Public Investment and Economic Growth in Bangladesh: A Time Series Approach

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Abstract
This paper attempts to examine the causal relationship between public investment and economic growth in Bangladesh from 1972/73 to 2013/14. Cointegration analysis indicates a long-run relationship between the two variables. A unidirectional causality from public investment to growth is found on the basis of Error Correction Model (ECM). The main result of the study is that public investment invariably leads to economic growth. As a policy suggestion, efficient management of public investment should be conducive to higher productive capacity which will lead to higher growth in Bangladesh.
Keywords: Public Investment, Economic Growth, Cointegration, Error Correction Model, Bangladesh.

1. Introduction
There is considerable debate on the relationship between public investment and economic growth of a country. Investment in public infrastructure is widely recognized as an essential component of economic growth in developed as well as in developing countries. It can be an important factor in identifying the growth rates of different countries as changes in investment spending leads to a rise in output growth rate.

A number of studies have been carried out in identifying the relationship between public investment and economic growth. Munnell (1992) identified public infrastructure investment to have a positive and significant impact on output and growth for the US economy. Ramirez and Nazmi (2003) analyzed the impact of public investment on economic growth for nine Latin American nations over the period 1983-93. Public investment was found to significantly contribute to economic growth. Moreover, public investment expenditures were also found to crowd out private investment spending. Swaby (2007) uncovered the relationship between public investment and growth in Jamaica through VECM (Vector Error Correction Model). Public investment was found to have a positive effect on GDP. Besides public investment crowded out net private investment. Bukhari *et al*. (2007) attempted to study the interactions between public capital and economic growth on the basis of 1971–2000 heterogeneous dynamic panel data from Korea, Singapore, and Taiwan. The analysis suggested that both public and private investment had a long-term dynamic impact on economic growth in all the countries. The pair-wise analysis showed bidirectional causality between public investment and economic growth. Shahbaz, *et al*. (2008) attempted to identify the determinants of economic growth in Pakistan. Domestic investment activities were found to create employment opportunities which led to an improvement in economic growth. Phetsavong and Ichihashi (2012) analyzed the interrelationship of public investment, FDI, and private domestic investment of 15 developing countries in Asia using panel data during 1984–2009. The empirical results indicated private domestic investment to have a major role towards economic growth whereas public investment reduced the positive effect of FDI and private domestic investment on economic growth. Watanabe (2013) showed economic growth to be promoted with an increase in minimum wage and the ratio of public investment to tax revenue. Juarez and Almada (2016) used panel data and the generalized method of moments for 32 Mexican states from 1993 to 2012 to find out whether the growing public debt of state governments increased public investment which in turn led to higher growth. Public debt was found to be positively correlated with public investment and generated economic growth.

On the other hand, a few studies found diversified results concerning the association between public investment and economic growth. Ghani and Din (2006) explored the role of public investment, private investment and public consumption in the context of Pakistan's economy. The results showed an insignificant effect of public investment and public consumption on economic growth. Fatima (2012) attempted to find out the joint impact of public and private investment on economic growth of Pakistan during 1975- 2010 on the basis of cointegration and error correction model. Private investment was found to have positive and significant impact on economic growth in the long run whereas it had positive but insignificant impact on economic growth in the short run. On the other hand, public investment had positive and significant impact on economic growth both in the short as well as in the long run. Imane (2013) analyzed the relationship between public, private investment and economic growth in Algeria during 1990–2012 on the basis of a Vector Autoregressive model (VAR). The empirical results showed that in the short term economic growth is not determined by public and private investments whereas in the long run public investment positively affects economic growth.

Haque (2012) analyzed the impact of public and private investment on economic growth in Bangladesh on the basis of the Cobb-Douglas production function from 1972/73 to 20110/11. Public and private investments were found to have a positive impact on economic growth both in the short as well as in the long run. Private investment was also found to be more effective than public investment in the long run. Uddin and Aziz (2014) explored the role on public investment on economic growth in Bangladesh during 1973-2011. The results indicated a positive impact of public investment on economic growth.

The objective of this paper is to re-investigate the causal relationship between public investment and economic growth in Bangladesh. The study relies on Cointegration and Error Correction Model (ECM) to look into the causal relationship by taking care of the stochastic properties of the variables. The rest of the paper is organized as follows. Section 2 presents the data set. The methodology and empirical results are presented in sections 3 and 4 respectively. The final section contains the conclusions and policy recommendations.

2. Data

This study is based on annual data covering the period from 1972/73 to 2013/14. The data on public investment (*PI*) has been obtained from various issues of Statistical Yearbook of Bangladesh, published by the Bangladesh Bureau of Statistics (BBS). Economic growth (*EG*) refers to the changes in real GDP. Real GDP is obtained by dividing GDP at current market price by the Consumer Price Index (CPI). Data on GDP and CPI (Base: 1995-96 =100) are gathered from different issues of Economic Trends, published by the Bangladesh Bank (BB). *PI* and GDP are expressed in terms of Taka (Domestic Currency of Bangladesh) in Crores[1]. Econometric estimations have been done using STATA 12.

3. Methodology

3.1 Testing for the Order of Integration

The stationarity property of univariate time series is tested on the basis of the Augmented Dickey-Fuller (ADF) (Dickey and Fuller, 1981) test. The ADF test is derived from the regression equation:

$$(1-L)X_t = \beta_0 + \beta_1 X_{t-1} + \beta_2 \sum_{i=1}^{m} (1-L)X_{t-i} + u_t \qquad (1)$$

where L is the lag operator and m is the number of lags on the dependent variable. The null hypothesis is that X is generated by a unit root process i.e. $\beta_1 = 0$. The ADF test statistic is calculated by dividing the estimate of β_1 by its standard error. If the calculated ADF test statistic is less than the critical value, the null hypothesis of a unit root can not be rejected and the series is said to be non-stationary. The order of integration of X is determined by conducting the ADF test on its first difference. The series will be integrated of order 1 if its first difference does not possess a unit root.

3.2 Testing for Cointegration

Cointegration implies the existence of a long-run or equilibrium relationship in economics. In the long-run, if two or more series move closely together, even though they are trended, the difference between them is constant. In such a case, it is possible for these series to show a long-run equilibrium relationship, as the difference between them is stationary (Hall and Henry, 1989). Time series should to be examined for cointegration which describes the long-run relationship among nonstationary time series. Two or more variables are said to be cointegrated if they are integrated of the same order. The Engle-Granger two-step method (Engle and Granger, 1987) is used for testing cointegration. The first step consists in identifying the order of integration of the variables included in the model. A series is said to be integrated of order n if it has to be differenced n times to become stationary. If the results of the first step indicate that the variables are integrated of same order, the next step is to estimate the long run relationship by OLS as follows:

$$Y_t = \alpha_0 + \alpha_1 X_t + \omega_t \qquad (2)$$

$$X_t = \alpha'_0 + \alpha'_1 Y_t + \omega'_t \qquad (3)$$

The residuals are retained from these regressions and the ADF test is applied to the residuals as follows:

$$(1-L)e_t = \mu e_{t-1} + \pi_i \sum_{i=1}^{s} (1-L)e_{t-i} + \upsilon_t$$

and test $H_0 : \mu = 0$ against $H_1 : \mu < 0$.

In other words, the null hypothesis of the cointegration test is that the series formed by the residuals of each cointegrating regressions are non-stationary.

The Cointegrating Regression Durbin-Watson (CRDW) test can also be applied to test for cointegration. The residuals (e_t) obtained from the cointegrating regression from equations (2) and (3) follow the first-order

[1] 1Crore = 10 Million.

autoregressive scheme:

$$e_t = \delta e_{t-1} + \varepsilon_t \qquad -1 < \delta < 1 \qquad (4)$$

where, δ is the first-order coefficient of autocorrelation and ε_t is a white noise error term. In CRDW, the Durbin-Watson statistic, d is obtained from the cointegrating regression. In detecting autocorrelation, the relationship between d and δ is $d \approx 2(1-\hat{\delta})$. The null hypothesis of unit root in the residuals implies that the estimated δ will be 1 which in turn makes d close to 0. Rejection of the null hypothesis implies that the residual series is stationary and the variables in the cointegrating regression are cointegrated (Gujarati, 2003).

3.3 Error Correction Model (ECM)

The standard Granger causality test (Granger, 1969) ignores the possible long run relationship even when there is cointegration between two variables. Besides, there may be disequilibrium in the short run. An error correction model (ECM) merges the long-run relationship with the short-run dynamics of the model in the presence of cointegrated variables. This approach calls for estimating the first difference of both the dependent and explanatory variable. Unidirectional or bidirectional Granger causality must exist in the presence of cointegration. Therefore, it is necessary to augment the standard Granger causality test as follows:

$$(1-L)Y_t = \gamma_0 + \varphi_0 \mu_{t-1} + \sum_{i=1}^{m} \sigma_i (1-L)Y_{t-i} + \sum_{j=1}^{n} \varsigma_j (1-L)X_{t-j} + v_t \qquad (5)$$

$$(1-L)X_t = \gamma_1 + \varphi_1 \eta_{t-1} + \sum_{i=1}^{m} \tau_i (1-L)X_{t-i} + \sum_{j=1}^{n} \upsilon_j (1-L)Y_{t-j} + w_t \qquad (6)$$

where L is the lag operator, Y is economic growth (*EG*), and X is public investment (*PI*), μ_{t-1} and η_{t-1} are the error correction terms which represents the lagged residuals from the cointegrating regressions, m and n are the lag lengths chosen by the Akaike Information Criterion (AIC) and v_t and w_t are the disturbance terms. Causality may be determined by estimating equations (5) and (6) by testing the null hypothesis that $\varsigma_j = \upsilon_j = 0$ for all j's against the alternative hypothesis that $\varsigma_j \neq 0$ and $\upsilon_j \neq 0$ for at least some j's.

X is said to Granger - cause Y not only if the coefficients ς_j 's are jointly significant but also if φ_0 is significant. Similarly, Y is said to Granger-cause X not only if υ_j 's are jointly significant but also if φ_1 is significant. If both ς_j and υ_j are significant then causality runs both way. Finally, X and Y are causally independent if ς_j and υ_j are not statistically different from zero.

4. Empirical Results

Results of the unit-root tests are reported in Table-1. The results indicate that at the levels public investment (*PI*) and economic growth (*EG*) are nonstationary. Therefore to achieve stationarity the variables must be first-differenced. The ADF statistics are only significant only for the first-differenced series. Thus, *PI*, and *EG* appear to be *I(1)*.

The results reported in Table-1 provide the basis for the test of cointegration i.e., conduct unit root test on the residuals obtained form the cointegrating regression. The ADF statistics for the cointegration tests are presented in Table-2. The results show that public investment and economic growth are cointegrated. The residuals of the cointegrating regressions are stationary indicating that deviations between public investment and economic growth reconcile together in the long-run. Based on the CRDW test, the computed d values are greater than the critical values. This in turn again implies that the residual from the cointegrating regressions are stationary i.e., public investment and economic growth are cointegrated. Therefore, it can be confirmed that there is stable long-run relationship between public investment and economic growth in Bangladesh. Given the cointegration of the two series, the direction of causality between the variables is determined through the error correction model outlined in equations (5) and (6).

Table-3 presents the estimated coefficients of the error correction terms and lagged values of the two series indicating the long-run and short-run effects respectively. The results show the existence of a significant relationship between public investment (*PI*) and economic growth (*EG*) as the estimated coefficient of the error correction term is significant at the 1 percent level with appropriate negative sign. If the two series is out of equilibrium, public investment will adjust to reduce the equilibrium error. The error correction term of -0.95

implies that 95 percent of the adjustment towards the long-run equilibrium relationship between public investment and economic growth for Bangladesh occurs within a year through changes in public investment. In addition, movements in public investment will lead to movements in economic growth in the short-run.

5. Conclusions

The main objective of this paper has been to examine the causal relationship between public investment and economic growth in Bangladesh over the period 1972/73 to 2013/14. In spite of both being nonstationary, an equilibrium relationship is found to hold between public investment and growth i.e, they are cointegrated. The analysis indicates a stable, long run relationship between the two variables. The ECM test also shows a unidirectional causality from public investment to economic growth. A positive impact of public investment on growth is observed which implies that public spending promotes economic development. Economic policies should create an appropriate environment favorable to fostering public investment. Besides, channeling funds to different projects should be based on meeting people's demand rather than being spent on extremely large projects that will not enhance the growth potential of the economy. Projects must be planned before implementation in such a way that in the long run resources are not wasted and the chosen projects are also not abandoned (Sevitenyi, 2012).

References

Bukhari, S. A. H. A. S., Ali, L. & Saddaqat, M. (2007). Public Investment and Economic Growth in the Three Little Dragons: Evidence from Heterogeneous Dynamic Panel Data. *International Journal of Business and Information*, 2 (1), 57-79.

Dickey, D. A. & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, 49, 1057-1072.

Engle, R. F. and Granger, C. W. (1987). Co-integration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55, 251-276.

Fatima, G. (2012). Joint Impact of Investment (Public and Private) On the Economic Growth of Pakistan: (Co-integration Approach). *International Journal of Humanities and Social Science*, 2(15), 171-176.

Ghani, E. & Din, M. (2006). The Impact of Public Investment on Economic Growth in Pakistan. *The Pakistan Development Review*, 45(1), 87-98.

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, 37, 424-436.

Gujarati, D. N. (2003). *Basic Econometrics*. (4th ed.). New York: McGraw-Hill.

Hall, S.G. and Henry, S.S.B. (1989). *Macroeconomic Modeling*. Amsterdam: Elsevier.

Haque, S. T. (2012). Effect of Public and Private Investment on Economic Growth in Bangladesh: An Econometric Analysis. [Online] Available: http://www.mof.gov.bd/en/budget/pathprosperity/chapter5.pdf (July 25, 2016).

Imane, Y. (2013). Public Investments And Economic Growth In Algeria: a VAR Approach. [Online] Available: http://eco.univ-setif.dz/seminars/Pub_Invstmnt/1-11.pdf (July 25, 2016).

Juarez, I. S. and Almada, R. G. (2016). Public Debt, Public Investment and Economic Growth in Mexico. [Online] Available: www.mdpi.com/2227-7072/4/2/6/pdf (July 25, 2016).

Munnell, A. H. (1992). Policy Watch, Infrastructure Investment and Economic Growth. *Journal of Economic Perspectives*, 6(4), 189-198.

Phetsavong, K. & Ichihashi, M. (2012). The Impact of Public and Private Investment on Economic Growth: Evidence from Developing Asian Countries. *IDEC Discussion Paper*, Graduate School for International Development Cooperation, Hiroshima University, 1-21.

Ramirez, M. D. & Nazmi, N. (2003). Public Investment and Economic Growth in Latin America: An Empirical Test. *Review of Development Economics*, 7(1), 115-126.

Sargan, J. D. & Bhargava, A. S. (1983). Testing Residuals from Least-Squares Regression for being Generated by the Gaussian Random Walk. *Econometrica*, 51, 153-174.

Sevitenyi, L. N. (2012). Government Expenditure and Economic Growth In Nigeria: An Empirical Investigation (1961-2009). *The Journal of Economic Analysis*, 3, 38-51.

Shahbaz, M., Ahmad, K. & Chaudhary, A. R. (2008). Economic Growth and Its Determinants in Pakistan. *The Pakistan Development Review*, 47(4), 471-486.

Swaby, R. (2007). Public Investment and Growth in Jamaica. [Online] Available: http://boj.org.jm/uploads/pdf/papers_pamphlets/papers_pamphlets_Public_Investment_and_Growth_in_Jamaica.pdf (July 25, 2016).

Uddin, M. M. & Aziz, M. S. I. (2014). Effect of Public Investment on Economic Growth in Bangladesh: An Econometric Analysis. *Journal of Economics and Sustainable Development*, 5(22), 37-50.

Watanabe, M. (2013). Minimum Wage, Public Investment, Economic Growth. *Theoretical Economics Letters*, 3, 288-291.

Table 1
Unit Root Test

	ADF		ADF	
Variables	C	First Difference	C, T	First Difference
PI	- 4.62 (1)	-1.44*** (1)	- 4.41 (1)	-3.38***(1)
EG	- 4.95 (1)	-1.42*** (1)	- 6.58 (1)	-3.56** (1)

Notes: i) The ADF test is carried out by replacing X_t with PI_t and EG_t in equation (1); ii) C = constant term included in the unit root test, C,T = constant and trend term included in unit root test; iii) Figures within parentheses indicate lag lengths chosen by the Akaike information criterion (AIC); iv) ***, and ** denote rejection of the null hypothesis of unit root at the 1%, and 5% levels respectively.

Table 2
Engle-Granger and Cointegrating Regression Durbin-Watson (CRDW) Test

Cointegrating Regressions	R^2	CRDW	ADF
$EG_t = 6.03 + 0.31\ PI_t$	0.61	1.99	-1.62 ***(1)
$PI_t = 10.22 + 0.43\ EG_t$	0.61	1.54	-1.94 ***(1)

Notes: i) The Engle-Granger two-step method is undertaken by substituting Y_t and X_t by EG_t and PI_t in equations (2) and (3) respectively; ii) Figures within parentheses indicate lag lengths chosen by the Akaki information criterion (AIC); iii) The null hypothesis of unit root in the residuals can be rejected at the 1% level; iv) The critical values for the CRDW are 1.00, 0.78 and 0.69 at the significance levels of 1%, 5% and 10%, respectively (Sargan and Bhargava, 1983).

Table 3
Causality Results Based on Error Correction Model (ECM)

	Dependent Variables	
Explanatory Variables	ΔEG_t	ΔPI_t
Constant	0.01 (0.02)	0.11 (0.93)
EC Term	- 0.95 (-3.06)***	0.05 (1.35)
ΔEG_{t-1}	0.14 (0.61)	-0.01 (-0.64)
ΔEG_{t-2}	-0.23 (-1.48)	-0.05 (-1.16)
ΔPI_{t-1}	0.67 (1.85)*	0.21 (1.25)
ΔPI_{t-2}	0.39 (3.36)***	0.12 (1.01)

Notes: i) The Granger Causality test is performed by replacing Y_t with EG_t and X_t with PI_t in equations (5) and (6) respectively; ii) Figures in the parenthesis are z-statistics; ii) The optimal lag length has been considered to be 3 according to the Akaiki information Criterion (AIC); (iii) *** and * indicate significant at the 1% and 5% levels respectively; (iv) Figures corresponding to the EC terms are the coefficients of the error correction terms in the relevant equations.