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Health Expenditure and Gross Domestic Product in Bangladesh: *A Time Series Analysis*

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Abstract: *The paper explores the time series behaviour of health expenditure and gross domestic product in Bangladesh during the period 1981-2007. The Augmented Dickey Fuller (ADF) test has been applied to asses whether the data suffer from unit root problem. Unit root test results indicate that both health expenditure and gross domestic product are non stationary. Granger causality test has been used to identify the direction of causality between the variables. The results show that there exists one-way causality running from gross domestic product to health expenditure. The Johansen cointegration technique is employed to sift the long run relationship between the variables. The findings show that there exists a long run relationship between the variables. Finally error correction model is used to analyse the short-run behaviour of the variables.*

1.0 Introduction

Expenditure on health is one of the most crucial issues that needs to be adressesd for its universality of appeal in an underdeveloped country like Bangladesh. In view of the growing population, health expenditure is increasing with the growing gross domestic product which can play a vital role in maintaining everburdening healthcare system but there is a great apprehension whether this increment has been a feed back effect. Recently the relationship between health expenditure and gross domestic product has been a major concern for health economists because recognising the basic determinants of resource allocation on health care at national level might sugnificantly help policy makers to utilize the resources more efficiently. Time series analysis between health expenditure and gross domestic product have also been focus of research in order to understand the key determinants of health expenditure and

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such state of art knowledge can play a pivotal role from the policy formulation point of view. Cointegration and direction of causation between health expenditure and gross domestic product have also been important instrument of policy implications for health care planning and development since 1980's (Newhouse,1977). If there exists unidirectional Granger causality running from GDP to health expenditure, it may be implied that health care expenditure may be increased without deteriorating economic growth of the economy. On the contrary, if unidirectional causality running from health expenditure, reducing health expenditure lead to plunge in GDP. In general, the overwhelming majority of the variation in health care expenditure can be explained by gross domestic product. Most studies show that there is a positive correlation between gross domestic product and health care expenditure of any contury which are based on country-by-county and panel data. Now a days, health economists have devoted a great deal of attention to analyze the time series pattern of health care expenditure and GDP in different countries. There is an extended version of literature on the issue of health expenditure and gross domestic product. Almost all the studies showed unanimous results examining different data series.

MacDonald and Hopkins (2002) analyzed the unit root properties of health care expenditure and GDP for OECD countries. They found that both HCE and GDP are non-stationary and a co-integrating relationship between HCE and GDP.

Kiymaz *et.al.* (2006) argued that all series under consideration are nonstationary at level form but become stationary after differencing. There are cointegrating relationships between the health care expenditure and gross domestic product. They also found that there is one way causality running from income to various definitions of the health care expenses.

Gerdtham and Lothgren (2000) observed that health expenditure and GDP are non stationary and cointegrated by using country-by-country and panel tests for the period 1960-1997 of 21 OECD countries.

Hansen and King (1996) found that there is no long-run relationship between health care expenditure, GDP, and a selection of non-income variables or between HCE and GDP alone for most OECD countries. They also observed that panel data estimations of the GDP and health expendidure may be spurious.

Johnson *et.al.* (1992) showed that national health care expenditure is dependent on per capita gross domestic product, level of urban development and some other health related factors for 19 industrializd countries.

However, there has not been any study on the relationship between health expenditure and gross domestic product in Bangladesh. For this reason this study is undertaken to fill this vacuum.

1.1 Objectives

The main objective of this paper is to examine the time series behaviour of health expenditure and gross domestic product during the period 1981 to 2007.

2.0 Methodology

2.1 Sources of Data

The secondary data used in this paper are on health expenditure (HE) and gross domestic product (GDP), which is a proxy to economic growth for the period 1981 to 2007. The data on health expenditure are taken from various issues of key indicators for Asia and the Pacific by Asian Development Bank and the data on gross domestic product are also taken from various issues of Bangladesh Bureau of Statistics (BBS) and Bangladesh Economic Review and key indicators for Asia and the Pacific by Asian Development Bank. In this study, health expenditure(y) and gross domestic product (x) are measured in billion taka. The gross domestic product is defined as the money value of all final goods and services in a particular year and the health expenditure is the sum of general government health expenditure in a given year calculated in national currency units in current prices. On the other hand, health expenditure is measured in terms of billion taka and gross domestic product is measured in billion taka.

Table-1: Health Expenditure and Gross Domestic Product of Bangladesh, 1981 to 2007

Year	Health Expenditure (Billion Taka)	Gross Domestic Product (Billion Taka)
1981	1.5	231.4
1982	2.1	350.9
1983	2.4	395.5
1984	2.9	475.2
1985	3.7	548.5
1986	3.7	628.4
1987	3.9	726.8
1988	4.7	804.9
1989	5.5	889.1
1990	6.2	994.2
1991	7.2	1097.0
1992	8.3	1188.9
1993	11.1	1249.9
1994	14.2	1342.4
1995	15.4	1512.1
1996	15.8	1648.4
1997	17.7	1807.0
1998	14.8	2001.8
1999	21.1	2197.0
2000	23.2	2370.9
2001	22.8	2535.5
2002	23.9	2732.0
2003	24.8	3004.9
2004	28.9	3329.7
2005	31.3	3707.1
2006	34.6	4157.3
2007	39.5	4724.8

Source: Asian Development Bank, Key Indicators for Asia and the Pacific, 2008 and 1999
Government of Bangladesh, Bangladesh Economic Review, 2009, 2006 and 2005

Table 1 shows the health expenditure and gross domestic product of Bangladesh. The health expenditure of Bangladesh increased significantly from 1981 to 2007. It increased from 1.5 billion taka to 39.5 billion taka during 1981 to 2007. From 1981 to 2007 the gross domestic product of Bangladesh increased from 231.4 billion taka in 1981 to 4724.8 billion taka in 2007.

2.2 Empirical Analysis

2.2.1 Unit Root Test

A situation of practical relevance is observed when health expenditure and gross domestic product are interrelated and integrated but the researcher mistakenly believes there is a relationship between these variables. In time series analysis the data series must be stationary for standard regression analysis. If the data series are not stationary, standard distribution theory does not apply and the OLS estimators can be biased.

Moreover, the conventional interpretation of goodness of fit statistic is not valid if the dependent variable is nonstationary. So, the estimated regression suffers from spurious or nonsense results. In that case Durbin-Watson statistic is near to zero and R2 is greater than d statistic. The unit root test for time series have been widely used as a way of testing stationarity. For a stationary time series, mean, variance and autocovariance (at various lag) of that data remain the same over the period. This implies that the mean and variance do not vary over time.There are various approaches to test for stationary of data series, namely Dickey-Fuller (DF), Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips- Schmidt-Shin (KPSS) unit root test. Augmented Dickey-Fuller (ADF) unit root test is employed in this study. The test can be carried out with the following regressions:

$$\Delta y_t = \beta_1 + \delta y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta y_{t-i} + \varepsilon_i \quad (1)$$

$$\Delta x_t = \beta_1 + \delta x_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta x_{t-1} + \varepsilon_i \quad (2)$$

where, Δ is a first difference, and ε_i is a error term and it is serially independent.

When the Dickey-Fuller (DF) test is applied to equation (1) then it is called Augmented Dickey-Fuller (ADF) test. The Augmented Dickey-Fuller (ADF) test follows the same asymptotic distribution as the Dickey-Fuller (DF) statistic, so the same critical values can be used. For a unit root test, the null hypothesis that the unit root $\delta = 0$ or $\alpha = 1$. If the coefficient δ is statistically different from 0 or the coefficient $\alpha < 1$ then the null hypothesis that depandent variables contain a unit root is rejected.

2.2.2 Granger Causality

The concept of causality is introduced by Granger (1969). It shows how much of dependent variable can be explained by its past value and past value of the other variables. Granger causality implies causality in the prediction sense rather than in a structured sense. Causality equation can be written as follows:

$$x_t = \sum_{i=1}^{n} \alpha_i y_{t-i} + \sum_{j=1}^{n} \beta_j x_{t-j} + u_{1t} \quad (3)$$

$$y_t = \sum_{i=1}^{n} \lambda_i y_{t-i} + \sum_{j=1}^{n} \delta_j x_{t-j} + u_{2t} \quad (4)$$

where u_{1t} and u_{2t} are zero mean, serially uncorrelated, random disturbances, and t denotes the time period and i and j are the number of lags .

If α_i coefficients as a set are statistically different from zero i,e. $\sum \alpha_i \neq 0$, then it may be concluded that x depends on past values of y, hence changes in x are caused by hanges in y. The same is applicable for y causing x when $\sum \delta_j \neq 0$.

There are four possible outcomes of Granger test. These are given below:

i) Unidirectional causality: x Granger causes y, but not vice versa. When only $\sum \alpha_i = 0$ and $\sum \delta_j \neq 0$

ii) Unidirectional causality: y Granger causes x, but not vice versa. When only $\sum \alpha_i \neq 0$ and $\sum \delta_j = 0$

iii) Bi-directional causality: x Granger causes y and y Granger causes x. When both $\sum \alpha_i \neq 0$ and $\sum \delta_j \neq 0$

iv) Independence: neither variable Granger causes the other. When both $\sum \alpha_i = 0$ and $\sum \delta_j = 0$

2.2.3 Test of Cointegration

The concept of cointegration is proved to be instrumental technique in helping to distinguish between genuine and spurious rgression. From the strategic point of view, testing of cointegration is only one part for model building and it is justified in advancing further if there is cointegration. It is worth mentioning that cointegrating regression is not spurious, that is, if the variables health expenditure and gross domestic product are cointegrated then the regeression is not spurious. Moreover, if there is cointregration, one is justified in estimating not only equilibrium relationship but also the dynamic relationship that incorporates short-run adjustments to that equilibrium.The theory of cointegration developed in Granger (1987) and elaborated in Engle and Granger (1987) addresses this issue of integrating short-run dynamics with long-run equlibrium. Cointegration analysis is used to identify the long run relationship between the variables. If the individual time series are found to be integrated of same order after the unit root tests, then these variables may be cointegrated. Alternatively if the two or more series are themselves non-stationary, but a linear combination of them is stationary, then the series are said to be cointegrated. The cointegration test is to be applied only for the same order integrated services. Cointegration implies that the two integrated series never drift far apart from each other, that is they maintain an equilibrium. Cointegration of two or more data series suggest that there is a constant long-run relationship between them but there may be disequilibrium in the short run.

The long run relationship can be written as:

$$y_t = \beta_1 + \beta_2 x_t + u_t \quad (5)$$

The error u_t represents the deviations from long term relationship.

The disequilibrium error can be written as:

$$u_t = y_t - \beta_1 - \beta_2 x_t \quad (6)$$

If these deviation are stationary then the two series are having cointegrated relationship and estimation is not spurious. There are several methods available for conducting the cointegration test. The most widely used methods are the residual-based Engle-Granger test, the maximum likelihood-based Johansen test, and the Johansen-Juselius test. Johansen test is used to determine the cointegration vector in this study. The presence of distinct cointegration vectors can be obtained by determining the significance of the characteristic roots of Π. The Johansen test can be expressed as:

$$\Delta y_t = \mu + \sum_{i=1}^{k} \Gamma_i \Delta y_{t-i} + \Pi y_{t-k} + \varepsilon_t \quad (7)$$

where $\Pi = \sum_{i=1}^{k} A_i - I$ and $\Gamma_i = \sum_{J=i+1}^{k} A_j$

The null hypothsis for r cointegrating vectors is:

H_0: Π has a reduced rank r π k

Where Π is k×k matrix of unknown parameters Π. The reduce rank condition implies that the process Δy_t is stationary and y_t is non stationary. If Π is zero, there is no cointegration, and if Π has a full rank which implies that all the variables in y_t are sationary otherwise it has a unit root. In addition, if the rank of Π is between r and k, the y_t variables are cointegrated and there exist r cointegrating vectors.

Johansen (1988) uses trace test and the maximum eigenvalue test for determining the number of cointegrating vectors. These two tests are used to determine the significance of the number of characteristic roots that are not different from unity and can be expressed as follows:

$$\lambda_{trace}(r) = -T \sum \ln(1 - \lambda_i) \quad (8)$$

and

$$\lambda_{max}(r, r+1) = -T \sum \ln(1 - \lambda_{i+1}) \quad (9)$$

where λ_i is the estimated values of the characteristic roots obtained from the estimated Π matrix, r is the number of cointegrating vectors, and T is the number of observations.

2.2.4 Error Correction Model

Estimating the long-run equilibrium relationship as well as adjustment with the changing environment has to be modelled as an error correction model. Error correction model incorporates adjustment to lagged disequilibrium and contemporaneous changes to show how informative an economic theory practically is. Having established cointegration as a long-run property of the data obviously follows an error correction model with a view to reconcile short-run and long-run behaviour between gross domestic product and health expenditure as an appropriate system of manuevering dynamic adjustment. The error correction machanisim was first introduced by Sargan (1964) as a way of capturing adjustments in a dependent variable which depend not on the level of some explanatory variables but on the extent to which an explanatory variable deviated from an equilibrium relationship with the dependent variable. Later it was corrected for disequilibrium and popularized by Engle and Granger. The error correction model, however, is particularly powerful since it allows an analyst to estimate both short term and long run effects of explanatory time series variables. An error correction model is a dynamic system with the characteristics that the deviation of the current state from its long run relationship will be fed into its short run dynamics because it involves lags of the dependent and explanatory variables.The coefficient on error correction term indicates the speed of adjustment back to the long-run relationship among the cointegrating variables. The usual stationary regression theory applies to the error corection model. The error correction model can be written as:

$$\Delta y_t = \gamma_1 + \gamma_2 \Delta x_t + \gamma_3 u_{t-1} + \varepsilon_t \qquad (10)$$

where u_{t-1} is the one-period lagged value of the residual, and ε_t is the error term with zero mean and a constant variance. The coefficients of error correction model can be estimated by ordinary least squares method.

3.0 Empirical Findings

The first step of this paper is to examine the test of stationarity of the data by using ADF test. The second step is to identify the cointegration between the variables and the last step is to examine the existence and direction of causal relationship between the variables.

3.1 Unit Root Test

In this section, the time series properties of the data have been analyzed. The results of the Augmented Dickey-Fuller (ADF) unit root test are presented in Table 2. It is found that the data series are non-stationary at their level form. Because the ADF test statistics of their level form of the two variables are less than their respective critical values (in absolute terms). So, the null hypothesis that non-stationary is accepted at the 10 percent level of significance. The results of the Augmented Dickey-Fuller test can be presented in Table 2.

Table- 2: Results of the ADF Test for Unit Root

Variable	**Test Statistic (Level)**	**Test Statistic (First Difference)**
Gross Domestic Product (GDP)	2.243335	3.213752
Health Expenditure	2.256870	-4.586883
Significance Level	Critical Value	Critical Value
1 percent	-3.711457	-3.724070
5 percent	-2.981038	-2.986225
10 percent	-2.629906	-2.632604

Mackinnon critical values for rejection of hypothesis of a unit root.

The test is performed using EViews 4

The results of the first difference variables health expenditure and gross domestic product show that the ADF test statistics for the two variables are greater than the critical values at 10% level of significance (in absolute value). So, the null hypothesis that non stationary is easily rejected at the 10% level of significance. It can be said that the first difference of health expenditure and gross domestic product series does not have a unit root and the two variable series are stationary

3.2 Granger Causality

The Granger test is applied to determine the direction of causality between health expenditure and gross domestic product. The causality results are reported in Table 3. The result of Granger causality shows that the null hypothesis health expenditure does not Granger causes gross domestic product is not rejected because the estimated F value is insignificant. But the null hypothesis that gross domestic product does not Granger causes health expenditure is rejected at 5 percent level of significance because the estimated F value is significant.The results of the Granger causality test of health expenditure and gross domestic product series are given in Table 3.

Table-3: Granger Causality Test For Health Expenditure and Gross Domestic Product based on the Difference Data

Null hypothesis	**Observation**	**Lag**	**F Statistics**	**Probability**
Gross domestic product does not Granger cause health expenditure	24	2	4.97103	0.01835*
Health expenditure does not Granger cause gross domestic product	24	2	0.00426	0.99575

Notes: *donotes the level of significance at 1%

The test is performed using EViews 4

Therefore, Granger causality runs from one-way from gross domestic product to health expenditure without feedback effect. This means that gross domestic product leads to health expenditure with the absence of feedback effect in Bangladesh.

3.3 Cointegration

In this paper Johansen (1991) rank based cointegration test is carried out to sift the long-run relationship. The number of cointegrating vector is determined by using the trace and max-eigen value test. The results of cointegration is presented in Table 4 with lag 1 and intercept term.

Table 4. Johansen Cointegration Test

Null Hypothesis	**Alternative Hypothesis**	**Eigen value**	**Trace Statistic**	**5% Critical value**	**1% Critical value**	**Max-Eigen Statistics**	**5% Critical value**	**1% Critical value**	**Hypothesis**
H_0: r = 0	H1: r =1	0.500564	24.591 59	15.41	20.04	16.66262	14.07	18.63	None**
H_0: $r \leq 1$	H1: r =2	0.281345	7.9289 72	3.76	6.65	7.928972	3.76	6.65	At most 1**

**denotes rejection of hypothesis at 1% significance level. Trace test indicates that 2 cointegrating equation(s) at both 5% and 1% significance level

The test is performed using EViews4

The results that appear in Table 4 suggest that the null hypothsis of no cointegration (H0:r =0) can be rejected at 1% level of significance in case of both the trace and max-eigen statistic due to the trace statistic and max-eigen value is greater than their critical value. In that case, there is a stable long-run relationship between health expenditure and gross domestic product. On the other hand the second row tests the null hypothesis of at most one cointegrating vectors (H0: r 1) can be rejected at 1 % level of significance in case of both the trace and max-eigen statistic which implies that these variables have with more than one cointegrating equation.

3.4 Error Correction Model

The error correction process is used to reconcile short-run and long-run behaviour among the variables.The results of error correction model can be presented in the following manner:

$$\Delta y_t = 0.265129 + 0.007091\Delta x_t - 0.436183\hat{u}_{t-1}$$

t = (0.542336) (3.10689) (-2.492296)

$R^2 = 0.413202$ d = 2.065717

The aforesaid regression establishes the relation between the change in health expenditure to the change in gross domestic product and the equilibrating error in the lag period.The results show that short-run change in gross domestic product have significant positive effect on health expenditure and that about 0.43 of the discrepancy in equilibrium will be eliminated or corrected in each quarter and the coefficient of adjusted term is significant at 5 percent level because the p value is 0.0203. The coefficient of first differenced gross domestic product is statistically significant at 1 percent level. The results of error correction model show that the independent variable explains over 41 percent of variation in dependent variable. The results reveal that more than 43 percent of the deviation from the equilibrium level can be corrected for health expenditure in each period and in case of gross domestic product, the deviation from the equlibrium will be closed very speedily in the short period. The estimated results of the short-run dynamic error correction model demonstrate that two variables have expected apriori sign which indicates the speed of adjustment back to the long-run relationship between the variables.

4.0 Conclusions

This paper systematically examines the stationality, causality, cointegration, and error corection model of health exapenditure and gross domestic product in Bangladesh for the period 1981-2007. The Augmented Dickey-Fuller unit root test is applied to check stationarity of health expenditure and gross domestic product data series. Empirical findings show that health expenditure and gross domestic product are nonstationary at level form and integrated of order one. Johanson cointegration technique are applied to examine long-run relationship between health expenditure and gross domestic product. The results of cointegration reveal that there is a significant long-run relationship between health expenditure and gross domestic product. The results of error correction model reveal that more than 43 percent of the deviation from the equilibrium level can be corrected for health expenditure in each period and in case of gross domestic product, the deviation from the equlibrium will be closed very speedily in the short period. The causation between health expenditure and economic growth in Bangladesh is examined using the Granger causality test.The findings show that there exists one-way causality running from gross domestic product to health expenditure in Bangladesh without feedback effect. From this analysis it can be said that the health expenditure does not cause GDP growth and GDP appears to be the main factor in determining the level of health expenditure. Only about 1 percent of the GDP has been allocated to the health sector against the WHO target of 5 percent of GDP. The implications of the study suggest that GDP growth would lead to increase health expenditure in the country. As a policy implication the government should increase expenditure on health according to world standard level for better human resources development which will further enhance GDP to a great extent.

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