-caused by γ_{2t} if the optimal predictor of γ_{1t} does not use information from γ_{2t}. While applying this idea, the predictor is usually restricted to be an optimal 'linear' predictor and optimality is defined as minimizing the mean square error (MSE) of the h-step predictor of γ_{1t}.

In order to be more specific, let γ_{1t} and γ_{2t} have vector autoregressive representation (VAR) in which γ_{1t} depends upon its own lags and lags of γ_{2t} and symmetrically γ_{2t} depends upon its own lags and lags of γ_{1t}.

Let us put the aforesaid VAR specification as following:

$$\gamma_{1t} = \mu_{10} + \pi_{t11.1}\, \gamma_{1t-1} + \cdots + \pi_{t11.p}\, \gamma_{1t-p} + \pi_{t12.1}\, \gamma_{2t-1} + \cdots + \pi_{t12.p}\, \gamma_{2t-p} + \varepsilon_{1t} \qquad (7.1)$$

$$\gamma_{2t} = \mu_{20} + \pi_{t21.1}\, \gamma_{1t-1} + \cdots + \pi_{t21.p}\, \gamma_{1t-p} + \pi_{t22.1}\, \gamma_{2t-1} + \cdots + \pi_{t22.p}\, \gamma_{2t-p} + \varepsilon_{2t} \qquad (7.2)$$

Here, first subscript denotes the variable and the second subscript denotes the observation index. This representation is bi-variate p^{th} order VAR.

Since we are having of a system of two equations (7.1) and (7.2), the errors may be contemporaneously correlated. Therefore, any shock to one of the equations would have 'ripple effect' on the other equation.

For specifications of the ε_{it}, $i = 1, 2$; is assumed to have an innovation with zero mean, constant variance, and no serial correlation, that is $E\{\varepsilon_{it}\} = 0$; $E\{\varepsilon^2_{it}\} = \sigma_i^2$ for $i = 1, 2$ and $E\{\varepsilon_{it}\ \varepsilon_{is}\} = 0$ for $t \neq s$ and $i = 1, 2$. Again it is also assumed that $E\{\varepsilon_{1t}\ \varepsilon_{2s}\} = 0$ for $t \neq s$ for no serial correlation. Additionally, the 'ripple effect' is captured by the covariance between ε_{1t} and ε_{2t}, denoted σ_{12}, which is assumed to be constant.

Along this course, for all t, the error variance matrix for the VAR with p lags will be,

$$\Omega(\varepsilon, p) \equiv E\begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}\begin{pmatrix} \varepsilon_{1t} & \varepsilon_{2t} \end{pmatrix} = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{bmatrix} \tag{7.3}$$

The equations (6.1) and (6.2), they may be replaced with the following matrix form:

$$\begin{pmatrix} \gamma_{1t} \\ \gamma_{2t} \end{pmatrix} = \begin{pmatrix} \mu_{10} \\ \mu_{20} \end{pmatrix} + \begin{bmatrix} \pi_{11.1} & \pi_{12.1} \\ \pi_{21.1} & \pi_{22.1} \end{bmatrix}\begin{pmatrix} \gamma_{1t-1} \\ \gamma_{2t-1} \end{pmatrix} + \dots + \begin{bmatrix} \pi_{11.p} & \pi_{12.p} \\ \pi_{21.p} & \pi_{22.p} \end{bmatrix}\begin{pmatrix} \gamma_{1t-p} \\ \gamma_{2t-p} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{7.4}$$

Now again, a third subscript is necessary on the coefficients to make a distinction of lag length which runs from 1 lag through p lags. In that case, it may be written as,

$$\gamma_t = \mu + \Pi_1 \gamma_{t-1} + \dots + \Pi_p \gamma_{t-p} + \varepsilon_t \tag{7.5}$$

where, $\gamma_t^{'} = (\gamma_{2t}, \gamma_{2t}), \mu^{'} = (\mu_{10}, \mu_{20}), \varepsilon_t^{'} = (\varepsilon_{1t}, \varepsilon_{2t})$ and Π_i are *2X2* matrices defined in response to equation (7.4).

7.4 Estimable Models for Granger Causality

Pursuing the methodology developed for Granger Causality Test in the section 7.3, we have developed 'causality equations' as presented below:

$$\Delta TD_t = \alpha_1 + \beta_1 \Delta TD_{t-1} + \gamma_1 \Delta BD_{t-1} + \gamma_2 \Delta BD_{t-2} + \gamma_3 \Delta BD_{t-3} + u_t \tag{7.6}$$

$$\Delta BD_t = \alpha_2 + \beta_2 \Delta BD_{t-1} + \theta_1 \Delta TD_{t-1} + \theta_2 \Delta TD_{t-2} + \theta_3 \Delta TD_{t-3} + w_t \tag{7.7}$$

7.5 Test Results of the Estimated Models for Granger Causality Test

We have obtained test results from the estimation of the models (7.6) and (7.7) which are being presented through the Tables 7.1 and 7.2:

Table - 7.1

Results of the Estimation of the Causality Equation (7.6)

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

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	Mean dependent var		-494.7297
Adjusted R-squared	0.007231	S.D. dependent var		2039.838
S.E. of regression	2032.450	Akaike info criterion		18.19696
Sum squared resid	1.32E+08	Schwarz criterion		18.41465
Log likelihood	-331.6438	F-statistic		1.065550
Durbin-Watson stat	1.906190	Prob(F-statistic)		0.389600

Table - 7.2

Results the Estimation of the Causality of Equation (7.7)

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

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	Mean dependent var		-92.86486
Adjusted R-squared	0.009413	S.D. dependent var		768.0508
S.E. of regression	764.4273	Akaike info criterion		16.24122
Sum squared resid	18699170	Schwarz criterion		16.45891
Log likelihood	-295.4626	F-statistic		1.085525
Durbin-Watson stat	1.970702	Prob(F-statistic)		0.380171

7.6 Correlogram of the Residuals of the Estimated Models

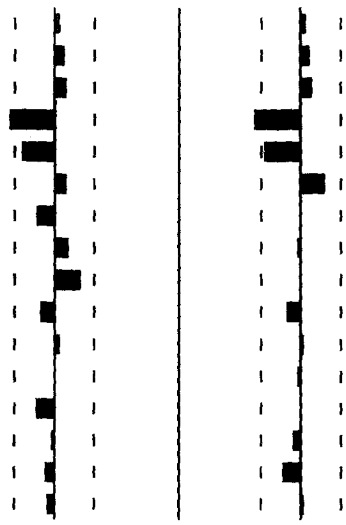
We have obtained correlograms of the residuals (RES_1 and RES_2) of both the models (7.6 and 7.7) designed for Granger Causality test. The AC and PAC plots of the respective models are being presented through the following figures (Figs 7.1 and 7.2):

Figure - 7.1

Correlogram of Residual ($\hat{u}_t$) of Equation 7.6

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

Autocorrelation | Partial Correlation



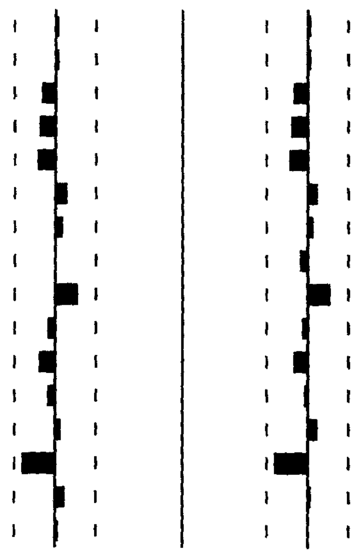
	AC	PAC	Q-Stat	Prob
1	0.039	0.039	0.0616	0.804
2	0.070	0.068	0.2614	0.877
3	0.093	0.088	0.6277	0.890
4	-0.370	-0.387	6.6258	0.157
5	-0.267	-0.290	9.8395	0.080
6	0.093	0.195	10.240	0.115
7	-0.139	-0.004	11.166	0.132
8	0.105	-0.022	11.717	0.164
9	0.211	0.001	14.001	0.122
10	-0.105	-0.103	14.591	0.148
11	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 - 7.2

Correlogram of Residual ($\hat{w}_t$) of Equation 7.7

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

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

7.7 Findings from the Test Results and Correlograms of $\hat{u}_t$ and $\hat{w}_t$ of the Estimated Models

The Tables 7.1 and 7.2 and the correlogram (Figures 7.1 and 7.2) give forth the following findings:

(i) The residual datasets for $\hat{u}_t$ and $\hat{w}_t$ display no significant spike in the corresponding ACF at the first lag.

(ii) 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 the stationarity of datasets for $\hat{u}_t$ and $\hat{w}_t$ of the equations 7.6 and 7.7.

(iii) In case of equation 7.6, $\hat{\gamma}_1$ 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.

(iv) In case of equation 7.7, $\hat{\beta}_2$, $\hat{\theta}_1$, $\hat{\theta}_2$, $\hat{\theta}_3$ are insignificant even at 10% level. These indicate that TD_t does not Granger causes BD_t.

7.8 Conventional Granger Causality Tests

Conventional Granger Causality Test tells more about the causal relationships between trade deficit and budget deficit.

The estimable models for Granger Causality test, (reproduced from Chapter III) are being presented as following.

$$BD_t = \sum_{j=1}^{m} a_j TDt_{-j} + \sum_{j=1}^{m} b_j BD_{t-j} + \varepsilon_t \tag{3.31}$$

$$TD_t = \sum_{j=1}^{m} a_j BD_{t-j} + \sum_{j=1}^{m} b_j TD_{t-j} + \eta_t \tag{3.32}$$

Test results derived from the equations (3.31 and 3.32) are being presented in following table (Table - 7.3).

Table - 7.3

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.

Source: Author's calculations based on data from various issues of International Financial Statistics, IMF.

7.9 Findings from the Conventional Granger Causality Test

From the Conventional Granger Causality tests, give forth the following observations:

(i) The F-statistics and its corresponding value of probability suggest that ***'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). It now clearly hints out that the ***real budget deficit does not Granger cause real budget deficit***.

(ii) However, F-statistics have been found significant at first, fourth and fifth lag values at the level of 10%, 1% and 5% level of significance respectively of real budget deficit indicating ***unidirectional causality*** from budget to trade deficit.

7.10 Summary of Findings

This chapter is devoted to identify the direction of causality of the model variables concerned. The summary of findings is being presented belows:

(i) Trade Deficit has been found 'not to Granger Cause' Budget Deficit in the Nepalese economy over the period of study.

(ii) Budget Deficit, on the other hand, has been found to 'Granger Cause' the Trade Deficit in this economy.

Consequently, the ***'Unidirectional Causality'*** *is found to run from the 'Budget Deficit' to 'Trade Deficit'. However, Budget Deficit has been found to be 'exogenous' in the system. This also confirms our finding in Chapter VI.*

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CHAPTER – VIII

TWIN DEFICITS IN NEPAL
VECTOR AUTOREGRESSION (VAR) MODELING

8.1 Introduction

In order to find the long-run dynamic relationship between trade deficit and budget deficit in Nepal, we cannot make any *a-priori* assumption of endogenity and exogeneity of variables concerned. For this purpose, Vector Auto-regressive Model (VAR) can be applied. This model treats all variables systematically without making reference to the issue of dependence versus independence. A VAR also 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 us to study the *'Variance Decompositions'* for these variables and this helps us understand the interrelationships among the variables concerned. We, therefore, seek to develop a VAR model for the Twin Deficit Relationship for the economy of Nepal in this chapter.

8.2 The VAR 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 (8.1) and (8.2) as:

$$\Delta TD_t = \alpha_1 + \sum_{i=1}^{k} \beta_{1i} \Delta TD_{t-i} + \sum_{i=1}^{k} \gamma_{1i} \Delta BD_{t-i} + u_{1t} \qquad (8.1)$$

$$\Delta BD_t = \alpha_2 + \sum_{i=1}^{k} \beta_{2i} \Delta BD_{t-i} + \sum_{i=1}^{k} \gamma_{2i} \Delta TD_{t-i} + u_{2t} \quad (8.2)$$

Where,

α_s = intercepts

u_{1t} and u_{2t} = Stochastic error terms (alternatively called as impulses or innovations or shocks in VAR Modeling)

$\sum_{i=1}^{k} \beta_{1i} \Delta TD_{t-i}$ and $\sum_{i=1}^{k} \gamma_{2i} \Delta TD_{t-i}$ = All summation Values of Lagged Variables of Trade Deficit (TD_t) in the model

$\sum_{i=1}^{k} \gamma_{1i} \Delta BD_{t-i}$ and $\sum_{i=1}^{k} \beta_{2i} \Delta BD_{t-i}$ = All Summation Values of Lagged Variables of Budget Deficit (TD_t)

8.3 Features of the VAR Model

The VAR model consists of equations (8.1) and (8.2) requires that

(i) ΔTD_t and ΔBD_t be stationary, and

(ii) u_{1t} and u_{2t} be white noise terms such that: $u_{1t} \sim iid\ N(0,\ \sigma^2 u_1)$, and $u_{1t} \sim iid\ N(0,\ \sigma^2 u_2)$

In this model ΔTD_t is stationary i.e. TD is stationary at first difference and ΔBD_t represents the first difference stationary dataset for budget deficit (BD). Consequently, the first requirement is satisfied.

However, the properties of u_{1t} and u_{2t} need to be studied. This will enable us to find if u_{1t} and u_{2t} are really white noise terms.

8.4 Selection of Lag Length

The appropriate lag-length needs to be determined before the estimation of VAR model. The lag-length may be selected through the 'Selection Criteria' like AIC, SIC, HQIC etc. The table 8.1 gives forth the statistics corresponding to different criteria across different lags.

Table 8.1

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 the Table 8.1 that

(i) LR and AIC statistics for lag 6 are significant at 5% level.

(ii) FPE, HQ and SIC statistics for lag 0 lag is significant at 5% level.

We, therefore, choose 6 (six) lags for each endogenous variable in their **autoregressive and distributed lag structures** in the estimable VAR model.

8.5 The Estimable VAR Model

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

$$\Delta Y_t = \alpha_1 + \beta_{11}\Delta Y_{t-1} + \beta_{12}\Delta Y_{t-2} + \beta_{13}\Delta Y_{t-3} + \beta_{14}\Delta Y_{t-4} + \beta_{15}\Delta Y_{t-5} + \beta_{16}\Delta Y_{t-6} + \gamma_{11}\Delta X_{t-1} + \gamma_{12}\Delta X_{t-2} + \gamma_{13}\Delta X_{t-3} + \gamma_{14}\Delta X_{t-4} + \gamma_{15}\Delta X_{t-5} + \gamma_{16}\Delta X_{t-6} + u_{1t} \tag{8.3}$$

$$\Delta X_t = \alpha_2 + \beta_{21}\Delta X_{t-1} + \beta_{22}\Delta X_{t-2} + \beta_{23}\Delta X_{t-3}\beta_{24}\Delta X_{t-4} + \beta_{25}\Delta X_{t-5} + \beta_{26}\Delta X_{t-6} + \gamma_{21}\Delta Y_{t-1} + \gamma_{22}\Delta Y_{t-2} + \gamma_{23}\Delta Y_{t-3} + \gamma_{24}\Delta Y_{t-4} + \gamma_{25}\Delta Y_{t-5} + \gamma_{26}\Delta Y_{t-6} + u_{2t} \tag{8.4}$$

Where, ΔY_t is the first difference of real Trade Deficit (TD) and ΔX_t is the first difference of real Budget Deficit (BD).

8.6 Results of Estimation of the VAR Model

The results of estimation of the VAR model consisting of equations (8.3) and (8.4) are given by the Tables (8.2) and (8.3).

Table - 8.2

Results of Estimations of the VAR Equation (8.3)

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 - 8.3

Test Statistics of the Estimated VAR Equation (8.3)

R-squared	0.658566	Mean dependent var	-516.7941
Adjusted R-squared	0.463460	S.D. dependent var	2125.857
S.E. of regression	1557.167	Akaike info criterion	17.82199
Sum squared resid	50920118	Schwarz criterion	18.40560
Log likelihood	-289.9738	F-statistic	3.375435
Durbin-Watson stat	1.704203	Prob(F-statistic)	0.007180

Table -87.4

Results of Estimations of the VAR Equation (8.4)

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

Table - 8.5

Test Statistics of the Estimated VAR Equation (8.4)

R-squared	0.253677	Mean dependent var	-108.2059
Adjusted R-squared	-0.172793	S.D. dependent var	798.8671
S.E. of regression	865.1375	Akaike info criterion	16.64652
Sum squared resid	15717721	Schwarz criterion	17.23013
Log likelihood	-269.9909	F-statistic	0.594831
Durbin-Watson stat	2.049229	Prob(F-statistic)	0.822482

8.7 Stability Conditions for the VAR Model

Let us consider the equation (8.3) and reproduce here,

$$\Delta Y_t = \alpha_1 + \beta_{11}\Delta Y_{t-1} + \beta_{12}\Delta Y_{t-2} + \beta_{13}\Delta Y_{t-3} + \beta_{14}\Delta Y_{t-4} + \beta_{15}\Delta Y_{t-5} + \beta_{16}\Delta Y_{t-6} + \gamma_{11}\Delta X_{t-1} + \gamma_{12}\Delta X_{t-2} + \gamma_{13}\Delta X_{t-3} + \gamma_{14}\Delta X_{t-4} + \gamma_{15}\Delta X_{t-5} + \gamma_{16}\Delta X_{t-6} + u_{1t} \quad (8.3)$$

Equation (8.3) can be written as,

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

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

$$\Delta Y_t = [A(L)]^{-1}[\alpha_1 + \gamma(L)\Delta X_t + u_{1t}] \quad (8.5)$$

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 the equation (8.5) requires that the roots of the *Characteristic Polynomial A(L)* be less than one.

Similarly, let us consider equation (8.4)

$$\Delta X_t = \alpha_2 + \beta_{21}\Delta X_{t-1} + \beta_{22}\Delta X_{t-2} + \beta_{23}\Delta X_{t-3}\beta_{24}\Delta X_{t-4} + \beta_{25}\Delta X_{t-5} + \beta_{26}\Delta X_{t-6} + \gamma_{21}\Delta Y_{t-1} + \gamma_{22}\Delta Y_{t-2} + \gamma_{23}\Delta Y_{t-3} + \gamma_{24}\Delta Y_{t-4} + \gamma_{25}\Delta Y_{t-5} + \gamma_{26}\Delta Y_{t-6} + u_{2t} \quad (8.4)$$

By the similar simplification process, the equation (8.4) can also be written as:

$$\Delta X_t = [B(L)]^{-1}[\alpha_2 + \gamma_2(L)\Delta Y_t + u_{2t}] \quad (8.6)$$

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 the equation (8.6) 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 (8.3) and (8.4) will be stable iff

(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

8.8 Stability of the Estimated VAR Model

The roots of the estimated **Characteristic Polynomials** A(L) and B(L) are given in the Table-8.6.

Table - 8.6

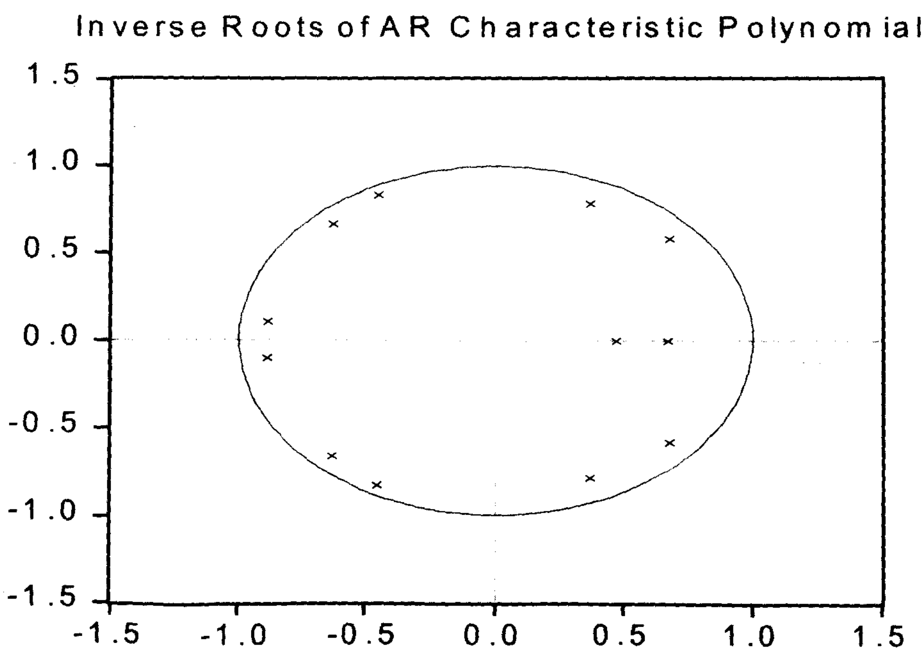
VAR Stability Condition Roots of the Characteristic Polynomial A(L) and B(L)

Endogenous Variable: ΔTD_t, ΔBD_t Exogenous Variable: C
Lag Specification: 1 - 6

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 - 8.1

VAR Stability Condition



It is observed from the Table 8.6 that

(i) there are six characteristic roots (eigen values) for A(L)

(ii) there are six characteristic roots (eigen values) for B(L)

(iii) Absolute values of the roots (modular) of the roots are less than unity.

(iv) ten of the roots are not statistically different from zero.

(v) five of the roots are positive, and

(vi) other five roots have negative values

All these observations testify for the stability of the VAR model.

Again the figure 8.1 shows that the inverse roots of the *AR Characteristic Polynomials* lie within the Unit Circle implying stability of the VAR mode.

Thus, all these findings confirm that the estimated VAR Model is stable.

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

The following Table 8.7 presents the results of the VAR Residual Normality Tests:

Table - 8.7

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 the Table 8.7 that

the JB statistic for $\widehat{u}_{1t}$ = 9.292980. It indicates that the null hypothesis (that $\widehat{u}_{1t}$ and $\widehat{u}_{2t}$ are multivariate normal) is accepted at 5% level.

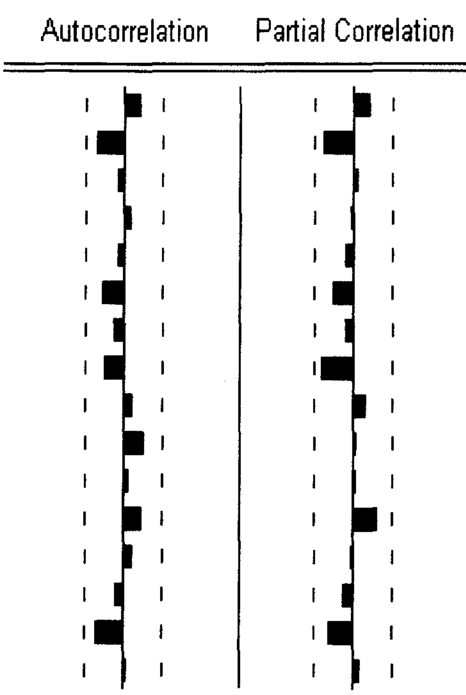
This finding testifies for the normality of $\widehat{u}_{1t}$ and $\widehat{u}_{2t}$, the residuals in equations 8.3 and 8.4 respectively.

8.10 Serial Independ~~ence~~ence for the Residuals ($\widehat{u}_{1t}$ and $\widehat{u}_{2t}$)

The residuals of the estimated VAR equations (8.3) and (8.4) are $\widehat{u}_{1t}$ and $\widehat{u}_{2t}$ respectively and ACF and PACF plots of these VAR residuals ($\widehat{u}_{1t}$ and $\widehat{u}_{2t}$) are being presented in Figures 8.2 and 8.3.

Figure - 8.2

Correlogram for $\widehat{u}_{1t}$



	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 - 8.3

Correlogram for $\widehat{u}_{2t}$

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 correlogram that

(i) the corresponding ACFs are marked by the absence of any dying out pattern of spikes, and

(ii) the corresponding PACFs are also free from any single significant spike at any lag.

These observations testify for the fact that $\widehat{u}_{1t}$ and $\widehat{u}_{2t}$ residuals are free from autocorrelations of any order.

8.11 Further Confirmation of Serial Independence for the VAR Residuals ($\widehat{u}_{1t}$ and $\widehat{u}_{2t}$)

The results of the serial independence for the VAR residuals are being examined further through the **VAR Residual Portmanteau Test and VAR Residual Serial Correlation LM Test** below. **VAR Residual Portmanteau Test** and ***VAR Residual Serial Correlation LM Test*** results are being presented through Table 8.8 and 8.9 in the following.

8.11.1 VAR Residual Portmanteau Test Results

The results of the **VAR Residual Portmanteau Test** for Autocorrelations are being presented through the Table 8.8 in the following:

Table - 8.8

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 the Table 8.8 show that

(i) the hypothesis of serial correlations have been rejected for up to the 8^{th} lag at 1% level.

(ii) the hypothesis of serial correlations have been rejected for the 9^{th} and 10^{th} lags at 5% level.

(iii) the hypothesis of serial correlation has been rejected at 10% level for the 11^{th} lag.

Consequently, **Portmanteau Test** testifies for the serial independence of the VAR residuals ($\widehat{u}_{1t}$ and $\widehat{u}_{2t}$).

8.11.2 VAR Residual Serial Correlation LM Test Results

The results of the **VAR Residual Serial Correlation LM Tests** have been presented through the Table 8.9 in the following:

Table - 8.9

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**
1	1.837243	0.7657
2	8.320099	0.0805
3	3.155266	0.5322
4	1.621287	0.8050
5	2.103152	0.7168
6	9.951638	0.0413
7	2.570008	0.6321
8	10.70807	0.0300
9	3.087800	0.5432
10	4.123171	0.3896
11	7.758058	0.1009
12	7.505920	0.1114
Probs from chi-square with 4 df.		

It is observed from the Table 8.9 that,

(i) 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.'

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

Time plots of the VAR residuals ($\widehat{u}_{1t}$ and $\widehat{u}_{2t}$) are given by the Figures 8.4 and 8.5 respectively.

Figure - 8.4

Time Plot of VAR Residuals ($\widehat{u}_{1t}$)

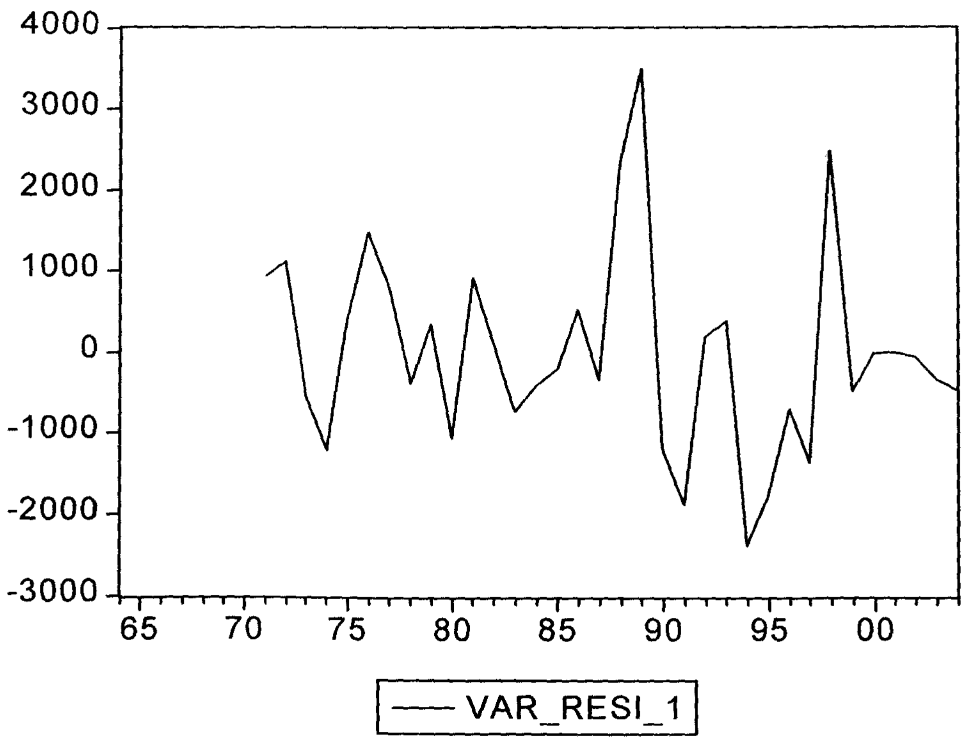
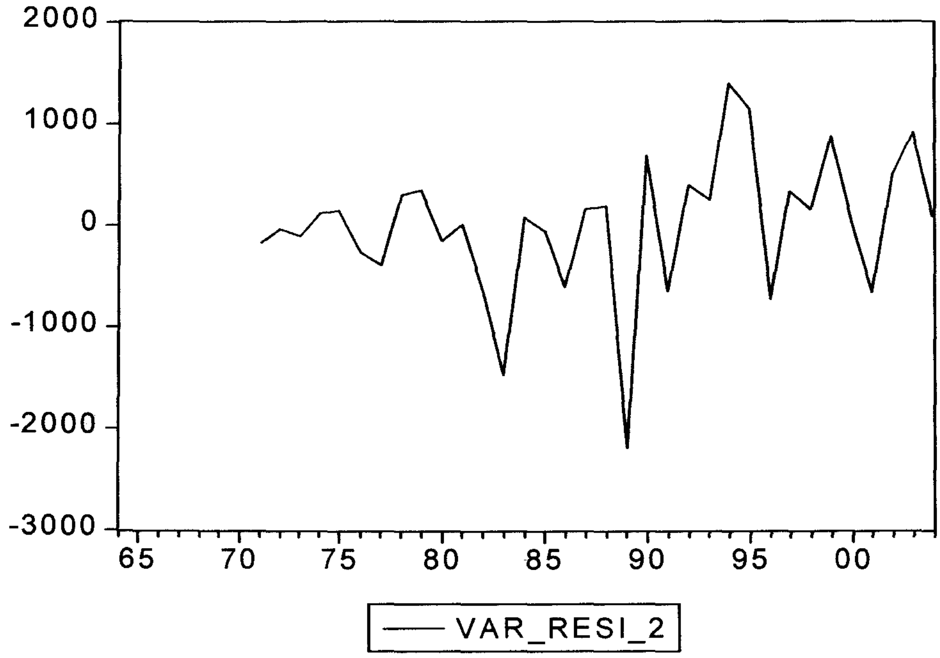


Figure 8.5

Time Plot of VAR Residuals ($\widehat{u}_{2t}$)



These figures 8.4 and 8.5 show that

(i) there exist no cluster in the time plot of $\widehat{u}_{1t}$, and

(ii) the time plot of $\widehat{u}_{2t}$ is also marked by the absence of any cluster.

These observations testify for the *'homoscadasticity'* of the residuals concerned.

8.13 Findings from Estimation of the VAR Model [Table 8.2 (Equation 8.3)]

It is observed from the Table 8.2 that in the estimated equation (8.3) that

(i) $\sum_{i=1}^{6} \beta_{1i} < 1$ and $\sum_{i=1}^{6} \gamma_{1i} < 1$,

These indicate that the *auto-regressive* and *distributed lag structures* in equation (8.3) are consistent.

(ii) $\hat{\gamma}_{15}$ *and* $\hat{\gamma}_{16}$ are significant at 1% level.

(iii) $\hat{\gamma}_{15} > 1$ *and* $\hat{\gamma}_{16} > 0$.

(iv) Calculated value of F-statistic = 3.375 is grater than $F^{13,21}_{0.05}$. It indicates the estimated equation is good fit.

(v) $\hat{\beta}_{11} < 0$ and $\hat{\beta}_{11}$ is significant at 1% level.

8.14 Economic Interpretations of the Findings

The economic significances of these findings are as follows:

(i) $\hat{\gamma}_{15}$ *and* $\hat{\gamma}_{16}$ being significant indicate that BD significantly affected TD, even in the presence of TD_{t-i} $(i = 1, \ldots\ldots, 6)$ in the vector of regressors. Consequently, BD, the Budget Deficit **Granger Caused** Trade Deficit in the economy of Nepal over the period of study.

(ii) $\hat{\gamma}_{15}$ *and* $\hat{\gamma}_{16}$ being significant also indicate that variations in budget deficit did not lead to an immediate in trade deficit. Trade Deficit, on the other hand, was affected by the variations in four and five period back deficits in the budgetary provision.

(iii) $\hat{\gamma}_{15} > 1$ *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.

(iv) $\hat{\beta}_{11} < 0$ indicate 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.

8.15 Findings from the Estimation of the VAR Model [Table 8.3 (Equation 8.4)]

It is observed from the Table 8.3 for the estimated equation 8.4 that

(i) $\sum_{i=1}^{6} \beta_{2i} < 1$ and $\sum_{i=1}^{6} \gamma_{2i} < 1$

These indicate that the auto-regressive and distributed lag structures in the equation (8.4) are consistent.

(ii) $\hat{\beta}_{2i}$ (i = 1, ..., 6) are not significant even at 10% level.

(iii) $\hat{\gamma}_{2i}$ (i = 1, ..., 6) are also not significant even at 10% level.

8.16 Economic Interpretations

The economic significances of these findings are as follows:

(i) $\hat{\gamma}_{2i}$ (i = 1, ..., 6) being insignificant (even at 10% level), in the presence of BD_t $(i = 1, \ldots\ldots, 6)$ 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.

(ii) $\hat{\beta}_{2i}$ (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.

8.17 Overview of the Findings

Findings in Sections 8.14 through 8.16 indicate that in the economy of Nepal over the period of study

(i) *budget deficit* ***Granger Caused*** *trade deficit.*

(ii) *trade deficit was found to be related to four and five period back budget deficit.*

(iii) *trade deficit* ***failed to Granger Cause*** *budget deficit.*

(iv) *budget deficits appeared to be completely* ***exogenous*** *in the VAR model.*

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CHAPTER – IX

INTERVENTION ANALYSIS THROUGH THE STUDY OF IMPULSE RESPONSE FUNCTIONS

9.1 Meaning and Relevance

Any shocks to any variable (say i-th variable) in a VAR System not only directly affect the respective variable (i-th variable) only, but it is also transmitted to all of the endogenous variables in the model through dynamic (lag) structure of VAR. An *Impulse Response Function* traces the effect of one time shock to one of the innovations on current and future values of the endogenous variables. As a matter of fact, *Impulse Response Function (IRS)* in VAR System traces the response of a variable through time to an unanticipated change in itself or other interrelated variables. Therefore, the Impulse Response Function can be used in a VAR System to describe the dynamic behavior of the whole system with respect to shocks in the residuals of the concerned time series dataset.

The VAR model estimate in the Chapter VIII contains two endogenous variables, namely, *Trade Deficit* and *Budget Deficit*. We, therefore, seek to study in this chapter the dynamic responses of *Trade Deficit* and *Budget Deficit* across different periods in response to shocks transmitted through channels of different endogenous variables concerned.

9.2 Graphical and Tabular Presentations of Impulse Response Functions for Trade Deficit (TD_t)

The relevant *Impulse Response Functions* of the estimated VAR model consisting of equations (8.3) and (8.4) are being presented through the Figures (9.1) and (9.2). Corresponding numerical values of such responses, given Cholesky one S. D. innovations are also being presented through the Table (9.1).

Figure - 9.1

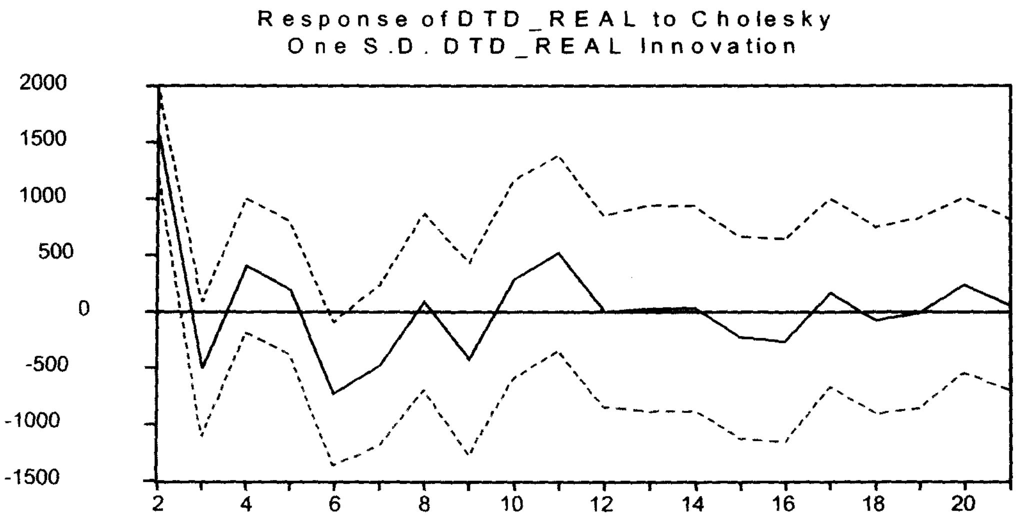

Figure – 9.2

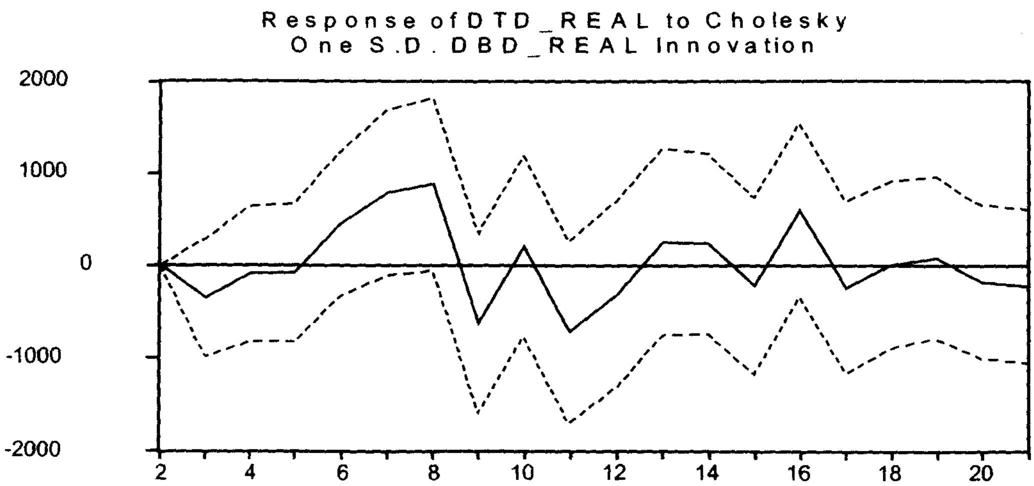

Table - 9.1

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

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

9.3 Findings from the Impulse Response Functions [as given in Figures-9.1 and 9.2]

(A) It is observed from the Figures (9.1) and Table (9.1) that following shocks, transmitted through the channel of Trade Deficit, trade deficit

(i) responded immediately by rising above the long-run base at t = 1

(ii) fell below the long-run base at t = 2

(iii) exhibited sharp ups and down until t = 11

(iv) touched the base at t = 11 and remained so until t = 11 periods

(v) exhibited damped oscillations around the base for $15 \leq t_2 < \propto$

(B) The Figure (9.2) and Table (9.1) shows that following shocks, transmitted through the channel of Budget Deficit channel, trade deficit

(i) exhibited delayed response by falling below the base level t = 2

(ii) registered a rise at t = 3, and continued such trend until t = 6 periods

(iii) exhibited non-convergent oscillations around the base level for

$7 \leq t \leq 20$.

(iv) did not collapse on the base line for $t > 20$.

9.4 Overall Findings on the Nature of TD Responses

(A) Findings in Section 9.3 **(A)** indicated that the shocks, transmitted through the channel of Trade Deficit,

(i) were short lived

(ii) failed to change the long-run equilibrium base of trade deficit

(iii) produced very damped oscillations in trade deficit around the long-run base

(B) Findings in Section 9.3 **(B)** indicated that the shocks, transmitted through the channel of Budget Deficit

(i) were not short-lived

(ii) began to account for the significant part of the short-run variations in trade deficit for $6 \leq t \leq 8$.

(v) accounted for most of the short-run variations in trade deficit for $t > 20$.

9.5 Graphical and Tabular Presentations of Impulse Response Functions for Budget Deficit (BD_t)

The *Impulse Response Functions of Budget Deficit* corresponding to equation (8.4) in Chapter VIII in the VAR system and in response to impulses transmitted through the channels of Budget Deficit and Trade Deficits are being presented through the following Figures (9.3) and (9.4). The corresponding numerical values of these responses are being presented through the Table 9.2.

Figure – 9.3

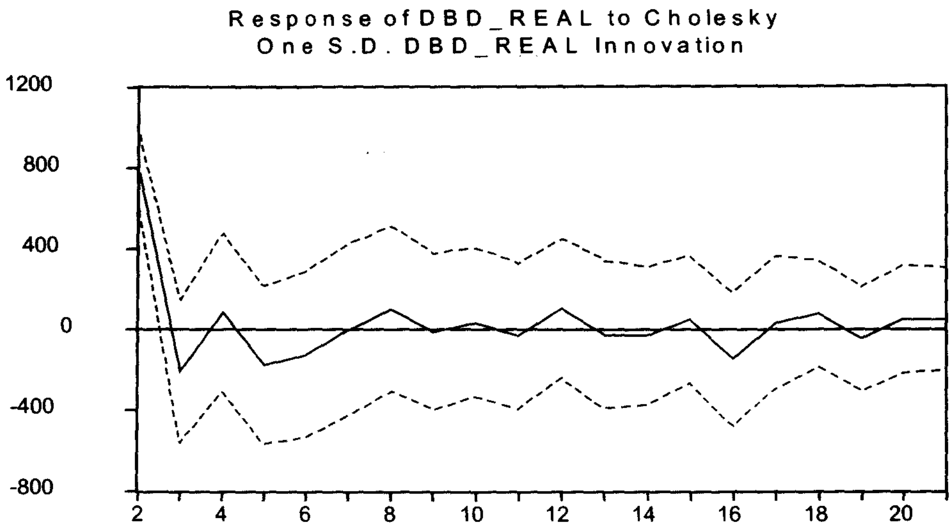

Figure – 9.4

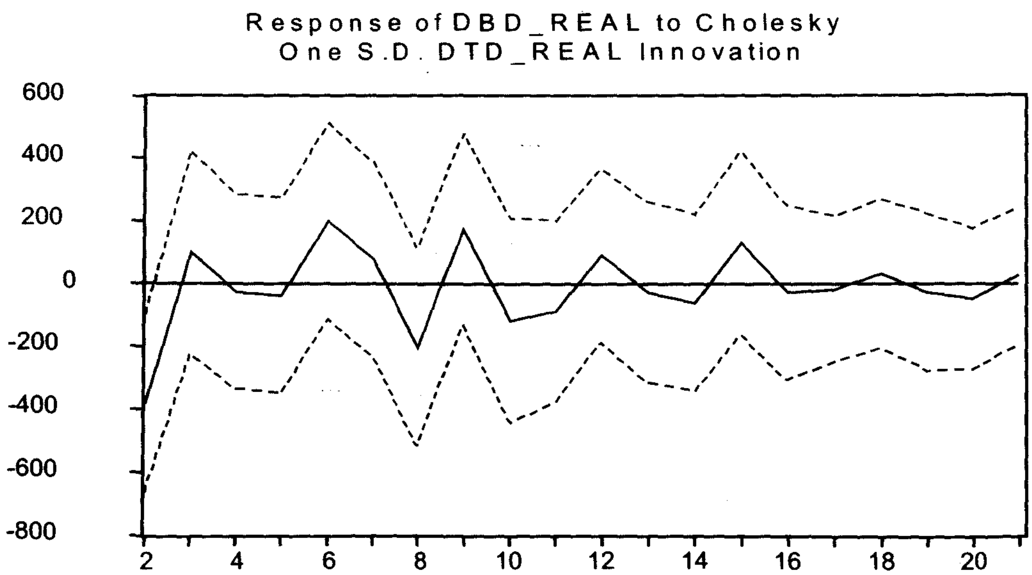

Table - 9.2

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

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

9.6 Findings from the Impulse Response Function (Figure 9.3)

The Figure (9.3) shows that, following to shocks transmitted through the channel of budget deficit, budget deficit

(i) exhibited immediate rise above the base line at t = 1

(ii) declined below the base line at t = 2

(iii) established damped oscillations around the long-run equilibrium level for $t \geq 8$

(iv) almost collapse on the equilibrium base line for $t \geq 19$

9.7 Findings from the Impulse Response Function (Figure 9.4)

The Figure (9.4) shows that, following impulses transmitted through Trade Deficit channel, budget deficit

(i) exhibited a sharp decline at t = 1

(ii) register a rise above the base level at t = 2

(iii) remained below the base level at t = 3, 4

(iv) exhibited damped oscillations for $5 \leq t \leq 19$

(v) almost collapsed on the base level for $t \geq 20$

9.8 Findings from the Joint Study of the Figures (9.3) and (9.4)

The joint study of Figures (9.3) and (8.4) indicates that

(i) short-run variations in Budget Deficit were mainly due to impulses transmitted through the channel of Budget Deficit

(ii) both types of shocks were short-live since these failed to change the long-term equilibrium base of Budget Deficits

9.9 Overall Findings from the Study with Impulse Response Functions

It is therefore, observed from the followings in Section 9.3 – 9.8 that

(i) *budgetary deficit shocks were the predominant cause behind the short-run variations in Budget Deficit*

(ii) *budgetary deficit accounted for increasingly large part of short-run variations in Trade Deficit*

(iii) *shocks, transmitted through budgetary deficit changed the equilibrium base of Trade Deficit. Consequently, budgetary shocks were not short-lived for Trade Deficit*

(iv) *shocks, transmitted through the channels of Budget Deficit and Trade Deficit, failed to change the equilibrium base of Budget Deficit. Consequently, both these shocks were short-lived for Budget Deficit.*

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CHAPTER – X

INTERVENTION ANALYSIS THROUGH THE STUDY OF VARIANCE DECOMPOSITION

10.1 Meaning and Relevance

We have seen 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*** we seek to separate the variations in an endogenous variable into some component shocks.

The ***Forecast Error Variance Decomposition*** reflects the proportion of the forecast error variance of a variable which is explained by an unanticipated change in itself as opposed to that proportion attributable to change in other interrelated variables. In other words, 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.

10.2 Variance Decomposition for Trade Deficit

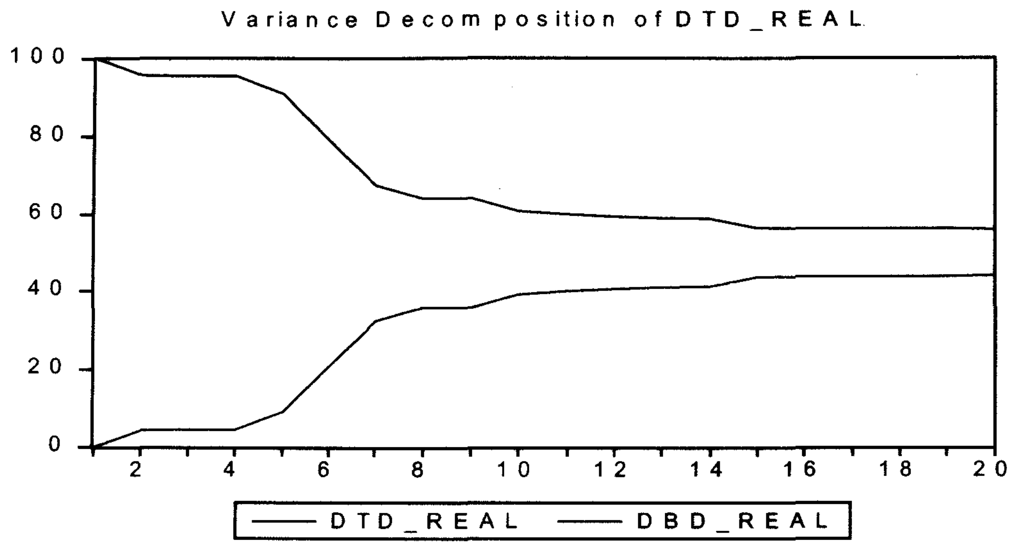
Variations in Trade Deficit over the period of study were basically the effects of responses of trade deficit to shocks transmitted through both trade deficit and budget deficit channels. So a part of total variances in trade deficit was due to trade deficit shocks and another part of the variation was due to the budgetary deficit shocks. The break-up of the total variations in trade deficit into the two deficit parts across different periods ($t = 1, 2, \ldots\ldots\ldots\ldots\ldots, 20$) constitute the '***Variance Decomposition***' of trade deficit. Such ***Variance Decomposition*** of trade deficit (TD_t) is given by the Table-10.1. The graphical presentation of Variance Decomposition for TD_t is being presented the Figure 10.1.

Table 10.1

Variance Decomposition of Trade Deficit (TD_t)

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

Figure 10.1



10.3 Findings from the Table 10-1 and Figure 10.1

The Table 10.1 and Figure 10.1 show that

(i) variations in trade deficit were mainly due to trade deficit shocks in the very early part of projections periods ($t \leq 4$).

(ii) shocks, transmitted through budgetary deficit, assumed grater role in explaining variations in Trade Deficit since t > 4 periods.

(iii) budgetary shocks became the dominant (important) factor behind short-run variations in Trade Deficit since t > 6 periods.

(iv) for $t \rightarrow \propto$, the contribution of budgetary deficits shocks to total variations in Trade Deficit was about 44% while that of trade deficit was at about 56%.

10.4 Variance Decomposition for the Budget Deficit

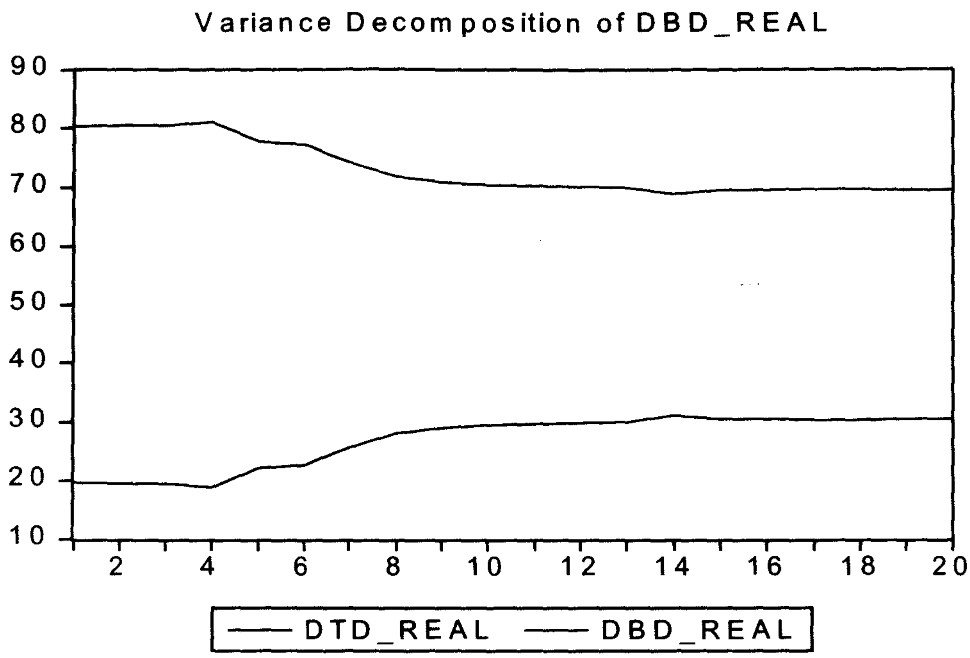
Variance in Budget Deficit overt the periods of study were basically the results of budget deficit to the shocks transmitted through budget deficit and trade deficit. So a part of total variations in budget deficit was due to budget shocks and the other part of was due to trade deficit shocks. The break-up of variances in budget deficit into these two definite parts across different periods (*t = 1, 2,……………, 20*) constituted the '***Variance Decomposition***' of budget deficit as given by the Table 10.2. The graphical presentation of the ***Variance Decomposition*** is being presented through the Figure 10.2.

Table – 10.2

Variance Decomposition of Budget Deficit (BD_t)

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

Figure 9.2



10.5 Findings from the Table 10.2

The Table 10.2 shows that

(i) budget deficit shocks dominated over 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 9% of such variations.

(ii) 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. Trade deficit shocks, on the other hand, contributed at most 30% to their account.

10.6 Findings from the Figure 10.2

The findings are being confirmed by the Figure 10.2, which shows that

(i) at $t = 1$, the total budget deficit variations was mainly due to budget deficit shocks. So,

(ii) 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.

10.6 Summary and Conclusion on Variance Decomposition Study

All these observations in Sections 10.2 – 10.5 show that

(i) 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.

(ii) 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 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.'***

CHAPTER - XI

SUMMARY, CONCLUSIONS AND FUTURE SCOPE

11.1 Summary

11.1.1 **The first chapter** of the present research study has focused on a brief introduction of the basic feature of Nepalese economy and policy issues. The characteristics of Nepalese economy, current trend and tendencies of macroeconomic variables of the economy have been analyzed. A brief scenario on global economy for the comparison with Nepalese economy has also been mentioned. As per the analysis, performance of the Nepalese Economy has been found poor compared to those of global and neighboring economies. Objectives of the study, hypothesis and plan of the study have also been stated in this chapter.

11.1.2 **The second chapter** delineated the findings from the literature review in the present research work. In this process, the conclusions of several works related to the present study in developed and developing economies have been reviewed. Reviewing those works, it has been found that the *twin deficit hypothesis (TDH)* has demonstrated mixed results. Some results have supported the *reverse proposition of TDH* and some have shown even no relationship between budget defiçit and trade deficit. However, TDH has been supported in most of the studies.

11.1.3 The third chapter has concentrated on the methodological issues as well as data and variables of the present research study. The introductions of several econometric methods related *Stationarity test, Co-integration test, Vector Error Correction modeling, Causality test, VAR modeling with Intervention Analysis through Impulse response Functions and Variance Decomposition* have been presented in detail.

11.1.4 The fourth chapter is focused on analyzing the nature of stationarity of model variables (trade deficit and budget deficit). Summary findings form the stationarity tests of the variables concerned are being presented as follows:

(i) *real times series for BD and TD datasets at level are non-stationary*

(ii) *these variables attain stationarity upon first order differencing i.e.*

$$BD\ (Real) \sim I\ (1)$$

and,

$$TB\ (Real) \sim I\ (1)$$

(iii) *first order differencing ensures stationarity for BD (Nominal) dataset, i.e.*

$$BD\ (nominal) \sim I\ (1)$$

(iii) *TD (Nominal) dataset fails to attain stationarity even upon second differencing (as given by the Unit Root Tests)*

11.1.5 The fifth chapter is concerned with the cointegration test for examining the existence of long-run relationship of the variables concerned. It is observed that

(i) real dataset of TD_t and BD_t series at level are not cointegrated i.e. TD and BD are not CI (1, 1). Consequently, there exists no long-run equilibrium relationship between real TD_t and BD_t series at level.

(ii) real datasets of TD_t and BD_t series upon first differencing are cointegrated i.e., TD_t and BD_t are CI (1, 0). Consequently, there exists a long-run equilibrium relationship between real TD_t and real BD_t series.

11.1.6 The sixth chapter is devoted to the study of the nature of stability of long-run relationships between TD and BD with the ***Vector Error Correction Modeling***. It has been observed from the tests that

(i) *ΔTD_t is the endogenous variable while ΔBDt is exogenous variable. In such case, TD maintains a long-run equilibrium relationship with BD.*

(ii) *The shocks significantly affected the long-run equilibrium relationship between TD and BD in the short-run.*

*The **'long-run equilibrium relationship' that TD maintains with BD is 'stable' since the 'short-run dynamics' displays a converging pattern.***

10.1.7 The seventh chapter examines the *nature and direction of Causal relation* between TD and BD in the Nepalese economy over the period of study. The study shows that

(i) *Trade Deficit has been found **'not to Granger Cause'** Budget Deficit in the Nepalese economy over the period of study.*

(ii) *Budget Deficit, on the other hand, has been found to **'Granger Cause'** the Trade Deficit in this economy.*

Consequently, ***the 'Unidirectional Causality' is found to occur from the 'Budget Deficit' to 'Trade Deficit'. However, Budget Deficit has been found to be 'exogenous' in the system.***

10.1.8 The eighth chapter involves the estimation of the ***Vector Auto Regression (VAR) Modeling*** for *further verification of causality between BD and TD.*F findings from this chapter are presented below:

(i) *LR and AIC statistics for lag 6 found significant at 5% level and FPE, HQ and SIC statistics for lag 0 lag at 5% level. We, therefore, chose 6 (six) lags for each endogenous variable in their* ***autoregressive and distributed lag structures*** *in VAR model.*

(ii) *we found six characteristic roots (eigen values) for A(L) and six characteristic roots (eigen values) for B(L). Absolute values of the roots (modular) of the roots are less than unity and ten of the roots are not statistically different from zero; five of the roots are positive, and other five roots have negative values. These all indicated that the VAR model was stable.*

(iii) *VAR residuals ($\hat{u}_{1t}$ and $\hat{u}_{2t}$) are multivariate normal.*

(iv) *Serial Independence test and Portmanteau Test verified that $\hat{u}_{1t}$ and $\hat{u}_{2t}$ residuals are free from autocorrelations of any order.*

(v) *no cluster in the time plot of $\hat{u}_{1t}$ was found, and the time plot of $\hat{u}_{2t}$ confirmed the absence of any cluster implying the model is in homoscadasticity of concerned residuals.*

(vi) *the auto-regressive and distributed lag structures in equations (8.3) are consistent.*

(vii) *BD significantly affected TD, even in the presence of TD_{t-i} (i = 1, ……,6) in the vector of regressors. Consequently, BD, the Budget Deficit,* ***Granger Caused*** *Trade Deficit in the economy of Nepal over the period of study.*

(viii) *variations in budget deficit did not lead to an immediate variation in Trade Deficit. On the other hand, it was affected by the variations in four and five period back deficits in the budgetary provision.*

(ix) *variations in 4-period and 5-period back budget deficits led to more than proportionate variation in trade deficit in the economy of Nepal.*

(x) *trade deficit at any period reduced the volume of trade deficit in the next period. Thus, trade deficit at any period was negatively related to trade deficit in the previous period.*

(xi) *trade* ***deficit failed to Granger Cause*** *the budget deficit in the economy of Nepal over the period of study.*

(xii) *budget deficit at any period was not related significantly to budget deficits which occurred at any previous periods.*

Consequently, these findings confirm that

(a) ***budget deficit Granger Caused trade deficit***

(b) ***trade deficit failed to Granger Cause budget deficit and***

(c) ***budget deficits appeared to be completely exogenous in the VAR model***

11.1.9 The ninth chapter is concerned with *Intervention Analysis* through the study of *Impulse Response Functions* of the endogenous variables under study. It analyzed the nature of responses of the variables in response to shocks transmitted through the channel of different endogenous variables.

The findings from this chapter are as follows:

(i) ***budgetary deficit shocks were the predominant cause*** *behind the short-run variations in Budget Deficit*

(ii) *budgetary deficit accounted for increasingly large part of* ***short-run variations in Trade Deficit***

(iii) *shocks, transmitted through budgetary deficit, changed the equilibrium base of Trade Deficit. Consequently,* ***budgetary shocks were not short-lived for Trade Deficit***

(iv) *shocks, transmitted through the channels of Budget Deficit and Trade Deficit, failed to change the* ***equilibrium base of Budget Deficit. Consequently, both these shocks were short-lived for Budget Deficit.***

11.1.10 The tenth chapter analyzed *Variance Decomposition* to find out the *n-period ahead forecast variations* of the endogenous variables under study. It has been observed that

(i) *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.*

(ii) *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 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.'***

11.2 Conclusions

Initial main objective of this study was to analyze whether *Twin Deficits Hypothesis (TDH)* is supported or *'otherwise'* in Nepal. Along the course of several time series econometric tools used in the study and findings derived, following conclusions are drawn:

(i) ***Trade Deficit*** *has been 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. It is* ***not Granger Caused by Trade Deficit****.*

(iv) *Budget Deficit being the* ***'exogenous'*** *to the system implies that other fiscal and socio-economic policies considerations took the leading role in establishing Revenue-Expenditure schedules. Consequently, Budget Deficit has been the outcome of the other socio-economic-political considerations and exercises in the economy of Nepal.*

(v) *Since the **Trade Deficit** has been **'Granger Caused'** by **Budge Deficit**, rational economic measures for containing Trade Deficit must come in the form of containing Budget Deficit.*

11.3 Public Policy Implications

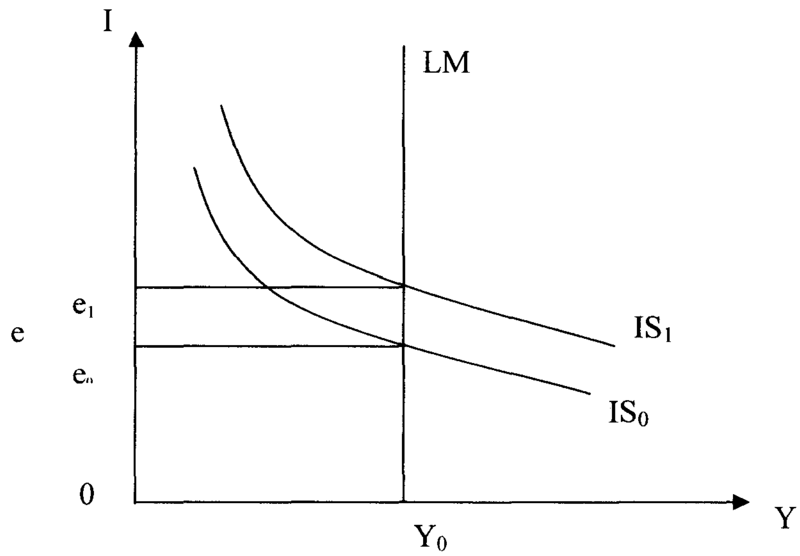
Trade Deficit has been Granger Caused by Budget Deficit. This indicates that any measures, in the presence of Budget Deficit, like import substitution or export promotion, deficit control etc, for containing Trade Deficit may not be effective. *The effective measure in this direction would mean reducing Budge Deficit through bridging the gap between expenditure and revenue.*

However, one may wonder if such reduction of Budget Deficit would have any adverse effect on economic growth. Such concern may appear to be baseless in view of the fact that fiscal policy measures, under globalization and flexible exchange rate regime, would have every little perceptible effect on economic growth.

Mundel-Flemming set-up has adequately proved ineffectiveness of fiscal policy in such event. This arises from the fact that LM curve becomes a vertical straight line under globalization and movement of IS curve fails to produce any change in income. This is explained below:

Figure: 11.1

IS-LM Framework under Flexible Exchange Rate System and Globalization



where, e = foreign price of domestic currency

With Budget Deficit escalating, IS_0 shifts to IS_1, leading to no change in income but a rise in the price of domestic currency. Consequently, domestic goods become dearer which leads to rise in import and fall in export. This causes trade deficit to rise.

Direct control policies are also not very effective under flexible exchange rate system and globalization. Quota or import restriction raises NX = X – M at the current period. As a result, IS_0 curve shifts to IS_1 because given the Y = C + I + G + (X-M), Y rises following rise in NX. However, ultimately income remains unchanged with rise in 'e'. Consequently, import (M) rises and export (X) falls and the initial improvement in the current A/Cs vanishes.

10.4 Future Scope

This research work has been done for the first time in the Nepalese context, purely on the basis of time series modeling by applying recent state-of-the-art econometric tools. Nepalese data on trade deficit and budget deficit have been used to test the Twin Deficit Hypothesis and data cover time series from 1964 to 2004. Though the latest IFS series of 2007 (Year Book) is available till to the date of thesis preparation and submission, the related data have not been found updated in it. That's why we have been unable to incorporate the latest data. Trade figures prior to 1964 were not available in the series of IFS so that only data for 41 years have been used to run the models. Initial assumption of "budget deficit being the source of trade deficit" has been accepted in the Nepalese perspective. However, scholars have a scope of testing this hypothesis in future by employing the longer horizon data to predict the more refined results.

This research paper has future policy implications to Nepal. As our finding has supported the twin deficit hypothesis, it has posed some inquisitive responses for policy reframing to the Nepalese economy in addressing the ill effects of twin-deficit cycle (vicious circle). Nepal Government may consider adopting a position more vigilant on its fiscal policy front. This research results indicate a need for fiscal tightening by curtailing unproductive expenses, broadening tax base, reforming tax administration, prioritizing the investment projects and adopting export-led growth policies, and proper import management.

Vector Autoregressive Moving Average (VARMA) Modeling is one of the predictions technique in time series analysis that follows the decline of traditional Macroeconometric modelling in the 70s and precedes its rise again more recently. It is the analysis that tries for predicting the reality of data movements on the basis of autoregression of the model variable and its moving average trends within the concerned vectors. The idea further be tested through the ***VARMA Analysis*** as in Sims (1972) "Money Income and Causality", AER (62):540-552 and Sims (1980) *"Macroeconomics and Reality" Econometrica (48):1-49.* However, owing to some technical reasons, we could not incorporate the vector autoregression moving average (VARMA) model and its analysis in this research paper. Any enthusiastic scholar can add the VARMA model to his future research work regarding on *Twin Deficit Hypothesis (TDH)* for the Nepalese time series.

Similarly, any scholar use *Spectral Analysis* in time series for the study for *Twin Deficit Hypothesis* for verifying *periodicity, spectral density function* and *cyclical pattern of datasets* of trade deficits and budget deficits in the Nepalese context.

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Annex - 1

Trade Deficit and Budget Deficit Time Series

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

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