Ricardian Equivalence, Twin Deficits and Feldstein-Horioka Hypotheses: Empirical Analysis form Pakistan

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Abstract

The study attempts to investigate relationship between both budget and current account deficits for the Pakistan using annual data from 1976 to 2016. In this regard, three hypotheses, Ricardian Equivalence (RE), Twin Deficits (TD) and the Feldstein-Horioka (F-H) are tested under the framework of Multivariate Cointegration techniques (Johansen, Autoregressive distributed lag) and Error correction modeling. The cointegration results reject the RE hypothesis and support the validity of TD hypothesis for Pakistan. It implies that debt-finance tax cut raised the interest rate which attracted the capital inflow. The findings of error correction model also support the short run linkage between both deficits and confirm that long run relationship exists between them, when interest and exchange rates are included in the model. The results of cointegration test further reveal a positive relationship between the current account deficit and investment in the long run. The long run coefficient of investment indicates the high degree of foreign capital mobility and rejects the Feldstein-Horioka hypothesis. However, positive and less than one value of short-run coefficient of investment provide weak support for the Feldstein-Horioka hypothesis. So, the empirical results suggest that investment (coefficient of foreign capital inflow) has a significantly positive impact on current account deficit only in the long run.

Key Words: Ricardian equivalence; Twin deficits; Current account deficit; Feldstein-Horioka Hypothesis; Cointegration; Pakistan.

1. Introduction

Economic growth, price stability and strong external sector have been remained main macroeconomic objectives in almost all economic policy regimes. "To achieve these objectives, governments of developed as well as of developing countries largely rely on fiscal policy. In most of the cases, especially in developing countries, it has been escorted with the large

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budget deficits. Governments of these countries finance budget deficits by borrowing from domestic and external sources. Due to the weak tax system and capital markets of these economies, the deficit financing is adversely affecting current account balance, interest rate, exchange rate, money supply and inflation. This issue has been emerged as one of the important economic debate in recent economic literature.[1]

The debate related to fiscal and external deficits is renowned as Twin deficits (TD) hypothesis which reveals that the two deficits are closely related and moved simultaneously. The correlation between both deficits has important policy implication because large budget deficits reduce the wellbeing of the nations by obstructing wealth accumulation and increasing burden on future generation due to borrowing (Hakro, 2009). Moreover, external imbalances cannot be alleviated unless policies that address government budget deficits are put into place (Bahrummshah *et al*., 2009). These grave implications are the source of growing interest of researchers in the analysis of relationship between the two deficits. Yet they didn't reach to consensus.

Pakistan like other developing countries has also been experiencing high degree of budget and current account deficits for the last few decades. The average budget deficit was 7.1, 6.8, and 4.5 percent of GDP in 80's, 90's and 2000's, respectively. While in 1987-88 it raised at the heights level of 8.5 percent of the GDP which never came back at 5 percent before 1994-1995. In 1997-1998, it reached at the level of 7.6 percent. After 1998 it came down and reached at the lowest level of 2.3 percent in 2004. During 2007-2008, it again raised to 7.6 percent of GDP. While the current account imbalance was 3.9, 4.5 and 2.2 percentage of GDP in the corresponding periods. Except for a few years, the current account remained in deficit during the last three decades. The current account deficit was 7.2 percent in 1995-1996 which was the maximum value of the 1990s decade. During 2000s, its maximum value was observed 8.7 percent in 2007-2008. So, the persistent large twin deficits have been remained major cause of concern for policy makers in Pakistan. Even adjustments and reforms in financial and real sector failed to achieve the targets of reduction in the twin deficits.[1] So, there is a need to investigate the relationship between them.

The debate related to twin deficits is not conclusive for Pakistan. Several studies have been carried out to find the causal link between both

[1] See Altintas and Taban (2011), Chaudhary and Shabbir (2005), Korsu (2006), Pahlavani and Saleh (2009).

[1] To reduce the budget deficit as the ratio of GDP, the programs of privatization, liberalization, exchange rate adjustment financial reforms, structural investment, price stability, reduction of tariff rate and investment incentives were considered as important (Naik Ejaz, 1993).

deficits. For example Burney and Yasmeen (1989), Burney and Akhtar (1992), Kazimi (1992) have employed ordinary least square techniques on time-series data set to relate twin deficits with other macroeconomic variables like interest rate, exchange rate, consumption and savings. "Although, all of these studies are important to know the links between the twin deficits and other macro-economic variables, but mostly reached at different results due to pre-specification of the structural relations used in their models" (Hakro, 2009). These studies focus on single macro-economic variable and ignore various linkages with budget deficit such as exchange rate and current account deficit. In addition, Aqeel and Nishat (2000), Mukhtar *et al*., (2007), Hakro (2009), Javid *et al*., (2011) and Khan and Saeed (2012) have examined the direction of causal link between both deficits. In context of Pakistan's economy, existing literature does not evaluate the phenomenon of twin deficits nexus by simultaneously considering the three hypotheses, RE, TD and F-H. The purpose of present study is to fill this gap in the literature for the Pakistan case".

The rest of study is organized as follows. The literature regarding the twin deficits nexus is reviewed in the Section 2. Section 3 reported model specification and results of three Hypotheses. Section 4 presented Conclusion.

2. Literature Review

The term twin deficit was initially introduced during 80's to describe the association between budget deficits and current account deficits in the US. "When, long term interest rate was raised, dollar was appreciated; government budget deficit and external deficit were moved in same direction due to the Regan fiscal policies. The connection between these two deficits was not unique to the US. During 1990s, European economies (Germany and Sweden) were faced similar situation, where high degree budget deficit was associated with current account deficit through the appreciation of their national currencies (Ibrahim and Kumah, 1996). Developing countries have also experienced the same condition of budget and current account imbalances (Khalid and Guan, 1999). If there exists a causal link between the two deficits, it can be of three types: (i) budget deficit cause of current account deficit; (ii) the current account deficit is a source of the budget deficit and (iii) bidirectional relationship between both deficits. Theoretically these linkages are explained as follows.

The Keynesian absorption theory explains that budget deficit raises the domestic absorption and volume of import. While export does not

increase proportionally to offset the increase in import, as a result current account deficit raises. According to the Mundell-Fleming analysis (Fleming, 1962; Mundell, 1963), under the flexible exchange rate system, an increase in budget deficit raises the interest rate; higher interest rate induces the capital inflow, which appreciates the domestic currency and in return net export reduces and current account deficit increases. While in the fixed exchange rate system, fiscal stimulation becomes the cause of higher prices and real income which leads to current account imbalances. Both traditional theories, the Keynesian absorption and the Mundell-Fleming, support the unidirectional positive causal relation that flows from budget deficit to current account deficit. This causal relation between both deficits is also connected with the degree of foreign capital transformation. According to Feldstein and Horioka (1980), in a state of perfect capital mobility, country saving and investment are not positively correlated and both deficits move together.

The Ricardian Equivalence Hypothesis of Barro (1989) challenged this traditional view by assuming that both the deficits are not related. It states that the substitution of debt for taxes to finance government spending does not affect the real interest rate, aggregate demand, magnitude of investment and current account deficit. Since consumers are rational, hence they save any increase in their disposable income due to the tax cut, to pay future tax liabilities. It implies that modes of financing the government expenditures do not affect the amount of private and national savings.

When the RE hypothesis does not confirm then there are other two possibilities regarding the twin deficits nexus. It may be possible direction of causality runs from the external to the internal imbalances. In such situation external imbalances lead to a reduction in economic growth and deteriorate budget balances, through a reduction in tax revenues and by putting the pressure on government to raise the expenditure in those sectors that are affected by the reduction of export. This reverse relationship from an external to an internal deficit is known as "current account targeting" by the Summers (1988). Secondly, bidirectional causality may be possible between both these deficits. In such situation, only reduction in budget deficit cannot reduce the current account imbalances. But export promotion strategies, interstate rate determination and exchange rate policies should be adopted to reduce both deficits.

The empirical evidence, related to twin deficits nexus can also be categorized into four major groups. The first group of studies supports the twin deficits hypothesis which claims that external deficits are caused by fiscal deficits. For example, Abell (1990) by using the Vector Autoregressive (VAR) model concludes that in US budget deficit affects the trade deficit indirectly. While the direction of relationship flows from

budget deficit to interest rate, to capital flow, to exchange rate and to trade deficit. In contrast, Zietz and Pemberton (1990) also examine the US data but contend that budget deficits affect the current account via the impact of imports of rising domestic absorption and income rather than of real exchange and interest rates. Similarly other studies such as Normidan (1999), Aqeel and Nishat (2000), Lechman and Francis (2002), Salvator (2006), Hakro (2009), Khan and Saeed (2012) suggest that causation run from budget to current account deficits.

The second group studies, inter alia, by Endres and Lee (1990), Kaufmann, *et al*., (2002) Kim and Roubin (2008) supports the Barro (1989) view of Ricardian Equivalence. Similarly, another study of Javid, *et al*., (2010), by utilizing the structural VAR model, finds out that twin deficits hypothesis does not exist in Pakistan and supports the Ricardian Equivalence. While Khalid (1996) uses cointegration technique (Johansen Maximum likelihood) to empirically examine the RE hypothesis in case of developing countries. The study finds mix results and indicates that temporary increase in government expenditure raises the aggregate demand. In case of India, Pakistan and Nigeria, if the RE holds then increase in the government expenditure also crowds out the private consumption. Ghatak and Ghatak (1996) conduct the multi- cointegration analysis by using the rational expectations model. But evidence from empirical results does not support the validity of RE hypothesis in case of India. The third group consists of studies that support reverse causality, i.e., current account deficit affects the budget deficit. Such situation is especially occurring in small open developing economies that highly depend on foreign capital inflows to finance their economic developments. Anoruo and Ramchander (1998), support this hypothesis in India, Indonesia, Philippines and Korea, While Khalid and Guan (1999), in Indonesia and Pakistan. By utilizing the cointegration technique, Marinheiro (2008) also concludes that RE does not verify for Egypt and inverse causation flows from external to internal deficits. Recently Bose and Jha (2011) by introducing the oil prices as mediating variable, report that evidence for reverse causation is very strong in case of India. The fourth group of studies, inter alia, by Mukhtar, *et al*., (2007) and Pahlavani and Saleh (2009) support the bidirectional causality between twin deficits. Baharumshah, *et al*., (2006), finds out the same results in case of Malaysia and the Philippines.

In the context of Pakistan, empirical facts related to the twin deficits relationship are mixed. For example, Aqeel and Nishat (2000), by applying the Johansen cointegration test, find out the existence of a unidirectional connection from budget to current account deficit. To check the robustness of results they also included other macro economic variables like, gross national product, GDP deflator, money supply, interest and exchange rate.

In the presence of these mediating variable result remains the same and supports the twin deficit hypothesis. Similarly, another study, conducted by Chaudhary and Shabbir (2005), examines the impact of government budget deficits on output, money supply, balance of payment and international reserves by applying the 2SLS technique with the annual data for over three decades. The study concludes that monetary expansion rises due to increase in budget deficits. Increase in quantity of money affects the trade balance through output which brings changes in foreign reserve (in term of outflow). Hakro (2009) and Khan and Saeed (2012) support the twin deficits hypothesis, While Kulkarni and Erickson (2001) support the reverse causation, i.e., from current account deficit to budget deficit. Other studies like Kazmi (1992, 2001) and Waqas *et al*., (2011) find that Ricardian Equivalence hypothesis does not hold in case of Pakistan. They argue that budget deficit affects the domestic consumption which may be the cause of current account deficit. So there is need to study the relationship meticulously by using longer and up to date data set, and advance econometrics techniques". In this regard the present study empirically examines the impacts of budget deficit on current account deficit. RE, TD and F-H hypotheses are tested and dynamic interactions among twin deficits and other macroeconomic variables are analyzed by utilizing multivariate econometric techniques.

3. Model Specification and Empirical Results

This section explains the empirical analysis of three hypotheses in the context of Pakistan. First, it describes the data and then presents the empirical outcomes.

3.1. The data

The appropriateness of data set is very crucial for any valid empirical analysis. "To investigate linkages among twin deficits for Pakistan, study employs annual data for the time spanning from 1976-2016. Main data sources are the World Development Indicator (WDI) database, International Financial Statistics, Hand Book of Statistic on Pakistan Economy and Pakistan Economic Survey. All the variables are obtained in local currency unit except current account deficit and public debt. We have converted the later in to local currency units by using the market exchange rate.

3.2. The Ricardian Equivalence

The Ricardian Equivalence (RE) Hypothesis asserts that for a given expenditure path, swap of debt for tax cut does not influence aggregate demand and interstate rate. It implies that budget deficit has no impact on current account deficit. To find out any relationship between the two deficits, the rejection of REH is, of course, a starting point. Hence, the validity of REH in case of Pakistan is checked first. In the empirical literature, to test the validity of REH many studies have estimated the reduce form consumption function or Euler equation.[1] The main concern of these studies was to examine the individual's consumption behavior in response to deficit financing. The present study estimates the reduce form consumption function rather than the Euler equation, namely the specification of Pereleman and Pestieau (1993).[2]

$$C_t = \beta_1 + \beta_2 Yd_t + \beta_3 BDEF_t + \beta_4 G_t + \beta_5 GD_t + \beta_6 W_t + \mu$$

Where C represents the private consumption, Yd the disposable income, BDEF the budget deficit, G the government expenditure, GD the government debt and W the wealth. For the Ricardian equivalence following restriction must be fulfilled: (1) $\beta_2 + \beta_3 = 0$, (2) $\beta_5 = 0$, and (3) $\beta_5 = \beta_6$.. First restriction states that sum of the effects of changes in disposable income and budget deficit must be equal to zero, which means that tax cut for the substitution of deficit financing has no impact on current consumptions. Second restriction states that changes in public debt do not affect current consumption. Third restriction states that the effect of change in public debt is equal to the effect of change in wealth which means consumers do not consider public debt as net wealth and in reaction of tax reduction increase their saving rather than their consumption. If these restrictions do not fulfill, its mean REH does not hold. It implies that rise in budget deficit inflates consumption, which affects the current account imbalances and this leads to the twin deficit phenomenon.

3.3 Estimation Technique

Economic theories present sufficient explanation regarding the relationships between twin deficits. But the validity of these theories appears to be an empirical issue. Following the literature, study empirically

[1] For more details see Pereleman and Pestieau (1993), Khalid (1996), Marinheiro (2001, 2008).

[4] The Euler equation approach defines the intertemporal optimization behavior of individual while under rational expectation REH is a simplification of permanent income hypothesis, thus Euler equation approach test the Ricardian equivalence in the utility maximization frame work. But it is difficult to get the data of net present value of future income and Marinheiro (2001) also points out that the sensitivity of consumption to the current income rises due to the shortage of data in support of Permanent Income Hypothesis.

examines the relationship between the two deficits using the advance time series econometric techniques (Johansen cointegration technique", Vector error correction model and ARDL). In this regard, unit root tests are conducted first.

3.3.1 Unit Root Tests

Proceeding estimation, "it's necessary to check whether time-series data is stationary or non stationary. If time series data is non stationary, then the results from simple ordinary least square regression analysis are spurious results.[1] Thus to check the stationarity of the series, the study applies two distinct unit root tests, Augmented Dickey–Fuller Test (ADF) and Phillip-Perron Test (PP). Generally, both are interconnected with each other and applied to ensure the accuracy of unit roots results. To test of Ricardian equivalence, the Variables are articulated in real per capita values, while for the testing of the twin deficit and the Feldstein-Horioka hypotheses, variables (budget deficit, current account deficit and investment) are used in GDP ratios. Stationarity of each variable is checked by using the two specifications, with intercept and with intercept and time trend. The results of unit root tests at level (I(0)) as well as at first difference (I(1)) are reported in table 1. According to results of both ADF and PP tests, all the variables (for REH) are non-stationary at levels. These results are robust across the different specifications.

[1] In OLS regression, tests for statistical inference are invalid and R^2 is very high. See Asteriou (2006), pp.339.

Table 1: Results of Unit Root

	ADF test				PP Test			
Variable	I(0)		I(1)		I(0)		I(1)	
Real per capita	Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend	Intercept	Intercept & trend
BDEF	-2.34	-2.56	-7.21**	-7.10**	-2.39	-2.63	-7.21**	-7.10**
C	-0.21	-1.98	-7.35**	-7.25**	-0.13	-1.98	-7.35**	-7.25**
G	-1.54	-2.01	-7.30**	-7.20**	-1.49	-2.08	-7.27**	-7.17**
W	-0.58	-2.86	-5.74**	-5.67**	-0.48	-3.08	-5.78**	-5.68**
GD	-0.90	-0.52	-5.80**	-6.26**	-1.05	-0.52	-5.80**	-6.32**
Yd	-1.06	-2.61	-5.26**	-5.37**	-0.99	-2.03	-5.36**	-5.42**
GDP ratios								
BDEF	-2.86*	-3.07	-7.74**	-7.64**	-2.86*	-3.03	-7.80**	-7.69**
CAD	-3.01**	-3.21*	-6.95**	-6.86**	-3.04**	-3.28*	-6.95**	-6.86**
i	-1.68	-2.90	-5.41**	-5.43**	-2.20	-2.11	-5.47**	-5.49**
E	2.85	-1.23	-5.32**	-5.32**	-1.69	-1.85	-4.04**	-4.24**
I	-1.58	-2.33	-5.68**	-5.61**	-1.71	-2.33	-5.65**	-5.58**

Note: Real per capita values of variables are obtained by using GDP deflator and population. In ADF test lag length is determined by Schwarz information criterion (SBC). In PP test appropriate lag length is determine, by using Bartlett Kernel method. **and *Represent that for the first difference, both tests are unable to accept the null hypothesis of non-stationarity of variables at 5% and 10 % level of significance.

It is apparent from above table that all the series (for REH) are non-stationary at I(0) or having a unit root problem. And all are stationary at their I(1) or they are integrated at same order. It implies that series of all variables follow the stochastic processes and under such condition use of

conventional estimation tools (OLS, 2SLS and etc) will lead bias and inconsistent results. Therefore Johansen (1988, 1991) cointegration technique is used to explore the relationship between given variables, which is based on multivariate analysis. This technique allows more than one cointegrating relationship for two or more than two variables. Another main reason for applying Johansen analysis is that it defines a proper background for estimating and testing the short and long-term associations among given variables. Johansen approach of cointegration is based on vector autoregressive model (VAR) and determines rank of integration in the series of variables, which separates it from other cointegration techniques. To find out the rank of matrix, Johansen (1988, 1991) and Johansen and Juselius (1990) defined two likelihood ratios tests (trace test and maximum eigenvalues test). The maximum eigenvalues, test is based on characteristic roots (eigenvalues) where null hypothesis asserts that r cointegrating vector, against alternative of r+1 cointegtared vector. Following formula is used to calculate the number of statistically significant characteristic roots.

$$\lambda_{\max} = -\mathrm{T}\ln(1-\hat{\lambda}_{r+1})$$

While Trace test is foundation of likelihood ratio and calculated as.

$$\lambda_{\text{trace}} = -\mathrm{T}\sum_{n=r+1}^{p}\ln(1-\hat{\lambda}_{r+1})$$

Null hypothesis of trace test claim that number of cointegrating vectors equal at most to r and the alternative hypothesis says more than r cointegrated vectors. The results of Johansen cointegration test are given in Table 2. Both trace test and maximum eigenvalue test confirm the alternative hypothesis and indicate the presence of the single cointegrating vector. Because value of trace test (109.15) and value of maximum likelihood test (40.15) are greater than their 5% critical values. After finding the presence of long term coalition among variables, the short term is examined by Vector Error Correction Model (VECM). VECM describes short term dynamics and speed of adjustment for long time stability after adjustment of short term fluctuation. Results of VECM are reported in Appendix 1. The coefficient of ECM is negative and statistically significant which supports the long term correlation. It also indicates that 92% current adjustment is required for stable long run equilibrium of dependent variable (private consumption). In the short run coefficients of government budget deficit and wealth are positively related while disposable income, debt and government expenditure are negatively related with private consumption, all these variables are statistically significant". Further to extract long term dynamics and the validity of hypothesis restrictions are imposed.

Table 2. Results of Johansen Cointegration Test

Trace test					Maximum Eigenvalues			
Eigen value	Hypothesized		Trace	0.05	Hypothesized		Maximum Eigen	0.05
	H_0	H_1	Statistic	Critical Value	H_0	H_1	Statistic	Critical Value
0.64	r = 0	r > 0	109.15**	95.75	r = 0	r = 1	40.15**	40.07
0.58	r ≤ 1	r > 1	68.99	69.82	r = 1	r = 2	33.51	33.87
0.36	r ≤ 2	r > 2	35.48	47.86	r = 2	r = 3	17.60	27.58
0.27	r ≤ 3	r > 3	17.87	29.79	r = 3	r = 4	12.55	21.13
0.09	r ≤ 4	r > 4	5.32	15.49	r =4	r = 5	3.98	14.26
0.03	r ≤ 5	r > 5	1.33	3.84	r=5	r =6	1.33	3.84

Note: r points out the cointegrating order. **, denotes the negation of null hypothesis at 5% significance level. A lag one is selected from VAR. The model for the cointegration analysis is specified with intercept only in cointegrating equation (3), by using the Pantula principle. Critical values for both tests are taken from the Mackinnon- Haug- Michelis (1992).

Results of Linear Restrictions on CE

Result of long run estimated vector and imposition of some restrictions are accounted in table. It observed from the table the coefficients of budget deficit, disposable income and wealth have a positive, while the debt and government expenditure have negative sign. The positive sign of the coefficient of disposable income implies that as disposable income increases private consumption of individual raises. "This result is contradictory with the Ricardian theory. The theory defines that when disposable income increase, individuals save this transitory increase in their income to protect themselves and their children from the future tax burden. A result also depicts budget deficits and wealth significantly raises the private consumption. This result supports the Keynesian view of domestic absorption and negates the Ricardian view that individuals do not consider today's tax cut as net wealth. Negatively significant effect of government expenditure on consumption supports both Keynesian conventional view

and RE, while debt refuses the Ricardian view and supports Keynesian crowding out effects.

Table 3: Cointegrating Vector and Restriction on Log Run Coefficients

	Yd	BDEF	G	GD	W	C	Restrictions	LR test
Basic regression	0.947	0.089	-0.270	-0.208	0.189	-0.779		
Ricardian Restrictions	-0.213	0.213	-1.597	0.000	0.000	-4.001	BDEF + Yd=0, GD=W GD=0	24.27 (0.000)

Note: results of restrictions are shown in the last column. Rejection and acceptance of null hypothesis is based on chi-square distribution with p value in parentheses.

To confirm these results, the following three restrictions are imposed: (1) the magnitude of the impact of changes in budget deficit and disposable income are equal, (2) debt has no impact on consumption behavior and (3) debt and wealth are equal. These Restrictions are rejected by VECM and the results are depicted in the above table. The last row of table defines the restriction on Ricardian view. The result of Likelihood ratio (LR) test does not support the Ricardian claim that the effect of changes in budget deficit is equal to that of disposable income, the effect of changes in debt is equal to zero and wealth increase in same amount as bound issues to finance the deficit (with p value is 0.000). Results showed that the RE hypothesis is not proved for Pakistan. The rejection of RE hypothesis indicates the possible validity of TD hypothesis and F-H puzzle which are formally tested in following Sections. It means that at given expenditure path, increase in the budget deficit is not fully compensated by the private saving. In such situation, deficit financing will motivate the external debt which leads to current account deficit (Marinheiro, 2008). The above findings of Ricardian Equivalence hypothesis also confirm the conclusions obtained by previous studies of Kazim (1992) and Waqas *et al*., (2011) that the RE does not hold in case of Pakistan".

3.4 Twin Deficits Hypothesis

From the previous section, "it's observed that the gap between government expenditure and revenue reduces the private saving and raises

the consumption which may be the cause of current account imbalances. There is another option that deficit financed tax cut raises the interest rate which appreciates the exchange rate and deteriorates the external deficit. Now study will address the twin-deficit nexus for Pakistan. In accordance with an open economy macroeconomics, a boost in an internal deficit raises the external deficit and this phenomenon is called the twin deficit hypothesis (Salvatore, 2006). Keynesian proposition also asserts that there are positive and significant linkages among both deficits, which can be derived by the national income approach as

$$Y = C + I + G + NX \quad (1)$$

Where Y, C, I, G and NX (X-M) demonstrate as domestic output, private consumption, private investment, government expenditure and net export. According to the income approach of national income accounts, Y is the sum of all incomes gain by all the persons of the economy. They use this income in four possible ways as, for consumption saving, pay for taxes and transfer to abroad.

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

Where S, T and Tr represent as private saving, taxes and income transfer abroad.
By equating the equation 1 and 2

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

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

$$CAD = (I - S) + (G - T) \quad (5)$$

Equation (5) shows that current account deficit is associated with investment saving gap and expenditure taxes gap. If investment and saving gap remains stable over time then a changes in budget deficit completely transfers into the current account deficit (Fidrmu, 2003). This causal link between both the deficits is expressed in the following functional form.

$$CAD = \beta_2 + \beta_2 BDEF + \varepsilon$$

Where CAD, BDEF and ε are illustrate as current account deficit, budget deficit and error term. The coefficient BDEF (β_2) is expected to be positive.

The relationship of monetary variables (interest rate and exchange rate) in the context of TD hypothesis can be demonstrated as follows. The

increase in government borrowing raises the interest rate. Higher interest rate discourages the domestic investment and attracts capital inflow. High foreign capital inflow raises the demand of local currency; in the result value of exchange rate appreciates which leads to reduction in the current account balance (Abell, 1990; Hokra, 2009).

To incorporate different viewpoints, present study estimates relationship between twin deficits directly and with other financial variables (interest rate, exchange rate) through Autoregressive Distributed Lag (ARDL) approach of cointegration, which is popularized Pesaran and Pesaran (1997) and Pesaran *et al*., (2001). Comparatively to other Such method of cointegration techniques has several advantages, first, it applied in the situation when the explanatory variables are integrated at different order (I(1), or I(0)) and mutually integrated but it requires that the non of variable is integrated at high level, for example I(2). Second, in case of small sample size, it performs well rather than other cointegration technique (Pesaran and Shin, 1999). Further it describes the existence of relationship among the given variables in conditions of long term and short term dynamics without evading long term information". Estimation of ARDL test consists of following equations.

$$CAD = \alpha_1 + \alpha_2(CAD)_{t-1} + \alpha_3(BDEF)_{t-1} + \sum_{q=1}^{p} \alpha_4 \Delta(CAD)_{t-q} + \sum_{q=0}^{p} \alpha_5 \Delta(BDEF)_{t-q} + \bullet_1 \quad (6)$$

$$\Delta CAD = \bullet_1 + \bullet_2(CAD)_{t-1} + \bullet_3(BDEF)_{t-1} + \bullet_4(i)_{t-1} + \bullet_5(e)_{t-1} + \sum_{q=1}^{p} \bullet_6 \Delta(CAD)_{t-q} + \sum_{q=0}^{p} \bullet_7 \Delta(BDEF)_{t-q} + \sum_{q=0}^{p} \bullet_8 \Delta(i)_{t-q} + \sum_{q=0}^{p} \bullet_9 \Delta(e)_{t-q} + \bullet_2 \quad (7)$$

The first part of the equation (6) and (7) with the coefficients α_2, α_3, δ_2, δ_3, δ_4 and δ_5 represent the long run relationship while the coefficients α_4, α_5, δ_6, δ_7, δ_8 and δ_9 represent the short run relationship and p shows the optimal lag length.

Since from table1 it observed that all series (current account deficit, budget deficit as ratio of GDP and interest rate) are integrated at I(0), except the exchange rate and interest rate. So, ARDL approach of cointegration is applied rather than Johansen, that require all the series are integrated at same level i.e., I(1). ARDL test is based on three steps, following the first step optimum lag length 1 is selected for both model (6) and (7), and the prevalence of long run association among given set of variables are estimated. In this regard, F-test statistics (Wald test) is conducted to check the null hypothesis: all the coefficients of lagged level variables are simultaneously equal to zero ((H_{01}: $\alpha_2 = \alpha_3 = 0$), (H_{02}: $\delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$)),

which indicates there is no cointegration among the variables, with the alternative hypothesis at least one coefficient of lag variables is not equal to zero. And computed value of F-statistics is compared with bound values tabularized by Pesaran and Pesaran (1997) or Pesaran *et al*., (2001). The results of F-statistic along with the diagnostics are transmitted in Table 4.
It is seen from the table; the estimated value of F-statistics of model (6) is less than the upper bound values at 1, 5 and 10 percent significance level. Hence, the alternative hypothesis is not accepted. While on the other side, the calculated value of F-test of model (7) is greater than upper bound values at 10 percent significance level. It implies that long run relationship exists between both deficits when mediating variables are incorporated in the model. After the existence of cointegration, in next steps, coefficients of long and short term are estimated. For the long run following model is analyzed and outcomes are described in table 5.

$$\mathrm{CAD_t} = \beta_1 + \sum_{q=1}^{p} \delta_2(\mathrm{CAD})_{t\text{-}q} + \sum_{q=0}^{p} \delta_3\,(\mathrm{BDEF})_{t\text{-}q} + \sum_{q=0}^{p} \delta_4(\mathrm{i})_{t\text{-}q} + \sum_{q=0}^{p} \delta_5\,(\mathrm{e})_{t\text{-}q} + \eta_2 \qquad (8)$$

Table 4. Bound Test for Cointegration

Model 6

K	F-Statistics	Critical value		
			Lower critical bound value	Upper critical bound value
1	3.9190	1%	7.057	7.815
		5%	4.934	5.764
		10%	4.042	4.788

Diagnostic Tests

R^2= 0.209	F_1 = 2.246 (0.084)	DW= 1.924
F_{RAMSEY} = 2.776 (0.105)	F_{LM} = 1.012 (0.321)	F_{NORMAL} = 0.704 (0.703)
F_{WHITE} = 0.677 (0.708)		

Model 7

K	F-Statistics	Critical value		
			Lower bound critical value	Upper bound critical value
3	4.2680*	1%	4.385	5.615
		5%	3.219	4.378
		10%	2.711	3.800

Diagnostic Tests

R^2= 0.6068	F_1 = 3.788 (0.002)	DW= 2.146
F_{RAMSEY} = 0.075 (0.786)	F_{LM} = 0.352 (0.988)	F_{NORMAL} = 0.732 (0.693)

Note: k shows the number of independent variables. * (**) denote 10% (5%) level of significance at given critical values, obtained from Pesaran *et al.,* (2001).

Table 5: Long Run ARDL (1, 1, 1,0) (Dependent Variable: CAD)

Variable	Coefficient	t-Statistic	Prob.

C	-0.233	-0.118	0.9064
CAD (-1)	0.414	2.467	0.019*
BDEF	0.500	2.022	0.051**
i	0.349	1.860	0.071*
E	-0.012	-1.107	0.276
BDEF(-1)	-0.274	-1.062	0.296
i (-1)	-0.232	-1.307	0.200
Long Run Coefficients Diagnostic tests			
R^2= 0.572	F-test = 7.346 (0.000)	F_{LM} = 0.327 (0.571)	F_{RAMSEY} = 0.933 (0.341)
	DW= 2.071	F_{WHITE} = 1.351 (0.249)	F_{NORMAL} = 1.826 (0.401)

Note: * (**) denote 10% (5%) level of significance.

It is apparent from the table 5 that the "estimated coefficients of budget deficit and interest rate have expected signs and are statistically Significant at 10 present levels. It suggests that in the long run, upward pressure in these variables deteriorate the current account deficit. The coefficient of budget deficit is positive which indicates that one percent increase in the ratio of budget deficit to GDP raises the ratio of current account deficit to GDP by 0.50 percent. The coefficient of interest rate is also positively related to current account deficit. It implies that increase in the domestic interest rate attracts the capital inflow which adversely affects the current account deficit. The results further reveal that coefficient of exchange rate is negative but is not statistically significant. It implies that although depreciation of the exchange rate raises the export, but the import bill also increases. So the net effect on the current account balance is not significantly different from zero. Trade balance which is major element of current account balance deteriorates due to depreciation of exchange rate. The main reason of such situation is higher import bill, which rose due to the higher foreign prices of crude oil. After estimating the long term relation, the short term dynamic of variables is examined by following error correction model

$$\Delta CAD_t = \delta_1 + \sum_{q=0}^{p} \delta_2 \Delta(BDEF)_{t-q} + \sum_{q=0}^{p} \delta_3 \Delta(i)_{t-q} + \sum_{q=0}^{p} \delta_5 \Delta(e)_{t-q} + \sum_{q=1}^{p} \delta_4 \Delta(CD)_{t-q} + \pi ECM1_{t-1} + \varepsilon_2 \quad (9)$$

(9)

Where ECM1 is the error correction term of equation (8), this term describes the short run adjustment for the long-run equilibrium.[1] • , coefficient of ECM1, indicates the speed of adjustment. Its

[1] See Altintas and Taban, (2011).

statistical significant negative sign also ensure that model is correct and long term equilibrium is achieved". The outcomes of ECM specification for ARDL (1,1,1,0) model are reported in Table 6.

Table 6. Error Correction Model (1, 1, 1, 0)

Variable	Coefficient	t-Statistic	Prob.
C	0.990	2.362	0.024*
ΔCAD (-1)	0.197	1.282	0.209
ΔBDEF	0.531	2.544	0.016*
Δ i	0.307	1.982	0.056*
Δ e	0.163	1.674	0.104
ECM_{t-1}	-0.886	-5.208	0.000**
ΔBDEF (-1)	-0.205	-0.922	0.383
Δi (-1)	0.357	2.406	0.022**
Diagnostic tests			
R^2=0.569	DW= 1.863	F_{RAMSEY} = 0.005 (0.942)	F_{NORMAL} = 1.267(0.530)
	F-test = 5.846 (0.000)	F_{WHITE} =0.517(0.899)	F_{LM} = 0.094(0.761)

Note: ** and * represent significance level at 5% and 10 % respectively.

According to Table 6, coefficient of budget deficit, interest rate, exchange rate and error correction term have expected signs. The estimated coefficient of ECM_{t-1} is negative and statistically significant, which supports the long run cointegration among the variables and indicates that 89% adjustment in current year is required for the correction of long run disequilibrium. The results also indicate that short period budget deficit significantly has an effect on current account deficit. Short period exchange rate positively affects current account but it is not statistically significant. The results of diagnostic tests specify that there is no proof of heteroscedasticity and serial correlation among variables in short run and functional form of the model is well specified. In last, stability of long and short term estimated coefficients are also examined by CUSUM and CUSUMSQ tests. It can be observed from figures that graph of CUSUM and CUSUMSQ lie within bound value of 5%, which implies that parameters of models (short and long period) are stable over time (See Appendix-2).

3.5 The Feldstein-Horioka Hypothesis

In this section we will analyze the degree of "foreign capital mobility and its impact on current account deficit. Feldstein and Horioka

(1980) defined the relationship between domestic saving and investment to measure the degree of foreign capital trasaction. According to them, domestic investment is not correlated with domestic saving in a world of perfect capital mobility. They explain that domestic savings response to the international possibilities for investment while domestic investment finances by the external resources. So, under conditions of inflow foreign capital inflow domestic savings and investments are unrelated. But empirically they founded that in the OECD countries capital was immobile and savings and investments were strongly correlated. Their findings are recognized as the Feldstein-Horioka Puzzle. TD hypothesis is also allied with the degree of foreign capital mobility. In the situation of perfect capital mobility, domestic savings are uncorrelated with domestic investments, and RE hypothesis do not hold, both twin deficits move together. In other words, when the RE does not hold than a raise in budget deficit reduces domestic saving. This reduction in domestic saving, at a given amount of domestic investment, worsens the current account balance. To explain both twin deficit and Feldstein-Horioka hypotheses, Fidrmuc (2003) derived the following regression model from the national income account identity.

$$x\text{-}m = \omega_0 + \omega_1 (t\text{-}g) - \omega_2 invt + \eta \qquad (10)$$

Where x-m is current account balance, (t-g) is budget balance, • invt is investment ratio and • is error term.

We can rewrite the equation (1) as

$$CA = \omega_0 + \omega_1 BD - \omega_2 I + \eta \qquad (11)$$

Equation (11) encompasses both Twin deficit and Feldstein-Horioka hypotheses. According to him, in the above regression model coefficient of budget balance should be positive ($\omega_1 > 0$) and investment should be negative ($\omega_2 < 0$). Then any increase in budget deficit and huge investment will deteriorate the current account balance. If country is completely integrated into the international financial market, then the coefficient of investments should be equal to one. Conversely if the coefficient of ω_2 is less than unity it represents the existence of F-H hypothesis. While, the negative value of ω_1 identifies the extinction of the TD hypothesis.

Following the work of Fidrmuc (2003) Study examines the relationship among current account, budget deficits and investment by applying the ARDL approach". The unrestricted error correction model (UECM) for the F-H is expressed as:

$$\Delta CAD_t = \beta_1 + \beta_2 (CAD)_{t-1} + \beta_3 (BDEF)_{t-1} + \beta_4 (I)_{t-1} + \sum_{q=1}^{p} \beta_5 \Delta (CAD)_{t-q} + \sum_{q=0}^{p} \beta_6 \Delta (BDEF)_{t-q} +$$

$$\sum_{q=0}^{p} \beta_7 \Delta(I)_{t-q} + \bullet_t \quad (12)$$

Where β_2, β_3, and β_4 are long run coefficients, β_5, β_6, and β_7 represent the short run relation and p describes optimal lag span. For the attendance of long term relation F-statistics has following hypotheses:

H_0: $\beta_2 = \beta_3 = \beta_4 = 0$

H_1: $\beta_i \neq 0$ at least for one i, where i varies from 2 to 4

After observing the cointegration among given series, the long and short term parameters are estimated by the following ARDL model.

$$CAD_t = \beta_1 + \sum_{q=1}^{p} \beta_2 (CAD)_{t-q} + \sum_{q=0}^{p} \beta_3 (BDEF)_{t-q} + \sum_{q=0}^{p} \beta_4 (I)_{t-q} + \bullet_t \quad (13)$$

$$\Delta CAD_t = \beta_1 + \sum_{q=0}^{p} \beta_2 \Delta(BDEF)_{t-q} + \sum_{q=0}^{p} \beta_3 \Delta(I)_{t-q} + \sum_{q=1}^{p} \beta_4 \Delta(CAD)_{t-q} + \bullet \; ECM_{t-1} + \bullet_t \quad (14)$$

3.5.1 Results of ARDL Estimation

The outcomes of conventional unit root tests from table 1 indicate that both deficits are integrated at I(0). While according to the PP test, the series of investment is not stationary at I(0), it is integrated at first difference. These results advocate that since variables are integrated at different orders; therefore the ARDL test is applicable. Following the first step of ARDL approach, the lag length 1 is selected on the basis of the lowest values of SIC. And for existence of long run relation, equation (12) is estimated by the OLS procedure and joint significance of the coefficients of lagged level variables is tested. The result of F-test with the diagnostic tests is expressed in Table 7.

Table 7. Results of Bound Test for Cointegration

K	F-Statistics	Critical value

			Lower critical bound value	Upper critical bound value
2	4.2838*	1%	5.288	6.309
		5%	3.793	4.855
		10%	3.182	4.126

Diagnostic Tests

R^2= 0.322	DW= 1.958	F_{RAMSEY} = 2.654 (0.114)
F_1 = 2.537 (0.040)	F_{LM} = 0.000 (0.994)	F_{NORMAL} = 0.172 (0.917)
	F_{WHITE} = 0.950 (0.516)	

Note: k shows the number of independent variable. * (**) represent 10% (5%) statistical significance level at the critical bound values, attained from Pesaran *et al.,* (2001).

The results in the table expose that the calculated value of F-statistic is higher than the 5 percent and 10 percent upper bound values. So, the Null hypothesis is not accepted. It implies that long term current account, budget deficit and investment associate with each other. In the next step, Equation (13) is estimated to examine long term parameters and results are presented in Table 8.

Table 8. ARDL Long Term (1, 0, 0) (Dependent Variable: CAD)

Variable	Coefficient	t-Statistic	Prob.
C	-10.140	-3.404	0.001**
CAD(-1)	0.374	2.942	0.005**
BDEF	0.378	2.072	0.045*
I	0.604	3.365	0.001**

Diagnostic tests

R^2= 0.593	DW= 1.853		F_{RAMSEY} = 1.455 (0.236)
F-test =17.504 (0.000)	F_{LM} = 0.353 (0.556)	F_{WHITE} = 0.918 (0.494)	F_{NORMAL} = 1.088(0.580)

Note: **and * represent 1% and 5% statistical significance level, respectively.

It can be observed from the table that all the variables are significant statistically. "The estimated coefficients of lag current account balance, budget balance and investment are positively related with current account deficit. The positive association of budget deficit with the current account deficit indicates the presence of TD hypothesis. Our findings suggest that a

raise in budget deficit by the one percent of GDP deteriorates the current account balance by 0.38 percent of GDP. This result is corresponding to the Aqeel and Nishat (2000) and Mukhtar *et al*., (2007). Further, the results also reveal that one present increase in investment to GDP ratio worsens the current account balance to GDP ratio by 0.60 present. The coefficient of investment is less than the one which implies that domestic savings and investments are not strongly correlated and F-H hypothesis does not hold. It also implies that 2/3rd of our home investment is finance by the foreign resources and the Pakistan is not completely integrated into the world financial market. The reason of such situation is that the capital flow was restricted during the period of 1976-1990.The above findings of F-H hypothesis also support the previous findings of Shahbaz *et al*., (2010) and Khan and Saeed (2012). They argued that domestic saving and investment are weakly correlated and in the long run F-H Puzzle does not hold for Pakistan".

3.5.2 Empirical Results of Short Run Relationship

To examine the Short term nexus between twin deficits and investment, error correction model is estimated. Error correction model also gives us another proof regarding the stable long run connection among the given series. Table 9 reported the estimated result.

Table 9: ARDL Short Run (1, 0, 0) (Dependent Variable: ΔCAD)

Variable	Coefficient	t-Statistic	Prob.
C	-0.050	-0.183	0.856
ΔCAD (-1)	0.106	0.699	0.490
ΔBDEF	0.678	3.081	0.004**
ΔI	0.377	1.140	0.262
ECM_{t-1}	-0.669	-3.640	0.000**
Diagnostic tests			
R^2=0.456	DW= 1.916 F-test = 7.132 (0.000)	$F_{RAMSEY=}$ 1.297 (0.263) F_{WHITE} = 0.428 (0.894)	F_{NORMAL} = 1.765 (0.414) F_{LM} = 0.231 (0.634)

Notes: * represents 1% level of significance. The numbers in parenthesis show the p-values in diagnostic test.

It is evident from the table, the short run coefficients are, in terms of signs, in line with the long run coefficients (given in the Table 8). The highly significant coefficient of budget deficit implies that twin deficits hypothesis exists in the short run in case of Pakistan. Investment is positively associated with current account deficit but not significant. The coefficient of investment is less than the unity which weakly supports the existence of F-

H hypothesis in the short run. The coefficient of ECM_{t-1} is negative and statistically significant, with the magnitude of 0.67, which implies that 67 percent of short run adjustments are required for the convergence of long term stability. The sketches of CUSUM and CUSUMSQ lie within the 5%. Which show that coefficients of both the long and short term models are stable over the entire sample and do not violate the structural stability (See Appendix 3).

4. Conclusion

This paper analyzed the causal linkages between the twin deficits within the context of Pakistan. The main objectives were to empirically examine the impact of budget deficit on current account deficit and its transmission mechanism. To achieve these objectives, three hypotheses are tested. Empirical evidence indicates that for long period in Pakistan RE hypothesis is not valid. This finding supports the conventional view that budget deficit reduces the national saving and increases the saving investment gap. "This may be filled partly by the domestic and partly by the foreign resources. Consequently, it will raise the domestic inters rate. It can be explained in simple words as substitution of debt for the tax cut raises the interest rate in the economy which attracts the capital inflows and appreciates the domestic currency and in the result current account deficit rises. It is evident from the empirical analysis of the TD hypothesis that long run interest rate is positively connected to the Pakistan current account deficit. Conversely, from the F-H, it is observed that $2/3^{rd}$ of our domestic investment is financed by foreign savings. It means that high interest rate attracts the capital inflow, but continuously depreciation of our exchange rate rather than the appreciation raises the debt burden in the economy. Resultantly, the trade deficit (which is major component of current account) has been continuously increasing due to the high import bills. So, in the long run, these two financial variables, specifically interest rate and exchange rate, form the main transmission channel between the both deficits. However, the short run results of REH do not allow taking a clear cut position. While from the analysis of both the TD and F-H hypothesis, it is observed that Short run budget deficit affects the current account deficit.

As the findings of present study reject the RE hypothesis in Pakistan, government of Pakistan may use the fiscal policy to stabilize the economy as a relevant and valid policy tool. However, attention should be paid on the sustainability issues by avoiding excessive debt and following public debt reduce policies such as by decreasing budget deficit and by escalating privatization programs. The results further endorse the influence of fiscal policy because individuals consider the public debt as the net

wealth which boosts consumption level in the economy. So, the fiscal policy can be used as major policy tool in order to control saving investment gap, degree of capital inflow and trade deficit. The finding of the study also verifies the existence of TD hypothesis both in short and long run. Since, both deficits are caused by other macroeconomic variables, i.e. interest rate and exchange rate, hence, the expansion in twin deficits may be effectively controlled by manipulating these policy variables. To reduce the trade deficit, a major component of the current account deficit, government should try to restrict the depreciation of domestic currency and stabilize it against other currencies by reconsidering the commercial policy". Finally, there is need to the coordinate fiscal, monetary and exchange control policies to overcome the macro economic imbalances and deteriorating situation of the economy. There is also a dire need to increase in the tax base by rationalizing the tax system.

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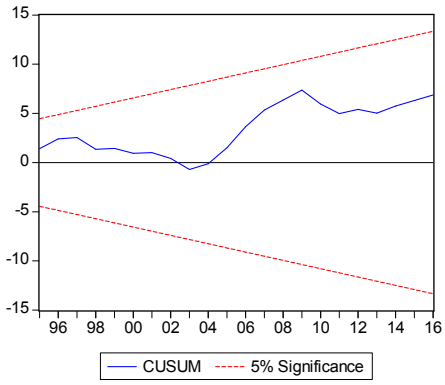
Appendix 1 Results of Vector Error Correction Model

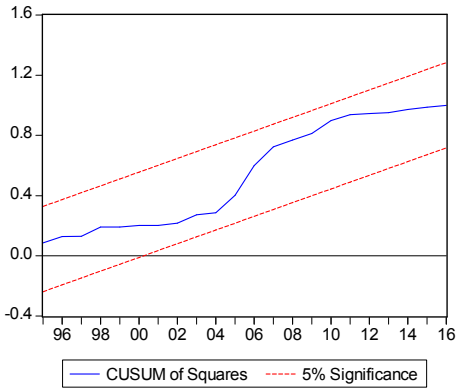
Cointegrating Equation						
C (-1)	C	Yd (-1)	BDEF(-1)	G(-1)	GD(-1)	W(-1)
Coefficient	-89.077	-0.947	-0.088	0.271	0.208	-0.189
Stander error	(12.16)	(0.061)	(0.017)	(0.025)	(0.019)	(0.047)
T statistics	[-7.320]	[-15.434]	[-5.139]	[10.401]	[0.401]	[-4.008]
Error correction regression						
Error Correction:	Δ(C)	Δ(Yd)	Δ(BDEF)	Δ(G)	Δ(GD)	Δ(W)
CointEq1	-0.922	-0.167	3.118	0.763	0.0151	0.598
	(0.195)	(0.142)	(1.155)	(0.851)	(0.539)	(0.561)
	[-3.168]	[-1.172]	[2,010]	[0.896]	[0.003]	[1.065]
Δ(C (-1))	-0.039	-0.143	0.259	-0.689	-0.632	-0.613
	(0.181)	(0.133)	(1.444)	(0.793)	(0.502)	(0.523)
	[-0.214]	[-0.113]	[0.179]	[-0.869]	[-1.259]	[-1.171]
Δ(Yd(-1))	0.118	0.209	03.970	3.132	0.510	0.763
	(0.303)	(0.221)	(2.405)	(1.320)	(0.836)	(0.870)
	[0.039]	[0.914]	[1.650]	[2.371]	[0.610]	[0.326]
Δ(BDEF(-1))	-0.045	-0.023	0.141	0.157	-0.012	0.023
	(0.025)	(0.018)	(0.197)	(0.108)	(0.068)	(0.071)
	[-1.853]	[-1.274]	[0.718]	[1.450]	[-0.175]	[0.326]
Δ(G(-1))	0.111	0.035	-0.741	-0.544	0.0267	-0.087
	(0.047)	(0.034)	(0.379)	(0.208)	(0.131)	(0.137)
	[2.321]	[1.013]	[-2.621]	[-2.621]	[0.203]	[-0.633]
Δ(GD(-1))	0.207	0.020	-0.995	-0.726	0.113	-0.609
	(0.073)	(0.053)	(0.576)	(0.316)	(0.200)	(0.209)
	[2.852]	[0.374]	[0.017]	[-2.294]	[0.566]	[-2.920]
Δ(W(-1))	-0.233	0.006	1.014	0.852	-0.119	0.224
	(0.069)	(0.050)	(0.550)	(0.302)	(0.191)	(0.199)
	[-3.357]	[0.117]	[1.842]	[2.821]	[-0.620]	[1.126]

Note: [ ] represent value of Stander Error & ( ) represents the value of t-Statistics.

Appendix-2

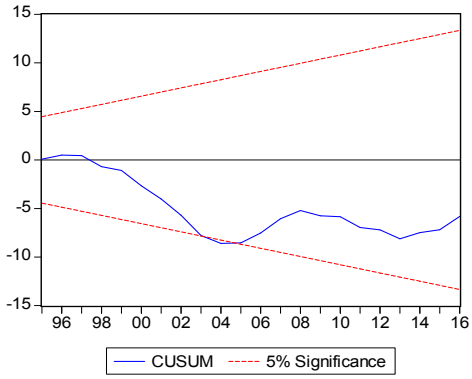
Figure**:** Long Run CUSUM and CUSUMSQ Tests Results

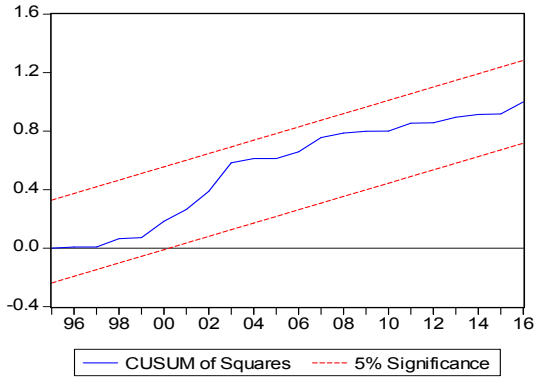




The straight lines denote critical bounds at 5% level of significance.

Figure: Short Run CUSUM and CUSUMSQ Tests Results

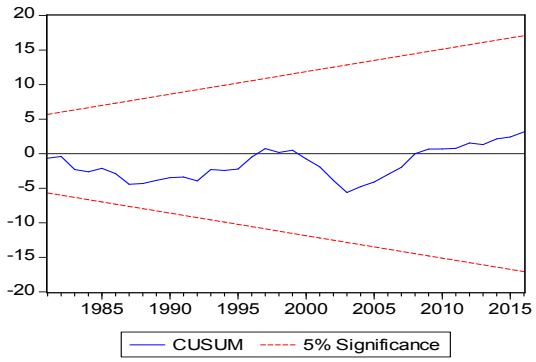




The straight lines denote critical bounds at 5% level of significance.

Appendix - 3

Figure: Long Run results of CUSUM and CUSUMSQ Tests



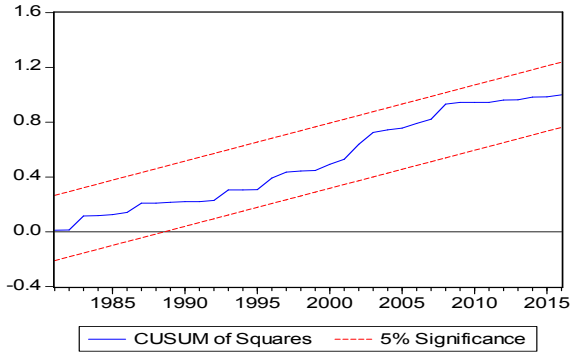
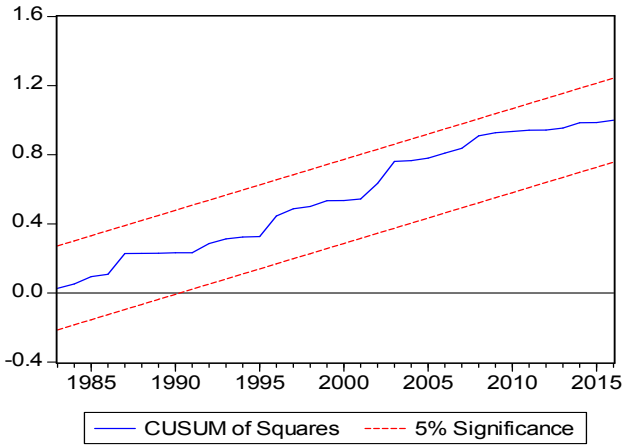
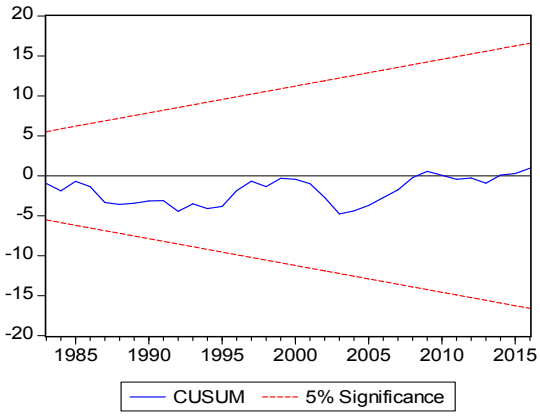


Figure**:** Short Run Results of CUSUM and CUSUMQ Tests




20
15
10
5
0
-5
-10
-15
-20
1985
1990
1995
2000
2005
2010
2015
CUSUM
5% Significance