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An Analysis of Feldstein-Horioka Puzzle regarding Economic Openness of Bangladesh

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Abstract: *This paper proposes an original framework to determine the influence of economic openness (trade-GDP ratio) on the Feldstein-Horioka result of Bangladesh with a positive saving-investment association. Based on panel Threshold Regression Model, Johansen Long Run Cointegrating Equation is developed for Bangladesh over the period 1972-2015.ECM model is also developed to test the short run dynamics of investment function. CUSUM and CUSUMQ have been used to test the stability of the investment model. The results show that, there is a long run relationship among savings, trade and investment. The results from ECM show that speed of adjustment in investment function is moderate in Bangladesh. The plot of CUSUM indicates the instability of the model. The results do not support the Feldstein-Horioka (1980) hypothesis meaning that the capital account of Bangladesh is not convertible.*

Keywords: *Feldstein-Horika puzzle, Panel Smooth Threshold Regression models, Johansen Long Run Co integrating Equation, TVP, saving-investment association, capital mobility, instability.*

JEL Classification: E200, N150.

Introduction

In their seminal article of 1980, Feldstein and Horioka provided evidence of a strong correlation between the national saving of countries and their domestic investment. Their results have been confirmed in most studies of EU and OECD countries. Considerable literature on the issue has arisen, in a world of capital mobility; an increase in national saving should not modify domestic investment. This result, generally known as the Feldstein — Horioka (FH hereafter) puzzle, has spawned a large amount of literature trying to explain why saving and investment appear to be correlated. The puzzle of Feldstein and Horioka (1980, henceforth FH) stems from the early eighties: the authors identified the correlation between a country's savings-to-GDP and investment-to-GDP ratio as a measure of international capital mobility. By using a cross-section analysis they concluded that the long-awaited capital mobility was not significantly present. The puzzle rose from the fact that the seminal article inspired a vast amount of literature with different research methods and data samples, but without a real wide consensus (Fouquau et al. 2007).

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In such situation, the study seeks to evaluate whether there is any correlation between savings and investment of Bangladesh. Is Feldstein-Horioka puzzle applicable for Bangladesh? The study intends to examine the foresaid questions.

The objective of this study therefore is to investigate the degree of international capital mobility in the case of Bangladesh by employing the Johansen Long Run testing approach to co integration.

This study explores the relationship among savings, trade and investment in Bangladesh during the period 1972-2015. Unlike previous studies, this study employed Johansen Long Run Co integrating testing approach to test for long run relationships. The results of the Johansen Long Run Co integrating test suggest that there is a long run relationship between savings, trade and investment. This result is consistent with a number of earlier studies reviewed in the literature that was found saving, trade and investment to be co integrated in the long run.

The rest of this paper is structured as follows. **Section 2** provides a brief review of the relevant literature. **Section 3** postulates a theoretical model that captures a conventional model of Feldstein-Horioka. The empirical econometric results for the long run relationship among savings, trade and investment, as well as policy implications of the study are set out in **Section 4**. **Section 5** presents some concluding remarks.

Literature Review

Economic theory predicts that under perfect capital mobility capital will tend to flow into the country where the highest yield is achievable, thus domestic savings and domestic investments should remain uncorrelated. However, in the original Feldstein-Horioka study the authors found that the correlation between domestic savings and domestic investment during the period 1960-74 was high for the sample of 16 OECD countries. They estimated the following well-known equation ever since:

$$\left(I/Y\right)_i = \beta_0 + \beta_1 \left(S/Y\right)_i + \epsilon_i \qquad \text{(FH)}$$

Here *I* means gross domestic investment, *S* stands for gross domestic savings and *Y* denotes GDP (later we'll use *i* and *s* for GDP fractions). In other words they regressed the average of the investment rates on the average of savings rates using a cross-sectional sample and they also estimated β_1 for sub-periods, using five-year-average rates. A β_1 near 1 would mean that domestic savings and domestic investment are highly correlated. They found that β_1 was about 0.9 for every sample period, which they interpreted as a lack of capital mobility (Varga and Plajner, 2012).

Their findings have been widely discussed. Lots of studies used simple OLS estimates for various groups of countries and periods. Several empirical researches showed that the coefficient in question is much lower than those estimated by FH, and it's especially lower for developing countries as emphasized by e.g. Frankel et al. (1987), Coakley et al. (1999).

Researchers used a wide set of econometric techniques to confirm or to refuse the original argument. Numerous studies used time series methods to examine the long-run and short-run connection between the saving and investment rates. To rule out spurious regressions some studies have been attempted to investigate if the direction of causality runs from saving to investment or inversely.

Various theoretical macroeconomic models have been built to explain the puzzle. Obstfeld and Rogoff (2000) created a model with budget constraints and transport costs.

Ho (2000) applied a two-state, first-order Markov regime-switching model for Taiwan using quarterly data for the 1979-95 intervals and concluded that capital mobility is more likely to have been high in the studied period. Other three East-Asian countries in addition to Taiwan (Korea, Hong Kong, Singapore) have been also studied by Sun (2003) using a TVP model. He claimed that due to the financial liberalization, during the 1980-97 period capital was very mobile, moreover the mobility was rising.

Papapetrou (2006) used recursive OLS, rolling OLS, Kalman filter and Markov switching regime modeling technique to capture major policy regime changes. Using quarterly data for Greece for the period 1980-2003 she found that the estimated time varying coefficients declined over time indicating that due to the financial liberalization the capital mobility increased.

Telatar et al. (2007) carried out an empirical research using a Markov switching model with heteroskedastic disturbances and they found that the effect of policy regime changes can be observed. They used annual data for 9 European countries for the period 1970-2002. They concluded that two groups of countries can be perceived in the sample. In six of nine countries (Belgium, Denmark, Finland, France, Italy and Sweden) a significant fall has occurred in the saving retention coefficient around 1994, after the creation of the European Monetary Union, which was a step to the direction of the European capital market integration. Capital mobility increased considerably as the FH coefficient declined. However in the remaining three countries (Germany, Netherlands, UK) they didn’t find such a substantial switching point.

Hatemi and Hacker (2007) analyzed the capital mobility in Sweden between 1993 and 2004. They used Kalman filter and found that the correlation is comparatively low and declined before 1995 when Sweden joined the EU. Surprisingly they observed that capital mobility hasn’t increased after Sweden joined the Union.

Gomes et al. (2008) investigated the investment-saving connection for the second half of the 20th century in three South-American countries (Argentina, Brazil, Chile). They asserted that the coefficient showed relatively high volatility over time, thus the time varying parameter approach is much better than the simple OLS estimation.

Evans et al. (2008) examined a very long period for 8 countries. They found that the saving retention coefficient showed remarkable volatility from 1850 to 1990. Their results were mixed as for example in the USA capital mobility seemed to have been low throughout the whole period in contrast with Canada. Changes in the value of the coefficient did not show any unanimous pattern.

Arisoy and Ucak (2010) studied the G7 countries trying to catch the changes in the relationship of saving and investment rates. Using Kalman-filter they did not confirm the earlier results as they did not find significant evidence that capital mobility has declined over time. The authors found that the coefficient remained relatively stable during the period from 1960 to 2007 except for Italy where a significant drop was observed (Varga and Plajner, 2012).

Many studies have attempted to solve the Feldstein-Horioka puzzle by examining its feasibility, either theoretically or empirically, or both in different countries. Tang and Lean (2011) applied Rolling Windows Bounds test to empirically investigate the relationship between savings and investment over the period 1960-2007 for Malaysia. The study showed that savings and investment are not co integrated implying that capital is internationally mobile over the same period.

The main critiques of these works incorporate the omitted variables, the econometric methods, and the data used. Early papers related to the puzzle used periods averages in terms of saving- and investment rates but that method seemed to be ineligible. Time-series studies used annual rates, but the estimated coefficients were constant over time which led to unsophisticated results. Using time-varying parameter approach (TVP) is the most effective way to capture the changes in capital mobility over time.

It has been seen that the TVP literature of the Feldstein-Horioka puzzle is relatively bold but lacks any research to use the TVP methods for a country like Bangladesh. This paper attempts to fill this gap. This paper also intends to fill the gap of estimating the stability of the model by developing ECM model and using CUSUM and CUSUMQ Test.

Objectives of the Study

The broad objective of this study is to investigate the degree of international capital mobility in the case of Bangladesh by employing the Johansen Long Run testing approach to co integration. The specific objectives of this study are:-

i. To determine the potential threshold effects (Trade-GDP Ratio) in the relationship between national saving and domestic investment rates.
ii. To retrieve the co integrating equation by normalizing vector.
iii. To interpret the co integrating equation
iv. To estimate how investment responds to changes in savings and trade.
v. To evaluate the stability of investment in Bangladesh during the period 1972-2015.
vi. To recommend policy guidelines for economic stability in Bangladesh.

Methodology

This research is descriptive in nature and the data is quantitative in nature. Only the secondary data were used. Secondary data were collected from the world development indicators report, internal database and websites.

The Johansen multivariate co integration technique is used in this paper to test the existence of a long-run equilibrium relationship among the variables specified in equation (1). An important step before using the Johansen multivariate technique is to determine the time series properties of the data. This is an important issue since the use of non-stationary data in the absence of co integration can result in spurious regression results. To this end, one unit root test, *i.e* the ADF test has been adopted to examine the stationarity, or otherwise, of the time series data. In this paper the lowest value of the Schwarz Information Criterion (SIC) has been used as a guide to determine the optimal lag length in the ADF regression.

ECM has been applied to estimate investment function and examine its stability in Bangladesh. An ECM model is effective tool to study the short run dynamic in investment function. The ECM allowed reuniting the short run and long run behavior of investment.

Next the structural stability of the error correction model of investment has been examined. Stability test is used to examine if investment and its determinants in Bangladesh were stable during the sample period. Cumulative sum (CUMSUM) and cumulative sum of squares (CUSUMQ) of recursive test has been used.

Theory & Model

The Feldstein–Horioka puzzle assumes that if investors are able to easily invest anywhere in the world, acting rationally they would invest in countries that offer the highest return per unit of investment. This would drive up the price of the investment until the return across different countries is similar. The discussion stems from the economic theory that capital flows act to equalize marginal product of capital across nations. In other words, money flows from lower to higher marginal products until the increased investment equalizes the return with that obtainable elsewhere. According to standard economic theory, in the absence of regulation in international financial markets, the savings of any country would flow to countries with the most productive investment opportunities. Therefore, domestic saving rates would be uncorrelated with domestic investment rates. Feldstein and Horioka argued that if the assumption is true and there is perfect capital mobility, we should observe low correlation between domestic investment and savings. Borrowers in a country would not need the funds from domestic savers if they borrowed from international markets at world rates. By the same token, savers would show no preference for investing within their own country, but would lend to foreign investors and would not need to lend domestically.

In this paper, the potential threshold effects (Trade-GDP Ratio) in the relationship between national saving and domestic investment rates are investigated. The baseline idea is very simple: common knowledge that international mobility of capital depends on other exogenous variables (trade openness, country size, demography, etc.) clearly matches the definition of a threshold regression model: "threshold regression models specify that individual observations can be divided into classes based on the value of an observable variable" (Hansen, 1999, page 346). Thus, it has been tested the relevance of breaking down the Feldstein and Horioka (FH thereafter) regression parameters (or saving-retention coefficients) into classes given the values of the main factor generally quoted in this literature: economic openness (Trade-GDP Ratio)

In a panel data context, the simplest way to introduce threshold effects consists in using a Panel Threshold Regression (PTR) Model proposed by Hansen (1999). This model assumes a transition from one regime to another depending on the value of a threshold variable (the trade openness for instance). In a model with two regimes, if the threshold variable is below a given value, called the threshold parameter, the domestic investment is defined by one equation (with a particular value of the saving-retention coefficients), while it is defined by another equation (with another saving-retention coefficients) if the threshold variable exceeds this threshold parameter. This model has been used by Ho (2000) to empirically re-evaluate the country-size argument for the FH puzzle (Fouquau et al. 2007).

On the one hand the PSTR can be thought of as a regime-switching model that allows for a small number of extreme regimes (saving-retention coefficients) associated with the extreme value of a transition function and where the transition from one regime to another is smooth. On the other hand, the PSTR model can be used to allow for a "continuum" of regimes (saving-retention coefficients), each one being characterized by a different value of the transition variable. The logic is then similar to that developed in the standard univariate time series STAR.

Based on PSTR specifications, saving-retention coefficients have been derived, which vary not only between countries but also with time. Thus, this work provides a simple parametric approach to capture both heterogeneity and time variability of the saving–investment correlations. This approach allows for smooth changes in correlations depending on a threshold variable (Trade-GDP Ratio).

The basis of this empirical approach is exactly the same as that used by many authors since the seminal paper of Feldstein and Horioka (1980). It consists of evaluating the mobility of capital for a panel of N countries. The corresponding model is then defined as follows:

$$I_{it} = \alpha_i + \beta S_{it} + \epsilon_{it} \qquad (1)$$

where I_{it} is the ratio of domestic investment to GDP observed for the i^{th} country at time t, S_{it} is the ratio of domestic savings to GDP and α_i denotes an individual fixed effect. The residual ε_{it} is assumed[2] to be i.i.d. $(0, \sigma_\varepsilon^2)$ (Fouquau et al. 2007).

Let us consider a PTR model:

$$I_{it} = \alpha_i + \beta_0 S_{it} + \beta_1 S_{it}\ g(q_{it}; c) + \epsilon_{it} \qquad (2)$$

where q_{it} denotes a threshold variable, c a threshold parameter and where the transition function $g(q_{it}; c)$ corresponds to the indicator function:

$$g(q_{it}; c) = \begin{cases} 1 & \text{if } q_{it} \geq c \\ 0 & \text{otherwise} \end{cases} \qquad (3)$$

With such a model, the FH coefficient is equal to β_0 if the threshold variable is smaller than c and is equal to $\beta_0 + \beta_1$ if the threshold variable is larger than c.

An ECM model helps us to study the short-run dynamics in the relationship between investment and its determinants. The error correction model enables us to reconcile the short-run behavior of investment with its long-run behavior (Jammeh, 2012). The ECM model is specified as:

$$\Delta \ln I_t = \alpha_0 + \alpha_1 \Delta \ln S_{t-i} + \alpha_2 \Delta \ln T_{t-i} + \Delta \ln I_{t-i} + \alpha_3 U_{t-1} + \in_t \qquad (4)$$

Where: $U_{t-1} = \ln I2_t - \beta_0 - \beta_1 \ln S_t - \beta_2 T_t$

Where $\alpha_3 U_{t-1}$ is the error correction term, it is the residual from the co integrating equation, α_3 is the error correction coefficient and α_i are the estimated short-run coefficients. The error correction coefficient works to push short-run investment disequilibrium back towards its long-run equilibrium and its shows the speed of this adjustment. The interest vested in the ECM model is the error correction coefficient and the stability test (Jammeh, 2012).

Econometric Estimation

The Augmented Dickey-Fuller (ADF) test of unit root shows that all the variables in the model are stationary at first difference. The econometrics result of the ADF test is presented in Table 1. These results show that the null hypothesis of unit root at level cannot be rejected for investment; savings and trade at 95 percent confidence level. The numbers of lags are included in the estimation in order to eliminate the possibility of autocorrelation in the error terms.

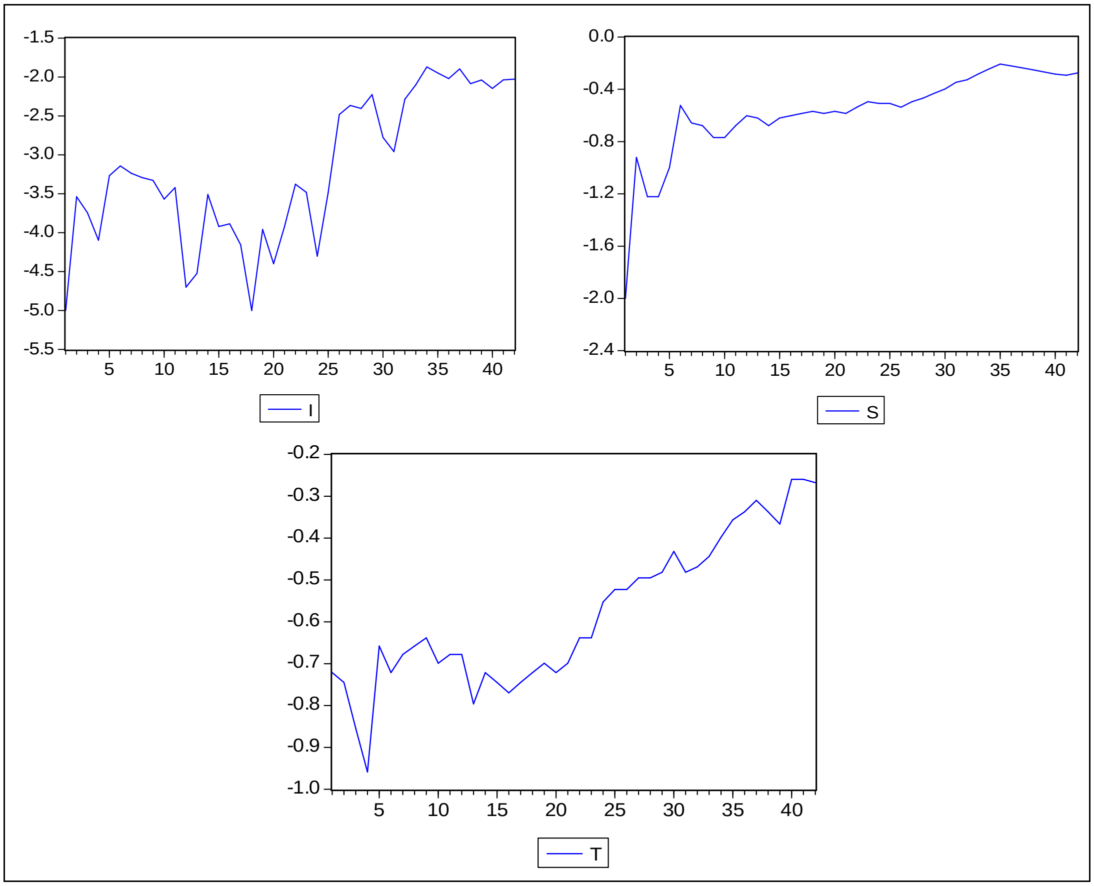
Table 1: Augmented Dicky Fuller (ADF) Unit Root Test

Variable	C (constant) and T (trend) in the equation	ADF statistics	Optimum lag
I	C & T	-6.980823	0
S	C & T	-13.67209	0
T	C & T	-7.431645	0

Source: Estimated

All the variables used in this paper have been plotted in order to have initial glue about the properties of the variables. Figure 1 shows a visual plot of all the variables.

Figure-1



Source: Estimated

Given that investment, savings and trade are stationary at their first differences, it has been proceeded to determine whether there is a long-run co integrating relationship among these variables. The trace statistics and the maximum Eigen value statistics revealed the existence of at least one co integrating vectors among investment, savings and trade. The result is shown in Table 2.

Table 2: Johansen Test for Co integration

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None *	0.389745	37.93027	28.89708	24.49392	20.14163
At most 1	0.294672	12.44634	14.49572	12.06948	13.27467
At most 2	0.009717	0.286859	2.842467	0.276859	2.941477

Source: Estimated

This signifies that there is a long-run relationship among investment, savings and trade in Bangladesh. As can be seen from the results obtained from the co integrating vector in Table 3, investment is negatively related to trade.

Table 3: Normalized Co integrating Vectors and the Corresponding Adjustment Coefficients

Variable	β Coefficients	α Coefficients	Standard error	t-value
I	1.000000	-0.189294	-	-
S	0.380443	0.029388	3.49255	-3.49002
T	-5.317839	0.025492	5.23525	3.13655
Constant	0.194182	-	-	-

Source: Estimated

Table 3 also shows the estimated adjusted coefficients (αs), which can be used to test for weak exogeneity. The adjustment coefficients contain weights with which co integrating vector(s) enter short-run dynamics. Given that this study finds one co integrating vectors, Table 3 presents the first column of α matrix. These coefficients measure the speed of the short-run response to disequilibrium occurring in the system. Therefore, these results indicate that savings and trade are weakly exogenous with respect to investment.

Attention is now directed on the discussion of the long-run coefficients. The estimated co integrating vector is presented below.

$$I_{it} = 1.00 + 0.38S_{it} - 5.32S_{it}\, g\,(q_{it}\,;\, c\,) \qquad + 0.19........ \qquad (5)$$

As seen from equation (5), there is positive coefficients for Savings-GDP ratio(S) and negative association for Trade-GDP ratio (T). But there exists a positive coefficient for Investment –GDP Ratio (I). So there is positive association between investment – savings and negative association between investment – trade. So if domestic investment goes up, domestic savings goes up and if investment goes up, trade goes down.

The ECM Stability test was also used to find out if investment function is stable in Bangladesh during the period 1972-2015. As shown in Table 4, the stability test shows that the relationship among investment, savings were not stable in Bangladesh during the period 1972-2015.

Table 4: Error Correction Representation

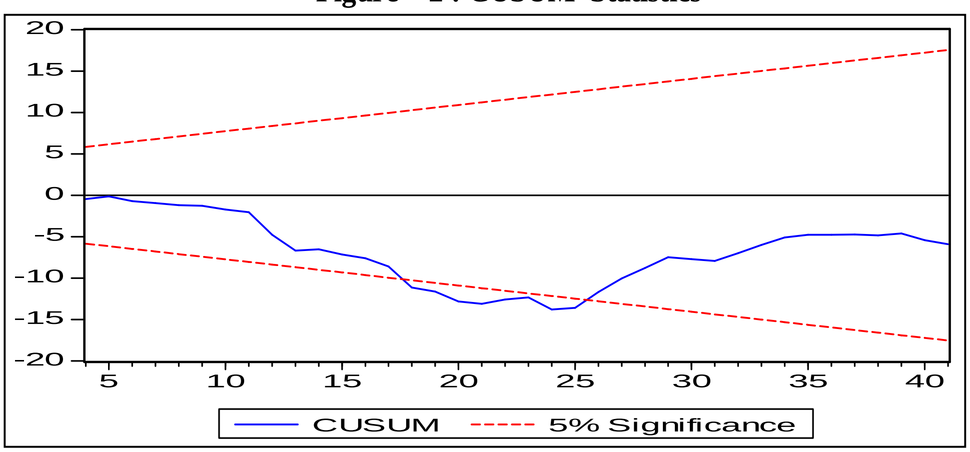
Variables	Coefficients	t-values	Standard error
Constant	0.086735	1.07142	0.08783
D(I(-1))	-0.120473	-1.27382	0.18562
D(I(-2))	-0.246361	-1.99827	0.16403
D(S(-1))	0.312489	3.07243	0.16123
D(S(-2))	-0.038033	-1.04528	0.03554
D(T(-1))	-0.512545	-2.96172	0.18487
D(T(-2))	-0.290387	-1.88452	0.10927
	D(I)	D(S)	D(T)
R-squared	0.184792	0.914596	0.372883
Adj. R-squared	0.006799	0.880301	0.347544
Akaike AIC	1.573065	-2.178072	-1.913008
Schwarz SC	1.018710	-1.953426	-1.569355
F-statistic	1.040727	17.80676	2.793476

Source: Estimated

All the parameter estimates are appropriately signed. The R^2 values indicate a relative good fit for the data set. The calculated F-statistics are statistically significant at 5% level indicating that the explanatory variables are jointly significant in explaining investment dynamics in Bangladesh. The estimated error correction terms suggest the validity of run equilibrium relationship among the variables. The estimated coefficient values suggest that the system corrects its previous period disequilibrium in a year which can be considered a moderate speed of adjustments.

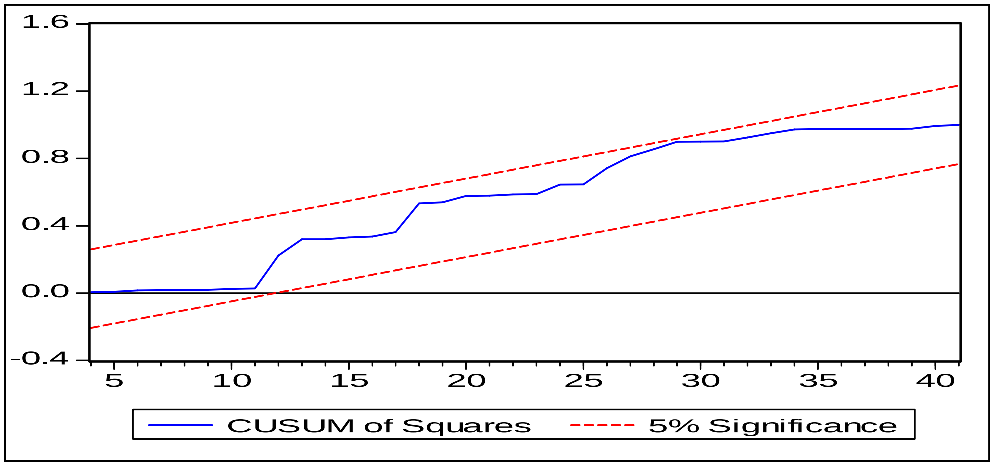
Since we are particularly interested in whether the estimations achieved are stable over time and therefore useful for forecasting purpose, we proceed with CUSUM and CUSUMQ tests. The results of the test statistics for evaluating the co integration vector stability are presented in the figure 2 and 3.

Figure – 2 : CUSUM Statistics



Source: Estimated

Figure – 3 : CUSUMQ Statistics



Source: Estimated

The graph 2 clearly shows that the investment function is not stable. If all the coefficient of ECM were stable, the CUSUM and CUSUMSQ plots will be under 5 percent critical bounds, but as graphs shown, the plot of CUSUM crossed the bounds and therefore indicates the instability of the model.

Findings

Table 2 and 3 revealed that there at least one co integrated equation exists in the model or in the system. From **t**able 3, we can see that an equation (5) is retrieved by the normalized vector where positive association between investment – savings and negative association between investments – trade exist. So if domestic investment goes up, domestic savings goes up and if investment goes up, trade goes down. Also, the results of the Johansen co integration test among investment, savings and trade indicate that there exists long run relationship among investment, savings, and trade for Bangladesh. Eventually we can say that Feldstein-Horioka Puzzle does not hold for Bangladesh.

The results from ECM show that speed of adjustment in investment function is moderate in Bangladesh. The absolute value of adjustment coefficient of error correction term shows that the disequilibrium adjusted in investment function by short run adjustment within a year.

The plot of CUSUM crossed the bounds and therefore indicates the instability of the model. The instability of investment function implies that savings is not purely an investment phenomenon in Bangladesh in the long run.

Conclusions & Suggestions

This paper examined the empirical analysis of dynamic relationship among saving, trade investment for Bangladesh over the period 1972–2015 by employing the Panel Smooth Threshold Regression Model (PSTR) and Johansen Long Run Co integrating Equation. The results revealed the evidence of a long-run relationship among saving, trade and investment. This result is consistent with a number of earlier studies in the literature that found saving and investment to be co integrated in the long run. The result doesn't support the Feldstein-Horioka (1980) hypothesis meaning that the capital account of Bangladesh is not convertible. Also, the study showed a negative and significant error correction term which implies the adjustment process to restore equilibrium is very moderate. It is widely acknowledged in the literature that international capital mobility is paramount in the allocation of resources to their best use (Fouquau et al. 2007). Therefore, this study recommends that if the current account gap is kept within the reasonable limits and the investment is highly productive or export oriented, then the current account deficit presents no problem. If a country is a net debtor, then economy must run trade surpluses in the future with a present discounted value equal to the initial net debt.

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