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Responses of Domestic Investment to a change in Real Exchange Rate in Case of Bangladesh

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Abstract

Private sector in Bangladesh along with government plays a prominent role in economic development through production, investment and export. The purpose of this paper is to investigate the response of private domestic investment to a change of real exchange rate. Here, it is considered whether investment responds differently to real depreciations versus real appreciations. In this paper The Johansen Co-integration likelihood approach and VECM were employed to examine the long run relationship and to detect the short-run and long-run causality among the variables (Domestic investment, Real Exchange rate and real income) using annual data over 1976 to 2015. The result shows that the domestic investment is positively affected by real income and real exchange rate which is statistically significant. Result of VECM shows that domestic investment and real income reaches in equilibrium after 12.5 years and 33.33 years respectively where exchange rate is already in equilibrium. Moreover there is long-run causality among the variables and short-run causality running from real income to domestic investment but no short run causality from exchange rate to domestic investment.

Keywords: Domestic investment, Exchange rate, Real income, Responses Johansen Co - integration, VECM.

JEL Classification: A10, E62, F31, G11

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1. Introduction

Private investment is treated as the driving force for economic development and growth. In FY2017-18, the total investment of GDP was 31.23 percent, out of which 23.26 percent was from private sector. In FY2016-17 a total of 1,745 private projects were registered in Bangladesh Investment Development Authority (BIDA) with a recommended amount of Tk.18, 52,618 million, which stood at Tk.20,72,925 million in FY2017-18 for 1,643 projects. In order to attract the private sector investment both from local and foreign investors, the government has taken different effective initiatives like construction of infrastructure facilities, endurance of uninterrupted supply of electricity, development of congenial environment for private investment, tax holiday, tax exemption etc. (BER 2017-18).

Private domestic investment may be affected by many factors (like GDP, inflation, savings, research, infrastructure, political stability, exchange rate etc) among those real exchange rate and real income are the two factors. Exchange rate is the rate at which one currency is exchanged to another currency i.e. it is the domestic price of a unit of foreign currency. Exchange rate can be real and nominal. When the influence of inflation is not considered then it is real exchange rate and when the influence of inflation is considered then it is nominal exchange rate (Uddin et al 2004). There are different exchange rate regimes. Bangladesh is an emerging country of the South Asian region that has been floated its exchange rate for taka with effect from 31 May 2003. Before that there were various types of pegged exchange rage regimes. Under floating exchange rate system, exchange rate is determined by the demand for and supply of respective currencies in the market. Now banks are free to set their own rates for interbank and customer transactions. After the genesis of floating regime, the scenario of exchange rate in Bangladesh experienced a depreciation of domestic currency (Mamun et al 2013).

Table-1: BD: Official Exchange Rate (OER): Average: per USD

Year	OER	Year	OER	Year	OER	Year	OER
2006	68.933	2009	69.039	2012	81.863	2015	77.947
2007	68.875	2010	69.649	2013	78.103	2016	78.468
2008	68.598	2011	74.152	2014	77.641	2017	80.438

Source: Ceicdata.com / World Bank

Currency depreciation or appreciation has countervailing impact on investment. It is expected that domestic investment will increase when currency depreciates since export become relatively cheap and raises the domestic and foreign demand. It leads to a sound economic environment. When the domestic currency depreciates, the marginal profit of investing an additional unit of capital is also likely to increase, because there are higher revenues from both domestic and foreign sales. Real depreciation could have a positive or negative impact on domestic investment, depending if more forms in a country are export oriented or import oriented. Clearly, a real depreciation that makes exports more attractive will boost exports and through multiplier effects it will also boost real income and eventually domestic investment. On the other hand, a real depreciation that raises the cost of imported inputs will hurt profit margins and discourage investment by firms that rely heavily on imported inputs, though this effect could be tempered due to slow adjustment of wages to inflationary effects of depreciation. If wages do not keep up with inflationary effects of depreciation, income and profits are redistributed from workers to producers (Bahmani-Oskooee and Hajilee, 2018). However investment is often modeled as the following function

$$I = f(Y, r)$$

Where I= investment, Y= income and r = interest rate

Investment is negatively related to interest rate because of the cost of acquiring funds with which to buy investment goods and positively related to income as higher income signals greater opportunities to sell the goods that physical capital can produce (https://en.wikipedia.org/wiki).

Therefore the main objective of this study is to:

(i) Examine whether there is any long run relationship among the examined variables (domestic private investment, real exchange rate and real income)

(ii) Examine whether there is any causal relationship among the examined variables.

(iii) Examine the short-run and long-run dynamics among the variables.

This study contributes to the existing literature by conducting an analysis of the effects of real exchange rate and real income on the private domestic investment of Bangladesh for the period 1976 to 2015. The next section considers the review of existing literature both inside and outside the country on this area. Third section focuses on data and methodology that are used in this paper. Fourth section deals with the discussion of the

results and fifth section presents the conclusion, limitation and recommendation of this study.

2. Theoretical Background

From Keynesian era investment has achieved more importance as it affects economic growth of a country. Among many investment theories, according to the Accelerator Theory of Investment, if either demand or income increases then investment expenditure also raises (Knox, 1952).

When firms expect demand for their products to rise then they want a large capital stock. As investment is the flow into this capital stock, it will respond to changes in this expected demand for output. So accelerator models are built upon the insight that investment will be determined by output growth (Baddeley, 2003). The Flexible Accelerator Theory or Lags in Investment states that there are lags in the adjustment process between the level of output and the level of capital stock. The neoclassical flexible accelerator model proposed by Jorgenson (1967) associates the user cost of capital (interest rate, depreciation and price of capital goods), where the firm boosts its market value by adapting its capital stock up to an equilibrium point of the market interest rate and marginal value product of capital, and the accelerator effect to elucidate investment performance. Tobin's *q* theory, (Tobin, 1969) is also a familiar model of investment which asserts that investment will be beneficial until the firm's value in the stock market is larger than the charge of acquiring the firm in the product market. From these models, it can expect that national income affects investment. Bahmani-Oskooee (2016) tried to incorporate exchange rate which is expected to have relationship with investment to understand the large import content of intermediate and capital goods. In the short run and long run, it is expected that real depreciation positively affect investment in case of high import content of capital goods and the traded goods sector respectively (Sioum, 2002).

3. Literature Review

Chowdhury (1993) choosing G-7 countries over the period 1973 to 1990 and employing a multivariate error-correction model, the study simplified that exchange rate volatility had negative significant effect on the volume of exports in G-7 countries.

Jayaraman (1996) wanted to find the major factors that affect the private investment in six South Pacific Developing member Countries (SPDMCs) and informed that real exchange rate instability had adverse impact on private investment.
Soleymani & Akbari (2011) adopted GARCH (1,1) approach to calculate the uncertainty of exchange rate for fifteen Sub-Saharan African countries. The estimated result suggested that there was a negative link between exchange rate uncertainty and investment as well as the share of investment from growth of GDP was very small in those countries.

Kogid et al. (2012) utilized ARDL bounds test and ECM based ARDL approach to depict the impact of exchange rate on the economic growth. Study referred that both nominal and real exchange rate had positive impact on economic growth of Malaysia but only real exchange rate had significant impact.

Mamun et al. (2013) used (OLS) method to explore the effect of depreciation on domestic output growth and price level and the study expressed that depreciation had an expansionary impact on output level and price level. Covering 36 countries Bahmani-Oskooee & Hajilee (2013) traced that real exchange rate volatility had significant impact on domestic investment in 27 countries out of 36 in short run. Exchange rate uncertainty raised the domestic investment in 14 countries while decreased domestic investment in 13 countries.

Zardashty (2014) used GARCH models on time series data 1961-2008 to identify the uncertainty in exchange rate. Then result indicated that the real exchange rate uncertainty had a negative significant impact on private investment to GDP ratio, besides this import of capital commodity and inflation had also negative impact on private investment to GDP ratio in Iran. Uddin et al. (2014) investigated a positive significant correlation between exchange rate and economic growth which was supported by the long run equilibrium relationship between exchange rate and economic growth and there was a bi-directional causality between the two variables (exchange rate and economic growth) over the period 1973 to 2013. Yusoff & Febrina (2014) analyzed the short run and long run relationship among the variables like economic growth, domestic investment, real exchange rate (RER) and trade openness and found that all the variables had positive

impact on the economic growth of Indonesia. Trade openness and gross domestic investment both led economic growth unidirectionally. From variance decomposition trade openness and RER found important while domestic investment identified as unimportant factor for explaining the variation in GDP. Mujahid & Zeb (2014) applying Granger Causality test on time series data 1980 to 2012 found a long run relationship between exchange rate and GDP and no causal relationship between the examined two variables in Pakistan.

Maepa (2015) conducted a study with the help of VAR multivariate Johansen Co-integration and Granger Causality approach to illustrate the relationship between the exchange rate and various types of investments in South Africa. In short run, there was insignificant relationship between the exchange rate and various types of investments and in long run, there was negative long run relationship between these.

Cambazoglu & Günes (2016) using ARDL model to data from January, 2007 to January, 2015 the researchers found that there were a cointegration relationship between the exchange rate level and FDI inflows in Turkey in query of exchange rate fluctuations and private domestic investment. Oniore et al. (2016) from Nigeria mentioned that, the depreciation of the currency and interest rate did not promote private domestic investment activities. While private domestic investment was positively affected by infrastructures, government size (proxied by the ratio of government spending to Gross Domestic Product) and inflation rate.

Canbaloglu & Gurgun (2017) selecting 25 emerging markets and developing economies (EMDEs) the researchers referred that the exchange rate uncertainty and economic growth had positive significant effect on domestic investment while the impact of global financial crisis and real exchange rate had negative impact on domestic investment. Utilizing annual data from 1980 to 2015 NjindanIyke & Ho (2017) explained that exchange rate uncertainty had differential effects on domestic investment in the short run. In short run current level of uncertainty promoted investment and previous levels of uncertainty vagued investment. Where in the long run, exchange rate uncertainty had a positive effect on domestic investment

Segun & Adedayo (2018) explored that exchange rate had positive significant impact on the industrial output of Nigerian economy during the time 1986 to 2016. Selecting seven

SARRC countries and collecting panel data over the time 1995 to 2016 Latief & Lefen (2018) traced that exchange rate volatility had negative significant that is adverse impact on international trade and FDI inflows in One Belt and One Road associated countries. Ruzima & Boachie (2018) applied ARCH based measure to get exchange rate volatility and related cross-country (BRICS) data for 1997 to 2015 and concluded that exchange rate volatility had a negative impact on private investment as confirmed by both random and fixed effects as well as GMM estimations.
Considering six emerging markets over 1980 to 2014, Bahmani-Oskooee et al.(2018) revealed that the effect of exchange rate on domestic investment is ambiguous and country specific.

Kilicarslan (2018) from Turkey counted the real effective exchange rate volatility with the help of GARCH model and concluded that increase in domestic investment, money supply and trade openness raises the real effective exchange rate volatility where increase in FDI, output and government expenditures decreases the real effective exchange rate volatility using FMOLS method

Adekunle et al. (2019) approaching with (ARDL) Model the researchers disclosed that FDI had positive significant impact on domestic investment where exchange rate and energy infrastructure had a positive but insignificant impact on domestic investment. Reviewing the existing literature we find the gap of conducting this study in as there are few studies in this area in Bangladesh.

4. Data and Methodology

In this study the annual data on Private Investment, Real income and Exchange rate in Bangladesh has been taken for the period 1976 to 2015. The main source of data is the data bank of the World Development Indicator published by the World Bank. In this paper, the dependent variable is private real domestic Investment which is measured by gross capital formation in real terms. The independent variables consist of real income, Y which is measured by real GDP, and the real exchange rate, REX (where an increase in exchange rate indicates currency depreciation and vice-versa). All the data are expressed in logarithms in order to include the proliferate effect of time series.

4.1 Unit root test

To check the stationary criteria of the selected time series data, this paper investigates unit root test (Augmented Dickey Fuller, Phillips-Perron test and KPSS test). Unit root tests used to detect that either any variable -the private investment, I (as a dependent variable) and real income, exchange rate (as independent variables) are integrated or have any causal relationship. Usually time series analyses consider stationary time series in empirical studies. A series is said to be stationary if mean and auto-covariance of the series do not depend on time. In order to examine whether each variable in the time series is integrated and has a unit root, this study has considered the widely used popular unit root test ADF and PP. Both of this tests use the null hypothesis that the series does contain a unit root (non-stationary variable) against a stationary variable in the alternative hypothesis while KPSS test uses the null hypothesis that the series does not contain a unit root (stationary variable) against a non-stationary variable in the alternative hypothesis. If the computed value of the F-statistic exceeds the critical values that are tabulated by Dickey-Fuller (1981) then the null hypothesis is rejected, it means the series is stationary. If the computed F-statistic falls below the critical values, the null hypothesis is not rejected; it means the series is non-stationary (Gujarati 2012) and the opposite situation is applicable for KPSS test. The test is based on the following regression equation.

$$\Delta Y_t = \beta_1 + \beta_2 + \alpha Y_{t-1} + \Omega i \sum^{m}_{i=1} \Delta Y_{t-1} + u_i \ldots\ldots\ldots\ldots\ldots (1)$$

Where, $\Delta Y_t = Y_t - Y_{t-1}$ and Y is the variable under consideration, m is the number of lags in the dependent variable and u_i is the stochastic error term. The null hypothesis of a unit root implies that the coefficient of Y_{t-1} is zero.

4.2 Co-integration test:

For testing the co-integration, Engle–Granger (EG) or Augmented Engle–Granger (AEG) Test is used. In first step how the variables are co-integrated is shown & second step Ordinary Least Square (OLS) is calculating the residuals. Variables such as LnI (Natural Log of investment), LnY (Natural Log of real income), LnECH (Natural Log of Exchange rate) are co-integrated if they are integrated in the similar order. To verify co-integrated relationship among the variables, Johansen Co-integration test (Johansen, 1988; Johansen and Juselius, 1990) unlike the Engle –Granger has been performed only on integrated of order one, i.e. Johansen and Juselius (1990) specify two likelihood ratio test statistics to

test for the number of co-integrating vectors. Critical values for both test statistics are tabulated by Johansen and Juselius (1990).

Both two test (max& trace) possess nonstandard distribution under the null hypothesis that provide nearly resembling critical values for the statistic exhibit Monte Carlo methods. The alternative hypothesis of trace test requires that the co-integrating vector is either equal or less than r+1, whereas r+1 are hold for the maximum Eigen value test. For carrying out Johansen, Investment is replaced to lnI, real income to lnY and exchange rate to lnECH.

4.3 Vector Error Correction Model (VECM): If non-stationary time series is integrated of order I(1) and found to be cointegrated we can proceed with VECM to examine the short-run and long-run dynamics of the series. Conventional ECM for cointegrated series is given below:

$$\Delta y_t = \beta_0 + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \sum_{i=1}^{k} \delta_{1,} \Delta x_{t-i} + \Phi Z_{t-1} + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Z is the ECT and is the OLS residual from the following long-run cointegrating regress:

$Y_t = \beta_0 + \beta_1 X_t + \varepsilon_t$……(3)

and is defined as $Z_{t-1} = ECT_{t-1} = y_{t-1} - \beta_0 - \beta_1 X_{t-1}$ ……..(4)

The coefficient of ECT Φ is the speed of adjustment because it measures the speed at which y returns to equilibrium after a change in x.

4.4 Econometric Model:

The study specifies the following econometric model:

Domestic Investment $= \beta_0 + \beta_1$ real income $+ \beta_2$ real exchange rate $+ \varepsilon_i$ …….(5)

Where ε_i = error term which represent the variables that affect private domestic investment but are not taken into consideration.

5. Result Discussion

According to the methodology mentioned above, sets of data are examined & empirical results are presented in this section. All variables are tested for the unit root to find out whether they are stationary or non-stationary. Here test is applied in series in level and first differences with lag parameter determined by Akaike information criterion. The

results are obtained by using econometric software EViews version 7 and are reported in following table.

Unit root test (ADF, PP, KPSS) for lnPrivate Investment, lnIncome, lnExchangerate: Here the following table represents the results of unit root test among the variables

Table-2: Unit root test (ADF) intercept & trend with intercept presented below

Variables	**Augmented Dickey Fuller (Intercept)**		**Augmented Dickey Fuller (Trend and Intercept)**	
	Level	1st Diff.	Level	1st Diff.
LnInvestment	-2.787548	-5.544863***	-2.924868	-4.080556***
LnIncome	4.506631	-4.914243***	0.464947	-8.407136***
LnExchange rate	-4.527940	-9.471096***	-4.561393	9.365945***
Notes: ***, ** and * indicate rejection of the null (variables are unit root/ non stationary) at the 1%, 5% and 10% level respectively.				

Table -3: Unit root test (PP and KPSS) intercept & trend with intercept

Variable	**Intercept**		**Trend and intercept**	
	PP	**KPSS**	**PP**	**KPSS**
	1st difference	**1st difference**	**1st difference**	**1st difference**
LnInvestment	0.0000	0.201028	0.0006	0.132874
L Income	0.0001	0.631832	0.0000	0.114730
L Exchange rate	0.0000	0.460445	0.0000	0.486842

The results of unit root test are presented in table(1) and in table (2) (AD, PP and KPSS) indicate that, at first differences of the variables Private Investment (LnI), Real Income (Ln Y), Exchange Rate (LnECH) are statistically significant at 1% significance level I(1). All the data are stationary at their first difference. With estimates the value with trend (trend + intercept) & without trend (intercept) both are stationary in the first differences but not in level. From the point of view of the entire test, first difference is accepted for all the variables (lnI, lnY, lnexchange rate).

5.1 Co-integration test

Johansen co-integration test is used to estimate the long-run relationship among the Private Investment, Real income & Real Exchange rate. For co-integration test we use lnI, lnY and lnECH. The Johansen test statistics show rejection for the null hypothesis of no co-integrating vectors under both the trace and maximal eigen-value forms of the test. For the trace test or max eigen-value test, the null of no co-integrating vectors is rejected if the trace statistic or max statistic is greater than the 5% critical value.

Table-4: Unrestricted Johansen Co -integration Rank Test (Trace and Max-Eigen)

Maximum Rank	Eigen Value	Trace Statistic	Critical Value	Max-Eigen statistic	Critical Value
None*	0.608209	59.16848	29.79707	36.54401	21.13162
At most 1*	0.331042	22.62448	15.49471	15.67932	14.26460
At most 2*	0.163125	6.945164	3.841466	6.945164	3.841466
* denotes rejection of the hypothesis at the 0.05 level					

For trace test the null of no co-integrating vectors is rejected since the trace statistic of 59.16848 is greater than the 5% critical value of 29.79707. Moving next test to the null of at most 1 co-integrating vectors, the trace statistic is 22.62448 while the 5% critical value is 15.49471, so the null hypothesis of the existence of at most 1 co-integrating vectors is rejected at 5%. Moving on to test the null of at most 2 co-integrating vectors, the trace statistic is 6.945164, while the 5% critical value is 3.841466, so the null hypothesis is rejected at 5%. Finally, from trace statistic the above results indicate the existence of at least three co-integrating equation among the variables in the series. Similarly, the max-Eigen value test results also indicate the existence of at least three co-integrating equations among the variables in the series at 0.05 levels.

Table-5: The values of the normalized co-integrating coefficients

Long-run impact of Ln private Investment, Real income and Exchange rate of Bangladesh (1976 – 2015)			
Variables	**Normalized Co-integrating Coefficient**	**Standard Error**	**T-Stat**
LnI(Private investment)	1.000000		
LnY(real income)	-2.397565	(0.13346)	-17.96467**
LnREX(real exchange rate)	- 0.227548	(0.07526)	-3.02349**

The values of the normalized co-integrating coefficients indicate that in the long run real private investment is positively related with real income and real exchange rate. Here, the outcome demonstrates that when exchange rate enhances (real depreciation for local currency) by 1% private investment will increase by 0.22% and if real income increases by 1% then private investment increases by 2.39% which are statistically significant.

5.2 Vector Error Correction Model (VECM):

VECM is constructed only if the variables are cointegrated and it is formed to examine long run and short run dynamics of the cointegrated series. Here in presence of cointegration, we can apply VECM to examine the causality between the examined variables. Estimated VECM with LNINV as target variable

$\Delta LNINV_t = -0.084678\ ect_{t-1} + 0.358754\ \Delta LNINV_{t-1} + 0.195345\ \Delta LNINV_{t-2} - 1.384618\ \Delta LNGDP_{t-1} - 0.557381\ \Delta LNGDP_{t-2} - 0.010184\ \Delta LNEX_{t-1} - 0.012772\ \Delta LNEX_{t-2} + 0.125214$ ……..(6)

Table 6: VECM (Speed of Adjustment)

Cointegrating equations	Coint Eq1	SE	T-STAT
D(LNINV)	-0.084678	(0.03461)	[-2.44648]
D(LN_GDP)	-0.030433	(0.01326)	[-2.29530]
D(LNEX)	1.936662	(0.96407)	[2.00883]
C	25.90981		

The estimated error correction coefficient in above table indicates that about 8 percent error is corrected in each year for LNINV. So LNINV becomes in equilibrium after 12.5 years in case of any shock. About 3 percent deviation of the LNGDP from its long run equilibrium level is corrected each year and LNEX is in already equilibrium.

5.3 Granger Causality under VECM:

We already have run the VECM test to derive the long run and short run causality under VECM model, we use the system equation originated from the VECM result. This will help us to determine long run and short run causality.

Table 7: (Given in Annex-1): Estimating Long-run Causality

From table 6 we see the probability value is 0.0207 which is less than 0.05 critical value. As the probability value is significant and the coefficient sign is negative, so we can say that there is a long run causality running from LNGDP, LNEX to LNINV. That is independent variables have an influence on dependent variables which means that income and exchange rate have influence on domestic investment in the long run. Now we want to check whether there is short run causality or not. For this to check we will proceed with Wald Test Statistics and we have the following null hypothesis:

1. Null: there is no short run causality running from LN GDP TO LN INV [(i.e. C(4)= c(5) =0]
2. Null: there is no short run causality running from LNEX to LNINV [(i.e. C(6)=c(7)=0]

Table 8: Estimating Short Run Causality Wald Test Result

Null Hypothesis	df	F statistic	Chi-square	Prob.	Decision
C(4)= c(5) =0	(2, 29)	3.398635	6.797269	0.0334	Causality from LNGDP TO LNINV
C(6)=c(7)=0	(2, 29)	2.226806	4.453612	0.1079	No causality from LNEX TO LNINV

Note: Normalized Restriction (=0). Restrictions are linear in coefficients.

The above table reveals that there is short run causality running from LNGDP to LNINV but no short-run causality running from LNEX to LNINV

6. Conclusion

The paper tried to investigate whether there is a link between investment and exchange rate in Bangladesh. In this study theoretical and empirical literature was assessed. Annual time series data for the period 1976-2015 was used for the purpose of running the analysis. It is known that when Currency depreciates, export as well as local output through multiplier effects increases. As a result to meet up the higher local and foreign demand firms accelerate their investment. On the contrary, the firms, which depend largely on imported inputs, reduce their investment on account of high cost of production. Here, the outcome demonstrates that when exchange rate enhances (real depreciation for local currency) by 1% private investment will increase by 0.22% and if real income increases by 1% then private investment increases by 2.39% which are statistically significant. Result of VECM shows that domestic investment and real income reaches in equilibrium after 12.5 years and 33.33 years respectively where real exchange rate is already in equilibrium. Furthermore there is long-run Causality among the variables and short-run causality running from real income to domestic investment but no causality from exchange rate to domestic investment in short-run. So, it can be stated that if exchange rate increases (real depreciation for local currency) private investment of the export oriented firms will improve. Thus it is necessary for the firms to become export oriented & depend on domestic inputs. Here, we focused on the effect of real exchange rate only on the private investment. But the foreign investment is also affected by exchange rate. Besides real exchange rate, interest rate and other variables also have effect on investment. In this paper, we use gross capital formation to represent investment. According to World Bank (2017), the quality of data of gross capital formation depends on the accounting system of government. But the government accounting system of developing countries has a tendency to be feeble.

Above all, here we tried to represent the original relationship between the real exchange rate and domestic private investment of Bangladesh as its economic growth largely influenced by private investment and exchange rate.

As Bangladesh is trying to graduate towards developing country status, it is urgent to increase investment both in home and abroad. Fiscal policy affects private investment through budgetary imbalance (Jayaraman1996).If it is possible to increase the investment then both employments and output will increase which lead to increase economic growth. So it is necessary to give proper attention on fiscal policy and stabilize the exchange rate as it affects domestic investment, increase the incentives and propose more policies to decrease production cost. The banking sectors are also need to keep stable to ensure free flow of capital to raise investment.

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Annex-1

Table 6: Estimating Long-run Causality

Dependent Variable: D(LNINV)
Method: Least Squares (Gauss-Newton / Marquardt steps)
Sample (adjusted): 1979 2015
Included observations: 37 after adjustments
D(LNINV) = C(1)*(LNINV(-1) - 1.95147563619*LN_GDP(-1) - 0.20689769656*LNEX(-1) + 25.9098116178) + C(2)*D(LNINV(-1)) + C(3)*D(LNINV(-2)) + C(4)*D(LN_GDP(-1)) + C(5)*D(LN_GDP(-2)) + C(6)*D(LNEX(-1)) + C(7)*D(LNEX(-2)) + C(8)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.084678	0.034612	-2.446481	0.0207
C(2)	0.358754	0.167403	2.143054	0.0406
C(3)	0.195345	0.148307	1.317166	0.1981
C(4)	-1.384618	0.532339	-2.601010	0.0145
C(5)	-0.557381	0.513368	-1.085733	0.2865
C(6)	-0.010184	0.007002	-1.454463	0.1566
C(7)	-0.012772	0.006142	-2.079571	0.0465
C(8)	0.125214	0.037722	3.319396	0.0024

R-squared	0.366261	Mean dependent var	0.081008
Adjusted R-squared	0.213290	S.D. dependent var	0.034046
S.E. of regression	0.030197	Akaike info criterion	-3.973318
Sum squared resid	0.026444	Schwarz criterion	-3.625011
Log likelihood	81.50638	Hannan-Quinn criter.	-3.850524
F-statistic	2.394313	Durbin-Watson stat	2.148784
Prob(F-statistic)	0.046139		